Summary Sheet

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Class 5

data.table computations

Here are some common computations that can be performed using data.table:

- **Subsetting:** You can subset data.table based on certain conditions using the square bracket [] notation. For example, to select rows where a certain column value is greater than a threshold, you can use:

```
dt <- data.table(X = 1:10, Y = letters[1:10])
dt
```

```
    X Y
 1:  1 a
 2:  2 b
 3:  3 c
 4:  4 d
 5:  5 e
 6:  6 f
 7:  7 g
 8:  8 h
 9:  9 i
10: 10 j
```

```
subset <- dt[X > 5]
subset
```

```
   X Y
1:  6 f
2:  7 g
3:  8 h
4:  9 i
5: 10 j
```

- **Aggregation:** you can compute summary statistics like mean, sum, count, etc., grouped by one or more columns. For example, to calculate the average value of column "x" for each unique value in column "y," and count the number of occurences of each group, you can use the `by` argument:

```
dt <- data.table(x = 1:10, y = rep(c("a","b"),5))
dt
```

```
    x y
 1:  1 a
 2:  2 b
 3:  3 a
 4:  4 b
 5:  5 a
 6:  6 b
 7:  7 a
 8:  8 b
 9:  9 a
10: 10 b
```

```
summary <- dt[, .(mean_x = mean(x), count = .N), by = y]
summary
```

```
   y mean_x count
1: a      5     5
2: b      6     5
```

You can also group by a *condition* rather than a column! For example, lets say we wanted to calculate the average value of column "x" for each unique value in column "y," and count the number of occurrences for each group based on instances where "x" was greater/less than 4.

```
dt[, .(mean_x = mean(x), count = .N), .(x >4)]
```

```
   x > 4 mean_x count
1: FALSE    2.5     4
2:  TRUE    7.5     6
```

- **Sorting:** You can sort a data.table based on one or more columns using the `order()` function. For example, to sort a data.table in ascending order based on column "x"

```
sorted <- dt[order(x)]
sorted
```

```
    x y
 1:  1 a
 2:  2 b
 3:  3 a
 4:  4 b
 5:  5 a
 6:  6 b
 7:  7 a
 8:  8 b
 9:  9 a
10: 10 b
```

can perform computations on multiple columns in a table using the lapply() function. For example,

```
dt_2 <- data.table(X = rep(c("a","b"),5), Y = 11:20, Z = 21:30)
dt_2
```

```
    X  Y  Z
 1: a 11 21
 2: b 12 22
 3: a 13 23
 4: b 14 24
 5: a 15 25
 6: b 16 26
 7: a 17 27
 8: b 18 28
 9: a 19 29
10: b 20 30
```

```
dt_2[, lapply(.SD, mean), by =X]
```

```
   X  Y  Z
1: a 15 25
2: b 16 26
```

Here, the **`lapply(.SD, mean)`** applies the **`mean()`** function to each column in the Subset of Data (**`.SD`**) for each group defined by the "X" column. The result is returned as a new data.table with the columns "X", "Y", and "Z" and their respective means for each group.

Functions

Functions provide a more robust and versatile approach to automating repetitive tasks compared to copy-and-pasting. Creating a function offers three significant benefits over copy-and-paste:

1. By assigning a descriptive name to a function, you enhance the comprehensibility of your code, making it easier for others to understand its purpose.
2. When requirements evolve, modifying a function in a single location suffices, instead of having to update multiple instances scattered throughout the code.
3. Copy-and-paste errors, such as forgetting to update a variable name in one instance but not in another, are eliminated when using functions, ensuring greater accuracy and reliability.

Basic function structure

```
function_name <- function(arguments){

some sort of operation you wish to perform

return(output)

}
```

3 main components:

1. name of function
2. inputs needed (also known as arguments)
3. body of the function that performs the operation

For example, lets say we wanted to create a function that calculates the square of a number.

```
square <- function(num) {
  result <- num^2
  return(result)
}
square(2)
```

```
[1] 4
```

Loops

Iteration is an additional technique that aids in minimizing redundancy by allowing you to perform identical operations on multiple inputs. It serves as a valuable tool when you encounter scenarios requiring repetitive actions on various elements.

