

# BB503/BB602 - R Training - Week III

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## R tips

- If you can't figure out how to solve an issue, Google is your friend. e.g., “how to calculate mode r”
- If you need help with the usage of a function, type `?function_name`. e.g. `?quantile`
- If you get an error, and cannot fix it. C/P the error into Google. Someone else most likely had a similar problem
- Some resources for learning the basic syntax of R;
  - Codecademy - <https://www.codecademy.com/learn/learn-r>
  - RStudio Cloud Primers - <https://rstudio.cloud/learn/primers>
  - Dataquest - <https://www.dataquest.io/course/introduction-to-data-analysis-in-r/>
  - R for Data Science - <https://r4ds.had.co.nz/index.html>
- Interesting read: <https://www.dataquest.io/blog/learn-r-for-data-science/>
- Some resources you might want to follow:
  - R-Bloggers - <https://www.r-bloggers.com/>
  - STHDA - <http://www.sthda.com/english/>
  - Quick-R - <https://www.statmethods.net/>

## R Basics

### Conditional Statements

```
### simple conditional (Boolean) statements
```

```
3 == 3
```

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

```
3 == 4
```

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

```
3 != 4
```

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

```
3 > 4
```

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

```
3 <= 4
```

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

```
5 %% 3 == 0
```

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

```
5 %% 3 == 2
```

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

```
### multiple conditions
```

```
# and
```

```
3 == 3 & 3 > 4
```

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

```
# or
```

```
3 == 3 | 3 > 4
```

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

```
# > 2 conditions
```

```
3 == 3 | (3 > 4 & 5 != 6)
```

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

```
!TRUE
```

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

We can use these conditions to selectively execute commands when these condition(s) are met:

```
# after a complex calculation X becomes 3
```

```
x <- 3
```

```
if (x == 3) {
```

```
  print("x is equal to 3")
```

```
  # other commands that should be executed if the statement is true go here
```

```
}
```

```
## [1] "x is equal to 3"
```

Using `else if` we can add even more conditions:

```
# after a complex calculation X becomes 5
```

```
x <- 5
```

```
if (x == 3) {
```

```
  print("x is equal to 3")
```

```
  # other commands that should be executed if this first statement is true go here
```

```
} else if (x > 3) {
```

```
  print("x is greater than 3")
```

```
  # other commands that should be executed if this second statement is true go here
```

```
}
```

```
## [1] "x is greater than 3"
```

Finally, using `else` we can execute any commands if none of the conditions are met:

```
# after a complex calculation X becomes 1
```

```
x <- 1
```

```
if (x == 3) {
```

```
  print("x is equal to 3")
```

```

    # other commands that should be executed if this first statement is true go here
} else if (x > 3) {
    print("x is greater than 3")
    # other commands that should be executed if this second statement is true go here
} else {
    print("x is less than 3")
    # other commands that should be executed if no condition is true go here
}

```

```
## [1] "x is less than 3"
```

## Loops

We may wish to execute certain commands repeatedly until a certain condition is met. For this purpose, we can use a while loop:

```

# initialize
current_number <- 1
while(current_number <= 10) {
    # execute any commands
    print(paste("Current #:", current_number))
    # update
    current_number <- current_number + 1
}

```

```

## [1] "Current #: 1"
## [1] "Current #: 2"
## [1] "Current #: 3"
## [1] "Current #: 4"
## [1] "Current #: 5"
## [1] "Current #: 6"
## [1] "Current #: 7"
## [1] "Current #: 8"
## [1] "Current #: 9"
## [1] "Current #: 10"

```

We may wish to execute certain commands repeatedly for a set amount of times. For this purpose, we can use a for loop:

```

for (i in 1:10) {
    # execute any commands
    print(paste("Current #:", i))
}

```

```

## [1] "Current #: 1"
## [1] "Current #: 2"
## [1] "Current #: 3"
## [1] "Current #: 4"
## [1] "Current #: 5"
## [1] "Current #: 6"
## [1] "Current #: 7"
## [1] "Current #: 8"
## [1] "Current #: 9"
## [1] "Current #: 10"

```

## Putting it all together - The Fizz Buzz Game

Fizz buzz is a group word game for children to teach them about division. Players take turns to count incrementally,

