



# R Programming Workshop 2024

Join the R Programming Language Online Workshop hosted by **Tri-Chandra Research Group** and transform your research capabilities!



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## ▼ Basic of R Programming Language

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R is a popular programming language used for statistical computing and graphical presentation. Its most common use is to analyze and visualize data.

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### Why Use R?

- It is a great resource for data analysis, data visualization, data science and machine learning
- It provides many statistical techniques (such as statistical tests, classification, clustering and data reduction)
- It is easy to draw graphs in R, like pie charts, histograms, box plot, scatter plot, etc...
- It works on different platforms (Windows, Mac, Linux)
- It is open-source and free
- It has a large community support
- It has many packages (libraries of functions) that can be used to solve different problems

## ▼ R & RStudio Setup on Windows

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Watch this Video By Click on it

Ep-1



Studio®

# INSTALLATION R is PROGRAMMING of STATISTICS

SUSCRÍBETE



## ▼ Get Started

```
# Start With "Hello World"  
print("Hello World!")
```

→ [1] "Hello World!"

```
name <- "Janak Singh"  
print(name)
```

→ [1] "Janak Singh"

```
add = "KTM"
```

```
cat("Hello Universe! 😊")
```

→ Hello Universe! 😊

```
cat(name)
```

→ Janak Singh

```
paste("Hello, Elon Musk! 😊")
```

→ 'Hello, Elon Musk! 😊'

```
paste("Hello", "World", sep=",")
```

→ 'Hello,World'

## ▼ User Input

```
my_name <- readline(prompt = "What is Your Name?")  
class(my_name)
```

```
age <- readline(prompt="What is Your age?")  
my_age <- as.integer(age)  
class(my_age)
```

→ What is Your Name?Janak SIngh DHami  
'character'  
What is Your age?20  
'integer'

```
r <- 5
```

```
name <- readline()
```

→ Ram Shah

```
print(name)
```

→ [1] "Ram Shah"

```
n <- readline(prompt = "What is your Name?")  
paste("Your name is", n)
```

→ What is your Name?Janak Singh dhami  
'Your name is Janak Singh dhami'

## ▼ Comments in R

---

Comments can be used to explain R code, and to make it more readable.

Comments starts with a #. When executing code, R will ignore anything that starts with #.

```
# This is Comment  
print("How are you?") #This is also comment ⚡
```

```
→ [1] "How are you?"
```

```
# this is comment  
print("Hello Guys")
```

```
#print(name) # My name
```

```
→ [1] "Hello Guys"
```

## ▼ Variables in R

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Variables in *R* are used to store data values. You can assign values to variables using the <- operator or the = operator.

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Variable names must start with a letter and can include letters, numbers, and underscores.

### Rules for Variable Naming:

- Must start with a letter.
- Cannot contain spaces or special characters (except \_ and .).
- Case-sensitive (e.g., var and Var are different).

```
# name  
# Name  
# my_name  
# my-name - X  
# my_addr = "KTM"
```

```
# case-sensitive  
addr = "Nepal"  
Addr = "India"
```

```
print(addr)  
print(Addr)
```

```
→ [1] "Nepal"  
[1] "India"
```

```

# Assigning values to variables

x <- 10          # Numeric value
y <- 20.5        # Decimal/float value
name <- "Alice"  # Character value
isOk <- TRUE     # Logical value
com <- 3i+6      #Complex number

# Using variables
sum <- x + y

message <- paste("Name:", name, "| Sum:", sum, "| isOk:", isOk)

# Printing the result
print(message)

```

→ [1] "Name: Alice | Sum: 30.5 | isOk: TRUE"

- The ***paste()*** function concatenates strings.
- The ***print()*** function displays the output.

```

a <- 55L
b <- 55.5
hlo <- "Hii"
is <- TRUE
com <- 3i +7

```

```

class(a)
class(b)
class(hlo)
class(is)
class(com)

```

→ 'integer'  
 'numeric'  
 'character'  
 'logical'  
 'complex'

```

# check variable type
class(x)
class(y)
class(com)

```

```
→ 'numeric'  
  'numeric'  
  'complex'  
  
x <- 1L # integer  
y <- 2 # numeric  
  
# convert from integer to numeric:  
a <- as.numeric(x)  
  
# convert from numeric to integer:  
b <- as.integer(y)  
  
p <- 5  
class(p)  
→ 'numeric'  
  
q = as.integer(p)  
class(q)  
→ 'integer'
```

## Multiple Variables

R allows you to assign the same value to multiple variables in one line:

```
addr1 <- aad2 <- "KTM"  
  
print(addr1)  
print(aad2)  
→ [1] "KTM"  
[1] "KTM"  
  
# Assign the same value to multiple variables in one line  
var1 <- var2 <- var3 <- "Orange"  
  
# Print variable values  
var1  
var2  
var3
```

```
→ 'Orange'  
  'Orange'  
  'Orange'
```

## ▼ Basic Data Types

---

Basic data types in R can be divided into the following types:

- **numeric** - (10.5, 55, 787)

A numeric data type is the most common type in R, and contains any number with or without a decimal, like: 10.5, 55, 787

- **integer** - (1L, 55L, 100L, where the letter "L" declares this as an integer)

I  
Integers are numeric data without decimals. This is used when you are certain that you will never create a variable that should contain decimals. To create an integer variable, you must use the letter L after the integer value

- **complex** - (9 + 3i, where "i" is the imaginary part)

I  
A complex number is written with an "i" as the imaginary part

- **character** (a.k.a. string) - ("k", "R is exciting", "FALSE", "11.5")

- **logical** (a.k.a. boolean) - (TRUE or FALSE)

We can use the `class()` function to check the data type of a variable.

```
# numeric  
x <- 10.5  
class(x)  
  
# integer  
x <- 1000L  
class(x)  
  
# string/character  
name <- "Janak"  
class(name)  
  
# complex  
x <- 9i + 3
```

```
class(x)

# character/string
x <- "R is exciting"
class(x)

# logical/boolean
x <- TRUE
class(x)
```

```
→ 'numeric'
  'integer'
  'character'
  'complex'
  'character'
  'logical'
```

```
Name <- "Ram"
class(Name)
```

```
→ 'character'
```

```
y <- 5i +6
class(y)
```

```
→ 'complex'
```