Basic loop structure

For loops

```
for(sequence to iterate over){

<code to execute>

}
```

While loops

```
while(iterator condition){

<code to execute>

}
```

While loop	**For loop**
repeatedly executes a block of code as long as a specified condition remains true.	repeatedly executes a block of code for a **specific number of iterations.**
The **number of iterations is not predetermined, and the loop continues until the condition is no longer satisfied**.	It takes on each value in the specified sequence, and the code block is executed for each iteration

Example of while loop:

```
x <- 1
while (x <= 3) {
  print(x)
  x <- x + 1
}
```

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

Example of for loop:

```
for (x in 1:3) {
  print(x)
}
```

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

To save the output of a loop into a vector, you can initialize an empty vector before the loop and then append the desired values to the vector within each iteration of the loop

```
# Initialize empty vector
output_vector <- c()

# Perform the loop and save output into the vector
for (i in 1:3) {
  output <- i*2
  output_vector <- c(output_vector, output) #append to vector
}
output_vector
```

```
[1] 2 4 6
```

If/else

If/else statements allows you to execute different blocks of code based on a specific condition.

Basic condition structure

```
if(condition){

<code to execute if condition is TRUE>

}``else{
```

```
<code to execute if condition is FALSE>

}
```

can combine multiple conditions:

Operator	Use
||	condition 1 OR condition 2
&&	condition 1 AND condition 2

`any()` to find out if any of the conditions are true

`all()` to find out if all the conditions are true

`ifelse()` function writes out the condition in a single line

for example, if we wanted to characterize numbers as odd or even

```
x <- 1:5
if_else(x%%2 == 0, "Even", "Odd")
```

```
[1] "Odd"  "Even" "Odd"  "Even" "Odd"
```

```
#if number is divisable by 2, return odd, else return even
```

`case_when()` function to write out multiple conditions

for example, if we wanted to assign letter grades based on numeric scores.

```
grade <- c(90,70,60,50,40)
case_when(
  grade >= 90 ~ "A",
  grade >= 70 ~ "B",
  grade >= 60 ~ "C",
  grade >= 50 ~ "D",
  TRUE ~ "Fail"
)
```

```
[1] "A"    "B"    "C"    "D"    "Fail"
```

Here,

- If the grade is greater than or equal to 90, it is assigned the letter grade “A”.
- If the grade is between 70 and 89 (inclusive), it is assigned the letter grade “B”.
- If the grade is between 60 and 69 (inclusive), it is assigned the letter grade “C”.
- If the grade is between 50 and 59 (inclusive), it is assigned the letter grade “D”.

- For any other grade, the condition `TRUE` is used as a catch-all, and the letter grade "Fail" is assigned.

Map

The `map()` family of functions from the `purrr library` allows you to apply a function to each element of a list or vector, and return the results in a new list.

- `map()` for lists. Note, `lapply()` is identical in functionality to `map()`
- `map_lgl()` for logical vectors
- `map_int()` for integer vectors
- `map_dbl()` for double vectors
- `map_chr()` for character vectors

Example of usage:

```
# Vector of numbers 1 to 5
numbers <- 1:5

# Square each number using map_dbl()
squared_numbers <- map_dbl(numbers, ~ .x^2)

# Print the squared numbers
print(squared_numbers)
```

```
[1]  1  4  9 16 25
```

Here, the `map_dbl()` function takes a numeric (double) vector to iterate over and apply the function to apply to each element. In this example, we use an anonymous function (`~ .x^2`) to square each element.

Note: *An anonymous function*, is a function defined without a specific name. Instead, it is defined inline within the code where it is needed. In the function above, we used the `~` (tilde) symbol followed by the expression `.x^2`. The `.x` represents the input parameter of the function.

We can also iterate over two lists simultaneously and apply a function to each corresponding pair of elements.

Example:

```
x <- list(100, 200, 300)
y <- list(10, 20, 30)
map2(x, y, ~ .x - .y)
```

```
[[1]]
[1] 90

[[2]]
```

```
[1] 180

[[3]]
[1] 270
```

In this example, we have two lists, `x` and `y`, each containing three elements. We want to calculate the difference between the corresponding elements of `x` and `y`.