- replacing any number divisible by 3 with the word “fizz”
- replacing any number divisible by 5 with the word “buzz”

```
for (i in 1:100) {  
  if (i %% 3 == 0) {  
    print("Fizz")  
  } else if (i %% 5 == 0) {  
    print("Buzz")  
  } else {  
    print(i)  
  }  
}
```

```
## [1] 1  
## [1] 2  
## [1] "Fizz"  
## [1] 4  
## [1] "Buzz"  
## [1] "Fizz"  
## [1] 7  
## [1] 8  
## [1] "Fizz"  
## [1] "Buzz"  
## [1] 11  
## [1] "Fizz"  
## [1] 13  
## [1] 14  
## [1] "Fizz"  
## [1] 16  
## [1] 17  
## [1] "Fizz"  
## [1] 19  
## [1] "Buzz"  
## [1] "Fizz"  
## [1] 22  
## [1] 23  
## [1] "Fizz"  
## [1] "Buzz"  
## [1] 26  
## [1] "Fizz"  
## [1] 28  
## [1] 29  
## [1] "Fizz"  
## [1] 31  
## [1] 32  
## [1] "Fizz"  
## [1] 34  
## [1] "Buzz"  
## [1] "Fizz"  
## [1] 37
```

```
## [1] 38
## [1] "Fizz"
## [1] "Buzz"
## [1] 41
## [1] "Fizz"
## [1] 43
## [1] 44
## [1] "Fizz"
## [1] 46
## [1] 47
## [1] "Fizz"
## [1] 49
## [1] "Buzz"
## [1] "Fizz"
## [1] 52
## [1] 53
## [1] "Fizz"
## [1] "Buzz"
## [1] 56
## [1] "Fizz"
## [1] 58
## [1] 59
## [1] "Fizz"
## [1] 61
## [1] 62
## [1] "Fizz"
## [1] 64
## [1] "Buzz"
## [1] "Fizz"
## [1] 67
## [1] 68
## [1] "Fizz"
## [1] "Buzz"
## [1] 71
## [1] "Fizz"
## [1] 73
## [1] 74
## [1] "Fizz"
## [1] 76
## [1] 77
## [1] "Fizz"
## [1] 79
## [1] "Buzz"
## [1] "Fizz"
## [1] 82
## [1] 83
## [1] "Fizz"
## [1] "Buzz"
## [1] 86
## [1] "Fizz"
## [1] 88
## [1] 89
## [1] "Fizz"
## [1] 91
```

```
## [1] 92
## [1] "Fizz"
## [1] 94
## [1] "Buzz"
## [1] "Fizz"
## [1] 97
## [1] 98
## [1] "Fizz"
## [1] "Buzz"
```

For a variation of the game, any number divisible by both 3 and 5 is replaced with the word “fizzbuzz”

```
for (i in 1:100) {
  if (i %% 3 == 0 & i %% 5 == 0) {
    print("FizzBuzz")
  } else if (i %% 3 == 0) {
    print("Fizz")
  } else if (i %% 5 == 0) {
    print("Buzz")
  } else {
    print(i)
  }
}
```

```
## [1] 1
## [1] 2
## [1] "Fizz"
## [1] 4
## [1] "Buzz"
## [1] "Fizz"
## [1] 7
## [1] 8
## [1] "Fizz"
## [1] "Buzz"
## [1] 11
## [1] "Fizz"
## [1] 13
## [1] 14
## [1] "FizzBuzz"
## [1] 16
## [1] 17
## [1] "Fizz"
## [1] 19
## [1] "Buzz"
## [1] "Fizz"
## [1] 22
## [1] 23
## [1] "Fizz"
## [1] "Buzz"
## [1] 26
## [1] "Fizz"
## [1] 28
## [1] 29
## [1] "FizzBuzz"
## [1] 31
```

```
## [1] 32
## [1] "Fizz"
## [1] 34
## [1] "Buzz"
## [1] "Fizz"
## [1] 37
## [1] 38
## [1] "Fizz"
## [1] "Buzz"
## [1] 41
## [1] "Fizz"
## [1] 43
## [1] 44
## [1] "FizzBuzz"
## [1] 46
## [1] 47
## [1] "Fizz"
## [1] 49
## [1] "Buzz"
## [1] "Fizz"
## [1] 52
## [1] 53
## [1] "Fizz"
## [1] "Buzz"
## [1] 56
## [1] "Fizz"
## [1] 58
## [1] 59
## [1] "FizzBuzz"
## [1] 61
## [1] 62
## [1] "Fizz"
## [1] 64
## [1] "Buzz"
## [1] "Fizz"
## [1] 67
## [1] 68
## [1] "Fizz"
## [1] "Buzz"
## [1] 71
## [1] "Fizz"
## [1] 73
## [1] 74
## [1] "FizzBuzz"
## [1] 76
## [1] 77
## [1] "Fizz"
## [1] 79
## [1] "Buzz"
## [1] "Fizz"
## [1] 82
## [1] 83
## [1] "Fizz"
## [1] "Buzz"
```

```
## [1] 86
## [1] "Fizz"
## [1] 88
## [1] 89
## [1] "FizzBuzz"
## [1] 91
## [1] 92
## [1] "Fizz"
## [1] 94
## [1] "Buzz"
## [1] "Fizz"
## [1] 97
## [1] 98
## [1] "Fizz"
## [1] "Buzz"
```