## ▼ Math in R

---

In this section, we will discuss about how we use math by using arthmatic operators in R.

```
# add
5+6
```

```
# sub
55-6
```

```
# divide
58/4
```

```
# sq.
2**3
```

```
# mod
```

```
10%%3
```

```
→ 11  
49  
14.5  
8  
1
```

```
3+5
```

```
→ 8
```

```
55-5
```

```
→ 50
```

```
10/5
```

```
→ 2
```

```
2**3
```

```
→ 8
```

```
3*4
```

```
→ 12
```

```
x <- 55  
y <- x**2
```

```
sum <- x + y
```

```
print(sum)
```

```
→ [1] 3080
```

## Built-in Math Functions

```
# Max and Min  
max(2, 5, 66, 4444)  
min(2, 5, 66, 4444)
```

```
# Square root
sqrt(25)

→ 4444
  2
  5
```

```
marks <- c(25,67, 78, 55)

first <- max(marks)
print(first)
```

```
→ [1] 78
```

```
fail <- min(marks)
print(fail)
```

```
→ [1] 25
```

```
a <- 44
sq <- sqrt(a)
print(sq)
```

```
→ [1] 6.63325
```

## ceiling() and floor()

The **ceiling()** function rounds a number upwards to its nearest integer, and the **floor()** function rounds a number downwards to its nearest integer, and returns the result:

```
ceiling(1.4)
```

```
floor(1.4)
```

```
→ 2
  1
```

```
# abs()
# The abs() function returns the absolute (positive) value of a number:
abs(-74.7)
```

```
→ 74.7
```

```
t <- -56
```

```
abs(t)
```

```
→ 56
```

## ▼ String in R

```
fname <- "Janak" # First name of the user  
lname <- "Dhami" # last name of the user # Corrected the assignment to lname  
age <- 20 #age of the user  
isHealthy = TRUE #health condition of user
```

```
msg = paste("My name is", fname, lname, "& i am", age, "Years old.")
```

```
print(msg)
```

```
→ [1] "My name is Janak Dhami & i am 20 Years old."
```

```
first_name <- "Janak"  
second_name <- "Dhami"
```

```
full_name <- paste("My name is", first_name, second_name)
```

```
print(full_name)
```

```
→ [1] "My name is Janak Dhami"
```

```
nchar(full_name)
```

```
→ 22
```

```
# String Length  
nchar(msg)
```

```
→ 43
```

```
grepl("Dhami", full_name)
```

```
→ TRUE
```

```
# Check a String  
# Use the grepl() function to check if a character or a sequence of characters  
grepl("Janak", msg)  
  
→ TRUE  
  
my_name <- "Janak Singh Dhami"  
  
# Split the string into individual characters  
ind <- strsplit(my_name, ",")  
ind[1]  
  
→  
1. 'Janak' · 'Singh' · 'Dhami'
```

## Escape Characters

To insert characters that are illegal in a string, you must use an escape character.

---

Code	Result
\\	Backslash
\n	New Line
\r	Carriage Return
\t	Tab
\b	Backspace

```
intro <- "Nepal \"isbeautiful\" country"  
cat(intro)
```

```
→ Nepal "isbeautiful" country
```

```
my_intro <- "My name is Janak. from DCL."  
print(my_intro)
```

```
→ [1] "My name is Janak. from DCL."
```

```
my_intro <- "My \b name is \t Janak. \n from DCL."  
cat(my_intro)
```

→ Myname is Janak.  
from DCL.

```
# Erro Example
```

```
intro <- "Nepal is beautiful country located in "Kathmandu""
```

→ Error in parse(text = input): <text>:2:50: unexpected symbol  
1: # Erro Example  
2: intro <- "Nepal is beautiful country located in "Kathmandu  
^

Traceback:

```
# Solution
```

```
intro <- "Nepal is beautiful country located in \"Kathmandu\". \n Mt. Everest"  
cat(intro)
```

→ Nepal is beautiful country located in "Kathmandu".  
Mt. Everest is also located in Nepal.

## ▼ R Booleans / Logical Values

---

When you compare two values, the expression is evaluated and R returns the logical answer

```
10 > 9    # TRUE because 10 is greater than 9  
10 == 9   # FALSE because 10 is not equal to 9  
10 < 9    # FALSE because 10 is greater than 9
```

→ TRUE  
FALSE  
FALSE

```
10 == 9
```

→ FALSE

```
"Janak" == "janak"
```

→ FALSE

```
# Example
a <- 10
b <- 9

a > b

# Note: We will use these conditions in if...else.. conditional statements ↴
→ TRUE
```

### ***Q&A: What is Statement?***

## **▼ Operators in R**

---

Operators are used to perform operations on variables and values.

R divides the operators in the following groups:

- Arithmetic operators
- Assignment operators
- Comparison operators
- Logical operators
- Miscellaneous operators

```
a <- 55
b <- 10
```

### **Arithmetic Operators:**

Arithmetic operators are used with numeric values to perform common mathematical operations

```
# 1. addition
add <- a + b
```

```
# 2. Subtraction
sub <- a - b
```

```
# 3. Division
div <- a / b
```

```
# 4. Mode
```

```
mod <- b %% a  
  
# 5. Exponent  
ex <- 4^2  
  
cat(add, sub, div, mod, ex)  
  
→ 65 45 5.5 10 16
```

```
a <- 4  
b <- 6  
  
sum <- a + b  
sub <- a - b  
div <- a/b
```

### Assignment Operators:

Assignment operators are used to assign values to variables

```
my_var <- 3
```

```
my_var <<- 3 # <<- is a global assigner.
```

```
3 -> my_var
```

```
3 ->> my_var  
y = 55
```

```
my_var # print my_var
```

```
→ 3
```

```
a <- 5
```

```
55 -> num
```

```
print(a)  
print(num)  
  
→ [1] 5  
[1] 55
```

## **Comparison Operators:**

Comparison operators are used to compare two values

```
# 1. Equal to
```

```
10 == 10
```

```
# 2. Not Equal to
```

```
5 != 6
```

```
# 3. Greater than
```

```
6 > 4
```

```
# 4. less than
```

```
4 < 56
```

```
# 5. Greater than or equal to
```

```
# >=
```

```
# 6. Less than or equal to
```

```
# <=
```

```
→ TRUE  
TRUE  
TRUE  
TRUE
```

```
"Janak" != "janak"
```

```
→ TRUE
```

```
55>6
```

```
→ TRUE
```

Start coding or generate with AI.