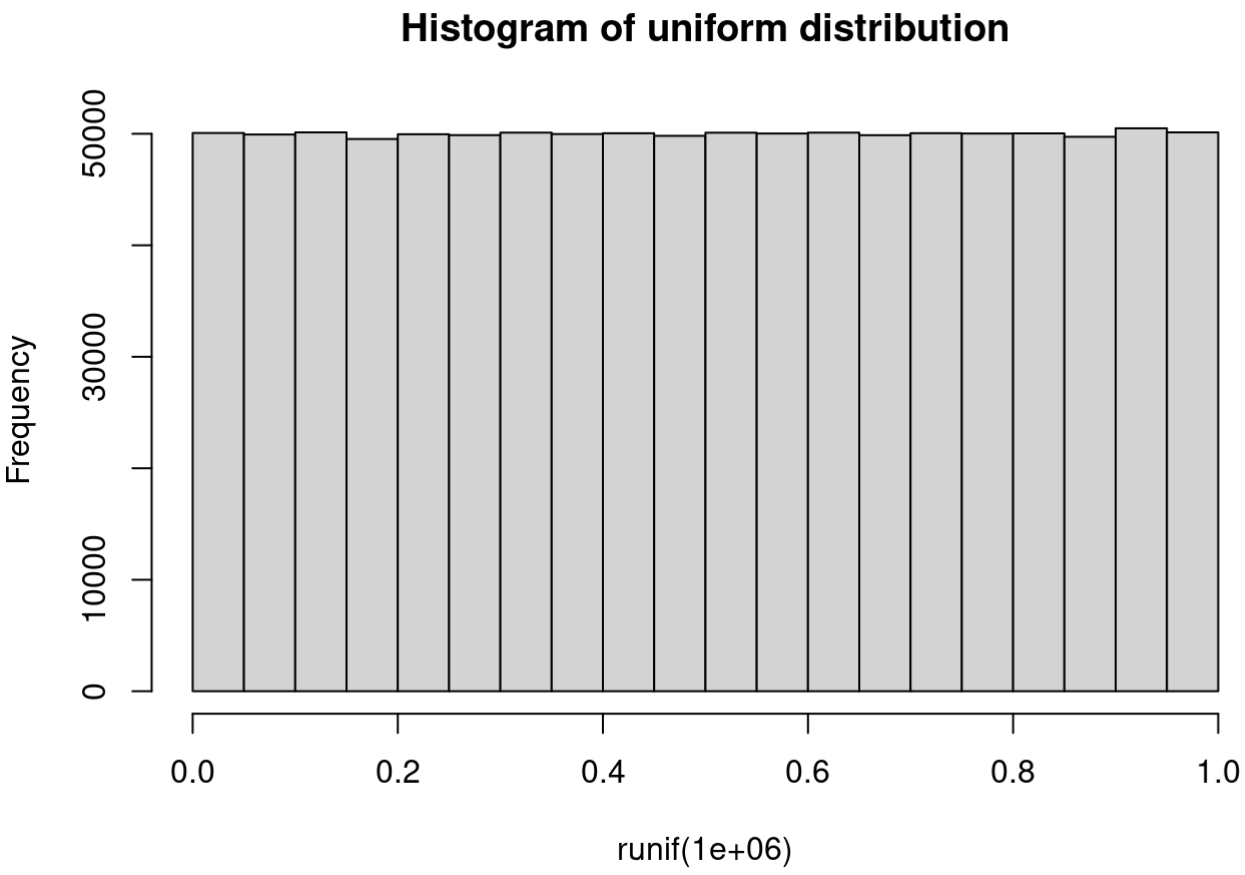
Here, the anonymous function (`~ .x - .y`) takes two arguments, `.x` and `.y`, which represent the corresponding elements from `x` and `y` in each iteration. The function subtracts `.y` from `.x` to calculate the difference.

Simulation

We can simulate random data from a uniform distribution using the `runif()` function. The `runif()` function generates random numbers from a uniform distribution with a specified **min and max.**