## Functions

Functions are modules of code that accomplish a specific task. They take in data, process it, and return a result.

The exponentiation function  $f(x, y) = x^y$  can be coded in R as:

```
pow <- function(x, y) {
  output <- x ^ y
  return(output)
}
```

E.g.,  $f(2, 3) = 2^3 = 8$ :

```
pow(2, 3)
```

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

Here,

- `pow` is the name of the function, and it is arbitrary
- `function(...)` is for defining any function in R
- `x` and `y` are input names (arguments), and names are arbitrary
- `output` is the object that stores the result (not created globally)
- `return` is the function for outputting the result

We may define default values for the arguments:

```
pow2 <- function(x, y = 2) {
  output <- x ^ y
  return(output)
}
pow2(3)
```

```
## [1] 9
```

```
pow2(3, 3)
```

```
## [1] 27
```



## Another Solution for Fizz-Buzz

```
fizz_buzz <- function(number) {  
  if (number %% 3 == 0 & number %% 5 == 0) {  
    return("FizzBuzz")  
  }  
  
  if (number %% 3 == 0) {  
    return("Fizz")  
  }  
  
  if (number %% 5 == 0) {  
    return("Buzz")  
  }  
  return(number)  
}
```

```
fizz_buzz(2)
```

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

```
fizz_buzz(3)
```

```
## [1] "Fizz"
```

```
fizz_buzz(5)
```

```
## [1] "Buzz"
```

```
fizz_buzz(15)
```

```
## [1] "FizzBuzz"
```

```
sapply(1:100, fizz_buzz)
```

```
##   [1] "1"      "2"      "Fizz"   "4"      "Buzz"   "Fizz"  
##   [7] "7"      "8"      "Fizz"   "Buzz"   "11"     "Fizz"  
##  [13] "13"     "14"     "FizzBuzz" "16"     "17"     "Fizz"  
##  [19] "19"     "20"     "Buzz"   "22"     "23"     "Fizz"  
##  [25] "25"     "26"     "Fizz"   "28"     "29"     "FizzBuzz"  
##  [31] "31"     "32"     "Fizz"   "34"     "Buzz"   "Fizz"  
##  [37] "37"     "38"     "Fizz"   "Buzz"   "41"     "Fizz"  
##  [43] "43"     "44"     "FizzBuzz" "46"     "47"     "Fizz"  
##  [49] "49"     "50"     "Buzz"   "52"     "53"     "Fizz"  
##  [55] "55"     "56"     "Fizz"   "58"     "59"     "FizzBuzz"  
##  [61] "61"     "62"     "Fizz"   "64"     "Buzz"   "Fizz"  
##  [67] "67"     "68"     "Fizz"   "Buzz"   "71"     "Fizz"  
##  [73] "73"     "74"     "FizzBuzz" "76"     "77"     "Fizz"  
##  [79] "79"     "80"     "Buzz"   "82"     "83"     "Fizz"  
##  [85] "85"     "86"     "Fizz"   "88"     "89"     "FizzBuzz"  
##  [91] "91"     "92"     "Fizz"   "94"     "Buzz"   "Fizz"  
##  [97] "97"     "98"     "Fizz"   "Buzz"
```

```
?sapply
```

## The apply family of functions

```
mat <- matrix(rnorm(30), nrow = 5, ncol = 6)
sample_types <- c("Tumor", "Tumor", "Tumor", "Control", "Control")
```

```
?apply
```

```
# apply mean to each row
```