## **Logical Operators:**

Logical operators are used to combine conditional statements

```
# 1. & and && are the Logical AND Operator
```

```
p <- 5
```

```
q <- 6  
  
p == 5 & q == 5  
  
# 2. | and || are the logical OR Operator  
p == 5 | q == 5
```

```
# 3. ! is the logical NOT Operator  
!q == 5  
!p == 5
```

```
→ FALSE  
TRUE  
TRUE  
FALSE
```

```
p <- 8  
a <- 5  
  
p > 6 & a < 6
```

```
→ TRUE
```

```
a == 5 | p > 10
```

```
→ TRUE
```

```
!a == 5
```

```
→ FALSE
```

### Miscellaneous Operators:

1. Miscellaneous operators are used to manipulate data

```
# : Creates a series of numbers in a sequence x <- 1:10  
num <- 1:5  
print(num)  
  
# %in% Find out if an element belongs to a vector x %in% y  
# wait for next topic
```

```
# %*% Matrix Multiplication x <- Matrix1 %*% Matrix2  
# wait for next topic
```

```
→ [1] 1 2 3 4 5
```

## ▼ Conditional Statements

---

Conditional statements let the program decide what to do based on whether something is true or false. They are used to make decisions and control what happens in your code.

### **if..else if ....else... Statement**

#### Syntax

```
if (conditions){  
  Positive Statements  
  Positive Statements  
}else if (conditions){  
  Positive statements  
}  
else{  
  False Statements  
}
```

```
a <- readline(prompt="Enter any number:")
```

```
→ Enter any number:67
```

```
if(a == 5){  
  print("Ohh, It's 5.")  
}
```

```
if(a == 6){  
  print("Ohh, It's 6.")  
}else{  
  print("Ohh, it's not 6.")  
}
```

```
→ [1] "Ohh, it's not 6."
```

```
a <- readline(prompt = "Enter your fav. Number:")  
if(a == 5){  
  print("Ohh, It's 5.")  
}else if( a==6){  
  print("It's 6.")  
}else if ( a == 0){  
  print("It's Zero.")  
}else{  
  print("Sorry!")  
}
```

→ Enter your fav. Number:45745754  
[1] "Sorry!"

```
height_of_janak <- 5.10  
height_of_sita <- 5.2  
height_of_ram <- 6
```

```
# if conditions  
if (height_of_ram >= height_of_sita){  
  cat("Height of Ram is greater than Sita.")  
}  
→ Height of Ram is greater than Sita.
```

```
# if...else... condition  
if (height_of_janak >= height_of_ram){  
  cat("Height of Janak is greater than Ram.")  
}else{  
  cat("Height of Ram is greater than Sita.")  
}
```

→ Height of Ram is greater than Sita.

```
# if....else if.....else... condition  
  
if(height_of_janak >= height_of_ram){  
  cat("Height of Janak is greater than Ram.")  
}else if(height_of_sita >= height_of_ram){  
  cat("Height of Sita is Grater than Ram")  
}else{  
  cat("Height of Ram is Grater than Janak and Sita.")  
}
```

→ Height of Ram is Grater than Janak and Sita.

```
# another example
```

```
a <- 5
```

```
b <- 6
```

```
if(a>b){  
  print("Ok")  
}else if(b>a){  
  print("not ok")  
} else{  
  "ho"  
}
```

→ [1] "not ok"

```
age <- readline(prompt="Enter your age:")  
age <- as.integer(age)  
if(age >= 18){  
  print("You are eligible for votting.")  
}else if(age < 18){  
  print("Sorry! your are not eligible for votting.")  
}else{  
  print("Sorry!")  
}
```

→ Enter your age:-3  
[1] "Sorry! your are not eligible for votting."

## Switch in R

---

A switch statement chooses one of several options to run based on the value of an input. It's like a menu where you pick a number or name, and the program performs the corresponding task.

```
switch(expression, option1, option2, ...)
```

```
a <- 3
```

```
res <- switch(a,  
"Hello",  
"Hii",  
"Fine",
```

```

"Go"
)
res

→ 'Fine'

# Example of switch statement
option <- 3

result <- switch(option,
  "Option 1 chosen",    # When option is 1
  "Option 2 chosen",    # When option is 2
  "Option 3 chosen"    # When option is 3
)

print(result)  # Output: "Option 2 chosen"
→ [1] "Option 3 chosen"

choice <- "C"

result <- switch(choice,
  A = "You chose A",
  B = "You chose B",
  C = "You chose C"
)

print(result)  # Output: "You chose B"
→ [1] "You chose C"

```

## ▼ Loops in R

---

Loops are used to repeat a block of code multiple times. They are helpful when you need to perform the same operation for multiple values or until a specific condition is met.