arguments = `n, min (default 0), max (default 1)`

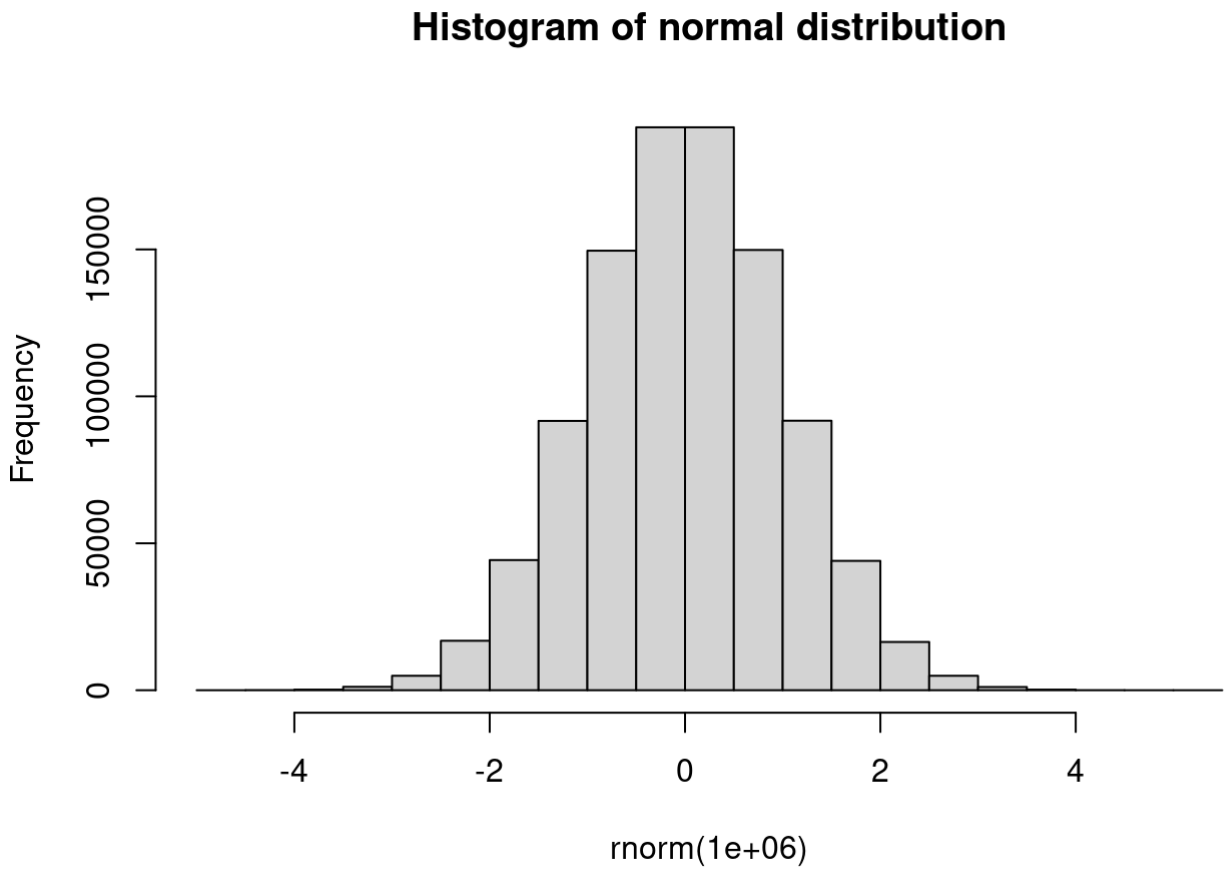
```r
hist(runif(1000000), main = "Histogram of uniform distribution")
```



We can simulate random data from a normal distribution using the `rnorm()` function. The `rnorm()` function generates random numbers from a normal distribution with a specified **mean and standard deviation**.

arguments = `n, mean (default 0), sd (default 1)`

```
hist(rnorm(1000000), main = "Histogram of normal distribution")
```



We set the seed using **`set.seed()`** to ensure reproducibility of the random data. By setting the seed to the same value, the random numbers generated will be the same each time the code is run.

`sample()` is used to generate random samples from a specified set of elements. It allows you to randomly select elements from a vector, shuffle the order of elements, or sample with replacement.

arguments = `vector, size, replace (default FALSE), prob (optional)`

For example,

```
# Vector of specified elements
x <- c("a", "b", "c", "d", "e")

# Randomly select two elements from the vector
random_selection <- sample(x, 2)

# Print the random selection
print(random_selection)
```

```
[1] "b" "c"
```

For sizes greater than the length of the vector, replacement must be set to TRUE or else an error will occur.

```
random_selection_without_rep <- sample(x, 100, replace = FALSE)
```

```
Error in sample.int(length(x), size, replace, prob): cannot take a sample larger than the population when 'replace = FALSE'
```