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

```
## [1] -0.067039  0.678174  0.168078 -0.533978  0.385003
```

```
# apply sd to each column
```

```
apply(mat, 2, sd)
```

```
## [1] 1.50306 1.26428 1.41083 0.92093 1.02926 0.40689
```

```
# Apply a function over a list or vector
```

```
sapply(mat[1, ], function(x) x^3)
```

```
## [1] 3.9653e-03 -9.7354e-02 6.4505e-01 -9.7673e-02 6.9723e-05 -1.6201e-01
```

```
# Apply a function over a ragged array
```

```
# mean values of 1st variable per sample type
```

```
tapply(mat[, 1], sample_types, mean)
```

```
## Control    Tumor
```

```
## -1.35809  0.94086
```

## Probability

### Basic Simulation - Flipping a fair coin

```
# by this you get the same answer all the time
set.seed(321)
```

```
# number of trials
```

```
n <- 5000
```

```
# tossing coins
```

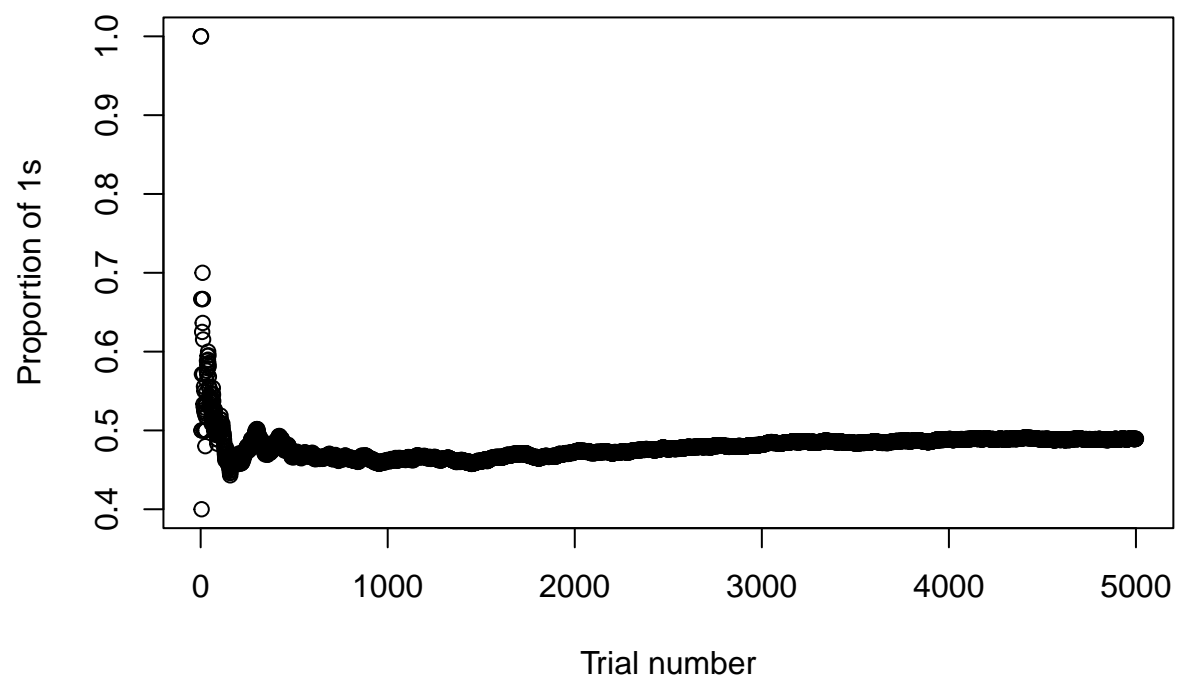
```
results <- c() # to store results
```

```
average_at_i <- c() # to store averages (will approximate 0.5)
```

```
for (i in 1:n) {
  current_res <- sample(c(0, 1), 1)
  results <- c(results, current_res)
  average_at_i <- c(average_at_i, mean(results))
}
```

```
# plot resulting averages by each trial
```

```
plot(average_at_i, xlab = "Trial number", ylab = "Proportion of 1s")
```



```
plot(average_at_i, xlab = "Trial number", ylab = "Proportion of 1s", type = "l")  
abline(h = 0.5, col = "red")
```