*R has two loop commands:*

1. **while** loops
2. **for** loops

---

### While Loop

---

A while loop keeps running as long as the condition is true.

```
while(conditions){  
    statements  
}
```

3 < 6

→ TRUE

a <- 2

```
while(a < 6){  
    print("Hello, How are you?")  
    a <- a + 1  
}  
  
print("Hello")
```

→ [1] "Hello, How are you?"  
[1] "Hello"

```
# while loop  
i <- 1  
while (i < 6) {  
    print(i)  
    i <- i + 1  
}
```

→ [1] 1  
[1] 2  
[1] 3  
[1] 4  
[1] 5

## For Loop

---

With the for loop we can execute a set of statements, once for each item in a vector, array, list, etc..

```
for(expressions){  
    statements  
}
```

```
x <- 1:5  
print(x)  
→ [1] 1 2 3 4 5
```

```
for(a in x){  
    print(a)  
}
```

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

```
a <- c("Janak", "Hari", "Shyam")
```

```
for(name in a){  
    print(name)  
}
```

```
→ [1] "Janak"  
[1] "Hari"  
[1] "Shyam"
```

```
# for loop  
for (i in 1:5){  
    print("NO")  
    break #Jump/exit from loop  
}
```

```
→ [1] "NO"
```

## nested loop

Start coding or generate with AI.

```
i <- 0  
while (i < 6) {
```

```
i <- i + 1
if (i == 3) {
  next #skip upcoming expression without terminating the loop
}
print(i)
}

→ [1] 1
[1] 2
```

## repeat Loop

A repeat loop runs until you use the break statement to exit it

---

```
repeat{
  statements
  if(exp.){
    break
  }
}
```

```
j <- 1
```

```
repeat{
  print("Hii")
  j <- j+1
  if(j > 3){
    break
  }
}
```

```
→ [1] "Hii"
[1] "Hii"
[1] "Hii"
```

```
# Example: Count to 5 using repeat
x <- 1
repeat {
  print(x)
  x <- x + 1
  if (x > 5) {
    break
  }
```

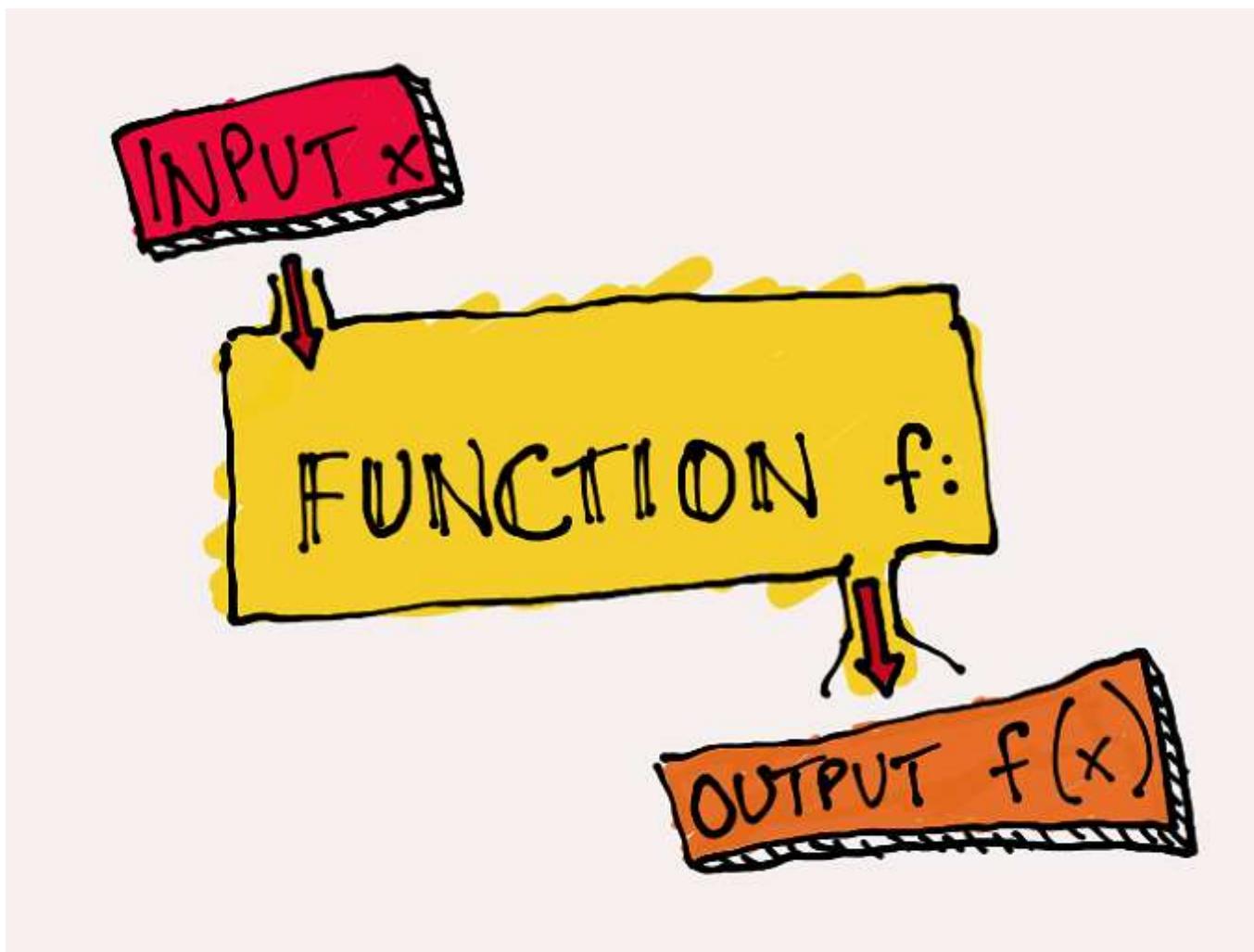
}

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

## ◀ Functions

---

1. A function is a block of code which only runs when it is called.
  2. You can pass data, known as parameters, into a function.
  3. A function can return data as a result.
- 



### Creating a Function

Syntax:

```
# function creating
function_name <- function(para1, para2,...) {
  Statements
  return()
}

# Function calling
function_name(para1, para2,...)

add <- function(a, b){
  sum <- a + b
  sub <- a - b
  print(sum)
  print(sub)
}

add(7, 9)
→ [1] 16
[1] -2

# functions
my_fun <- function(x,y){
  print(x)
  print(y)
}

#Calling
my_fun(4, 6)
→ [1] 4
[1] 6

# function with return value
# create function with name add
add <- function(a,b){
  sum <- a + b
  # sum # This line will return the value of 'sum'
  return(sum) #This is also correct
}

# calling function
```

```
result <- add(44, 88)

cat("The sum of a and b is:", result)

→ The sum of a and b is: 132
```

**Note:** In R, the last expression evaluated within a function is automatically returned.

## ▼ Data Structures

---

R provides several built-in data structures to store and manipulate data. Each data structure serves a specific purpose depending on the type and arrangement of the data.

---

### 1. Vector

- A one-dimensional array that holds elements of the same type (e.g., numeric, character, logical).
- Created using the `c()` function.

### 2. Matrix

- A two-dimensional array with rows and columns. All elements must be of the same type.
- Created using the `matrix()` function.

### 3. List

- A collection of elements that can be of different types (e.g., numeric, character, logical).
- Created using the `list()` function.

### 4. Data Frame

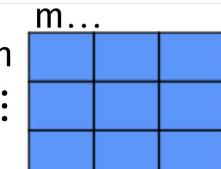
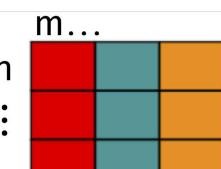
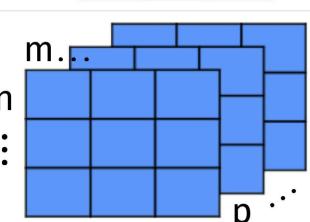
- A table-like structure where each column can have different types of data.
- Ideal for handling datasets.

### 5. Factors

- Used for categorical data and can store unique levels of a variable.
- Created using the `factor()` function.

### 6. Array

- A multi-dimensional array that can hold elements of the same type.
- Created using the `array()` function.

	Dimensions	Mode (data "type")	Example
<b>Vector</b>	1 	Identical	<code>c(10,0.2,34,48,53)</code>
<b>Matrix</b>	n 	Identical	<code>matrix(c(1,2,3, 11,12,13), nrow = 2, ncol = 3)</code>
<b>Data frame</b>	n 	Can be different	<code>data.frame(x = 1:3, y = 5:7)</code>
<b>Array</b>	m... n 	Identical	<code>array(data = 1:3, dim = c(2,4,2))</code>
<b>List</b>	$\left\{ \begin{array}{l} \text{Vector} \\ \text{Matrix} \\ \text{Data frame} \\ \text{Array} \end{array} \right\}$	Can be different	<code>list(x = cars[,1], y = cars[,2])</code>

## ▼ 1. Vector

A vector is simply a list of items that are of the same type.

To combine the list of items to a vector, use the `c()` function and separate the items by a comma.

**Purpose:** Used for storing homogeneous data.

```
students <- c("Janak", "Ram", "Manish")
marks <- c(56, 78, 68.89)
class(students)
print(marks)
```

→ 'character'  
[1] 56.00 78.00 68.89

```
students[2]
```

```
marks[3]
```

```
→ 'Ram'  
68.89
```

## Access Vectors

You can access the vector items by referring to its index number inside brackets []. The first item has index 1, the second item has index 2, and so on.

```
# creating vectors  
names <- c("ZemB", "Janak", "Ram", "Sita")  
numbers<- c(1, 4, 6, 2, 4, 6, 8, 9)  
conditon <- c(TRUE, FALSE)
```

```
# access the element  
names[4]
```

```
→ 'Sita'
```

```
vectors <- c("janak", 5, TRUE)  
vectors
```

```
→ 'janak' · '5' · 'TRUE'
```

```
# multiple access  
names[c(1, 4)]
```

```
→ 'ZemB' · 'Sita'
```

```
names[c(4)]
```

```
→ 'Sita'
```

```
# Access all items except for the first item  
numbers[c(-1)]
```

```
→ 4 · 6 · 2 · 4 · 6 · 8 · 9
```

```
length(students)
```

```
→ 3
```

```
# measure length of vector
length(names)

→ 4

# sort the vector ascending
sort(names)

→ 'Janak' · 'Ram' · 'Sita' · 'ZemB'

# Vector with numerical values in a sequence
num <- 1.2:5
num

→ 1.2 · 2.2 · 3.2 · 4.2

sr <- seq(from=1, to=100, by = 25)
sr

→ 1 · 26 · 51 · 76

# To make bigger or smaller steps in a sequence, use the seq() function:
series <- seq(from = 550, to = 100, by = -20)
series

→ 550 · 530 · 510 · 490 · 470 · 450 · 430 · 410 · 390 · 370 · 350 · 330 · 310 · 290 · 270 · 250 · 230 · 210 · 190 ·
   170 · 150 · 130 · 110
```

### Change individual item from vector

```
student_names <- c("Janak", "Ramesh", "Ram", "Hari")
student_names
```

```
→ 'Janak' · 'Ramesh' · 'Ram' · 'Hari'
```

```
student_names[1] <- "Manish"
student_names
```

```
→ 'Manish' · 'Ramesh' · 'KP' · 'Hari'
```

```
student_names[2] <- "Krishna"
student_names
```

→ 'Manish' · 'Krishna' · 'KP' · 'Hari'

## Repeat Vectors

To repeat vectors, use the rep() function:

```
msg <- c("Hii!", "Hello!")
```

```
final <- rep(msg, each=2)
```

```
final
```

→ 'Hii!' · 'Hii!' · 'Hello!' · 'Hello!'

```
test <- rep(c("Get Out", "Janak"), each=2)
cat(test)
```

→ Get Out Get Out Janak Janak

```
hare <- "हरे"
ram <- "राम"
krishna <- "कृष्ण"
```

```
mantra_form <- rep(c(paste(hare, ram), ram, hare, paste(hare, krishna), krishna), times=2)
mantra_form
```

→ 'हरे राम' · 'हरे राम' · 'राम' · 'राम' · 'हरे' · 'हरे' · 'हरे कृष्ण' · 'हरे कृष्ण' · 'कृष्ण' · 'कृष्ण' · 'हरे' · 'हरे'

```
# Repeat each value:
```

```
mantra <- rep(c("हरे राम", "राम ", "हरे", "हरे कृष्ण", "कृष्ण", "हरे"), each=2)
mantra
```

→ 'हरे राम' · 'हरे राम' · 'राम ' · 'राम ' · 'हरे' · 'हरे' · 'हरे कृष्ण' · 'हरे कृष्ण' · 'कृष्ण' · 'कृष्ण' · 'हरे' · 'हरे'

```
# Repeat the sequence of the vector:
```

```
jap = rep(mantra, times=108)
# jap
```

```
# Repeat each value independently:
```

```
repeat_indepent <- rep(c(1,2,3), times = c(5,2,1))
repeat_indepent
```

→ 1 · 1 · 1 · 1 · 1 · 2 · 2 · 3

## ▼ 2. Lists

---

A list in R can contain many different data types inside it. A list is a collection of data which is ordered and changeable.

- To create a list, use the `list()` function:
- **Purpose:** Used for storing heterogeneous data.
- **Access:** Accessed using `[[ ]]` or `$` for named elements.

```
# create lists
countries <- list("Nepal", "Bharat", "Bhutan", "Bangladesh", "Shrilanka", '
countries[1]
```

→ 1. 'Nepal'

```
location <- list(country="Nepal", district="Kathmandu")
location$district
```

→ 'Kathmandu'

```
y <- list(name="Janak", addr="DCL")
```

```
y[["addr"]]
```

→ 'DCL'

```
y$name
```

→ 'Janak'

```
student <- list(name="Janak Singh Dhami", year="2", sub=c("Math", "Chemistry"))
```

```
student$sub[3]
```

→ 'Physics'

```
about <- paste("My Name is", student$name, "and i'm from", student$location)
cat(about)
```

→ My Name is Janak Singh Dhami and i'm from Kathmandu

```
# access list item by position
student[[1]]
```

→ 'Janak Singh Dhami'

## Change Item Value

```
# i want change my name
student$name <- "Janak Dhami"
student$name
```

→ 'Janak Dhami'

```
countries[6] <- "Maldivash"
```

```
countries
```

→  
1. 'Nepal'  
2. 'Bharat'  
3. 'Bhutan'  
4. 'Bangladesh'  
5. 'Shrilanka'  
6. 'Maldivash'

## List Length

```
length(countries)
```

→ 6

## Check if Item Exists

```
"USA" %in% countries
```

→ FALSE

## Add List Items

```
# i think, i should add pakistan in SARC countries
countries <- append(countries, "Pakistan")
countries
```



1. 'Nepal'
2. 'Bharat'
3. 'Bhutan'
4. 'Bangladesh'
5. 'Shrilanka'
6. 'Maldivash'
7. 'Pakistan'

To add an item to the right of a specified index, add "after=index number" in the append() function:

```
countries <- append(countries, "Afganistan", after=6)
countries
```



1. 'Nepal'
2. 'Bharat'
3. 'Afganistan'
4. 'Bhutan'
5. 'Bangladesh'
6. 'Shrilanka'
7. 'Afganistan'
8. 'Maldivash'
9. 'Pakistan'

```
# By mistake
countries <- append(countries, "China")
countries
```



1. 'Nepal'
2. 'Bharat'
3. 'Afganistan'
4. 'Bhutan'
5. 'Bangaladesh'
6. 'Shrilanka'
7. 'Afganistan'
8. 'Maldivash'
9. 'Pakistan'
10. 'China'

## Remove List Items

```
# 🤔 Humm, China is not SARC country....I need to remove this one from our c  
countries <- countries[-10] # 10 is index number of China  
countries
```



1. 'Nepal'
2. 'Bharat'
3. 'Afganistan'
4. 'Bhutan'
5. 'Bangaladesh'
6. 'Shrilanka'
7. 'Afganistan'
8. 'Maldivash'
9. 'Pakistan'

## Range of Indexes

You can specify a range of indexes by specifying where to start and where to end the range, by using the : operator

```
# i think i need to create another hindu countries list  
hindu_countries <- (countries)[1:2]
```

`hindu_countries`



1. 'Nepal'
2. 'Bharat'

## Join Two Lists

There are several ways to join, or concatenate, two or more lists in R.

The most common way is to use the c() function, which combines two elements together:

```
# 🤔Hummm, i should also create muslim countries list..... Okay 🙌 I CAN
first_list <- (countries)[4:4]
second_list <- (countries)[6:8]

muslim_countries <- c(first_list, second_list)
muslim_countries
```

→

- 1. 'Bhutan'
- 2. 'Shrilanka'
- 3. 'Afganistan'
- 4. 'Maldivash'

## Access List through For Loop

```
for (i in muslim_countries){
  print(i)
}

→ [1] "Bhutan"
[1] "Shrilanka"
[1] "Afganistan"
[1] "Maldivash"
```

## 3. Matrices

---

A matrix is a two dimensional data set with columns and rows.

A column is a vertical representation of data, while a row is a horizontal representation of data.

A matrix can be created with the matrix() function. Specify the nrow and ncol parameters to get the amount of rows and columns

```
my_matrix <- matrix(c(2, 5, 6, 7, 8, 6), nrow=3, ncol=2)

print(my_matrix)
```

→

	[,1]	[,2]
[1,]	2	7
[2,]	5	8
[3,]	6	6

```

my <- c(1, 4, 5, 6, 7, 8)

my_matrix <- matrix(my, nrow= 2, ncol= 3)
print(my_matrix)

→ [,1] [,2] [,3]
[1,] 1 5 7
[2,] 4 6 8

first <- matrix(c('A', 'B', 'C', 'D'), nrow = 2, ncol = 2)
print(first)

→ [,1] [,2]
[1,] "A" "C"
[2,] "B" "D"

```

## Access Matrix Item

You can access the items by using [ ] brackets. The first number "1" in the bracket specifies the row-position, while the second number "2" specifies the column-position

```

# my_matrix[1, 2]
my_matrix[2, 2]

→ 6

```

*The whole row can be accessed if you specify a comma after the number in the bracket*

```

my_matrix[1,]

→ 1 5 7

```

*The whole column can be accessed if you specify a comma before the number in the bracket*

```

my_matrix[,3]

→ 7 8

```

## Access More Than One Row

```
country <- matrix(c("Nepal", "India", "China", "Pakistan", "USA", "UK"), nrc  
print(country)  
→ [,1] [,2]  
[1,] "Nepal" "Pakistan"  
[2,] "India" "USA"  
[3,] "China" "UK"  
  
# c(1,2) is a vector that tells R to select the 1st and 2nd rows.  
# , after c(1,2) means all columns.  
country[c(1, 3),]
```

→ A matrix: 2 × 2 of  
type chr  
Nepal Pakistan  
China UK

## Access More Than One Column

More than one column can be accessed if you use the c() function:

```
country[,c(1,1)]  
# , before c(1,2) means all rows.
```

→ A matrix: 3 × 2  
of type chr  
Nepal Nepal  
India India  
China China

## Add Rows and Columns

Use the cbind() function to add additional columns in a Matrix.

*Note: The cells in the new column must be of the same length as the existing matrix.*

```
print(country)  
→ [,1] [,2]  
[1,] "Nepal" "Pakistan"  
[2,] "India" "USA"  
[3,] "China" "UK"
```

```
jan <- cbind(country, c("Afgan", "Bangladesh", "Bhutan"))
print(jan)
```

```
→ [,1]   [,2]   [,3]
[1,] "Nepal" "Pakistan" "Afgan"
[2,] "India"  "USA"     "Bangladesh"
[3,] "China"  "UK"      "Bhutan"
```

```
dh <- rbind(jan, c("Asis", "Asia", "Asia"))
print(dh)
```

```
→ [,1]   [,2]   [,3]
[1,] "Nepal" "Pakistan" "Afgan"
[2,] "India"  "USA"     "Bangladesh"
[3,] "China"  "UK"      "Bhutan"
[4,] "Asis"   "Asia"    "Asia"
```

```
new_country <- cbind(country, c("Japan", "UAE", "Korea"))
print(new_country)
```

```
→ [,1]   [,2]   [,3]
[1,] "Nepal" "Pakistan" "Japan"
[2,] "India"  "USA"     "UAE"
[3,] "China"  "UK"      "Korea"
```

Use the rbind() function to add additional rows in a Matrix

Note: The cells in the new row must be of the same length as the existing matrix.

```
new_new_country <- rbind(new_country, c("Russia", "Afganistan", "Bangladesh"))
```

```
print(new_new_country)
```

```
→ [,1]   [,2]   [,3]
[1,] "Nepal" "Pakistan" "Japan"
[2,] "India"  "USA"     "UAE"
[3,] "China"  "UK"      "Korea"
[4,] "Russia" "Afganistan" "Bangladesh"
```

## Remove Rows and Columns

Use the c() function to remove rows and columns in a Matrix

```
hhh <- new_new_country[-c(1), -c(2)]
print(hhh)
```

```
→ [,1]   [,2]
 [1,] "India"  "UAE"
 [2,] "China"   "Korea"
 [3,] "Russia"  "Bangladesh"
```

#Remove the 3rd row and the 3rd column

```
pre <- new_new_country[-c(3), -c(3)]
```

```
print(pre)
```

```
→ [,1]   [,2]
 [1,] "Nepal"  "Pakistan"
 [2,] "India"   "USA"
 [3,] "Russia"  "Afganistan"
```

## Check if an Item Exists

To find out if a specified item is present in a matrix, use the `%in%` operator.

```
"Japan" %in% pre
```

```
→ FALSE
```

## Number of Rows and Columns

Use the `dim()` function to find the number of rows and columns in a Matrix.

```
dim(pre)
```

```
→ 3 · 2
```

```
nrow(pre)
```

```
→ 3
```

```
ncol(pre)
```

```
→ 2
```

## Matrix Length

Use the `length()` function to find the dimension of a Matrix.

```
length(pre)
```

## Loop Through a Matrix

You can loop through a Matrix using a `for` loop. The loop will start at the first row, moving right

```
for (rows in 1:nrow(pre)) {
  for (columns in 1:ncol(pre)) {
    print(pre[rows, columns])
  }
}
```

```
→ [1] "Nepal"
[1] "Pakistan"
[1] "India"
[1] "USA"
[1] "Russia"
[1] "Afganistan"
```

## Combine two Matrices

Again, you can use the `rbind()` or `cbind()` function to combine two or more matrices together

```
# Combine matrices
Matrix1 <- matrix(c("apple", "banana", "cherry", "grape"), nrow = 2, ncol =
Matrix2 <- matrix(c("orange", "mango", "pineapple", "watermelon"), nrow = 2,
print(Matrix1)

print(Matrix2)

# Adding it as a rows
Matrix_Combined <- rbind(Matrix1, Matrix2)
print(Matrix_Combined)

# Adding it as a columns
Matrix_Combined <- cbind(Matrix1, Matrix2)
print(Matrix_Combined)
```

```
→      [,1]      [,2]
[1,] "apple"   "cherry"
[2,] "banana"  "grape"
      [,1]      [,2]
[1,] "orange"  "pineapple"
```

```
[2,] "mango"  "watermelon"
      [,1]      [,2]
[1,] "apple"   "cherry"
[2,] "banana"  "grape"
[3,] "orange"  "pineapple"
[4,] "mango"   "watermelon"
      [,1]      [,2]      [,3]      [,4]
[1,] "apple"   "cherry" "orange" "pineapple"
[2,] "banana"  "grape"  "mango"  "watermelon"
```

## ⌄ 3. Arrays

---

Compared to matrices, arrays can have more than two dimensions.

We can use the array() function to create an array, and the dim parameter to specify the dimensions

```
arr <- 1:10
arr
→ 1 · 2 · 3 · 4 · 5 · 6 · 7 · 8 · 9 · 10
```

```
arrrr <- c(arr)
arrrr
→ 1 · 2 · 3 · 4 · 5 · 6 · 7 · 8 · 9 · 10
```

```
my_array <- array(arrrr, dim=c(2, 2, 3))
print(my_array)
```

```
→ , , 1
      [,1] [,2]
[1,]    1    3
[2,]    2    4
, , 2
```

```
      [,1] [,2]
[1,]    5    7
[2,]    6    8
, , 3
```

```
      [,1] [,2]
[1,]    9    1
[2,]   10    2
```

```
sel <- my_array[2, 2, 2]
print(sel)
```

```
→ [1] 8
```

```
thisarray <- c(1:12)
multiarray <- array(thisarray, dim = c(2, 2, 2))
```

```
print(multiarray)
```

```
→ , , 1
```

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

```
, , 2
```

```
 [,1] [,2]
[1,] 5 7
[2,] 6 8
```

```
print(multiarray[2,2,2])
```

```
→ [1] 8
```

You can also access the whole row or column from a matrix in an array, by using the `c()` function

```
# access all items from the 1st row c(row number),, matrix
print(multiarray[c(1),, 2])
```

```
→ [1] 5 7
```

```
# Access all the items from the first column from matrix one | c(column), m
print(multiarray[, c(2), 1])
```

```
→ [1] 3 4
```

## Check if an Item Exists

```
56 %in% multiarray
```

```
→ FALSE
```

## Amount of Rows and Columns

```
dim(multiarray)
```

```
→ 2 2 2
```

```
length(multiarray)
```

```
→ 8
```

```
for(x in multiarray){  
  print(x)  
}
```

```
→ [1] 1  
[1] 2  
[1] 3  
[1] 4  
[1] 5  
[1] 6  
[1] 7  
[1] 8
```

## 4. Data Frame

- Data Frames are data displayed in a format as a table.
- Data Frames can have different types of data inside it. While the first column can be character, the second and third can be numeric or logical. However, each column should have the same type of data.
- Use the `data.frame()` function to create a data frame:

```
ddf <- data.frame(  
  Name = c("Janak", "Shiv", "Ram"),  
  Com = c("PCM", "PSM", "MPM"),  
  CLZ = c("TC", "NIC", "St. Xaiver")  
)
```

```
print(ddf)
```

```
→    Name Com      CLZ  
 1 Janak PCM      TC  
 2 Shiv PSM      NIC  
 3 Ram MPM St. Xaiver
```

```
# create dataframe
df <- data.frame(
  Names = c("janak", "Ram", "Sita", "Shiv"),
  Addr = c("dcl", "india", "mithila", "kailash"),
  isFine = c(TRUE, TRUE, FALSE, FALSE),
  Marks = c(67, 55, 89, 98)
)
print(df)
```

	Names	Addr	isFine	Marks
1	janak	dcl	TRUE	67
2	Ram	india	TRUE	55
3	Sita	mithila	FALSE	89
4	Shiv	kailash	FALSE	98

## Summarize the Data

```
summary(df)
```

	Names	Addr	isFine	Marks
Length:4	Length:4	Mode :logical	Min.	:55.00
Class :character	Class :character	FALSE:2	1st Qu.:	64.00
Mode :character	Mode :character	TRUE :2	Median :	78.00
			Mean :	77.25
			3rd Qu.:	91.25
			Max. :	98.00

mtcars



A data.frame: 32 × 11

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<dbl>										
<b>Mazda RX4</b>	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
<b>Mazda RX4 Wag</b>	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
<b>Datsun 710</b>	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
<b>Hornet 4 Drive</b>	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
<b>Hornet Sportabout</b>	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
<b>Valiant</b>	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
<b>Duster 360</b>	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
<b>Merc 240D</b>	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
<b>Merc 230</b>	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
<b>Merc 280</b>	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
<b>Merc 280C</b>	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
<b>Merc 450SE</b>	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
<b>Merc 450SL</b>	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
<b>Merc 450SLC</b>	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
<b>Cadillac Fleetwood</b>	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
<b>Lincoln Continental</b>	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
<b>Chrysler Imperial</b>	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
<b>Fiat 128</b>	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
<b>Honda Civic</b>	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
<b>Toyota Corolla</b>	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
<b>Toyota Corona</b>	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
<b>Dodge Challenger</b>	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
<b>AMC ..</b>	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2

```
?mtcars
```

```
# demo data  
car_info <- data.frame(mtcars)
```

```
summary(car_info)
```

```
→ mpg cyl disp hp  
Min. :10.40 Min. :4.000 Min. : 71.1 Min. : 52.0  
1st Qu.:15.43 1st Qu.:4.000 1st Qu.:120.8 1st Qu.: 96.5  
Median :19.20 Median :6.000 Median :196.3 Median :123.0  
Mean   :20.09 Mean   :6.188 Mean   :230.7 Mean   :146.7  
3rd Qu.:22.80 3rd Qu.:8.000 3rd Qu.:326.0 3rd Qu.:180.0  
Max.   :33.90 Max.   :8.000 Max.   :472.0 Max.   :335.0  
drat wt qsec vs  
Min. :2.760 Min. :1.513 Min. :14.50 Min. :0.0000  
1st Qu.:3.080 1st Qu.:2.581 1st Qu.:16.89 1st Qu.:0.0000  
Median :3.695 Median :3.325 Median :17.71 Median :0.0000  
Mean   :3.597 Mean   :3.217 Mean   :17.85 Mean   :0.4375  
3rd Qu.:3.920 3rd Qu.:3.610 3rd Qu.:18.90 3rd Qu.:1.0000  
Max.   :4.930 Max.   :5.424 Max.   :22.90 Max.   :1.0000  
am gear carb  
Min. :0.0000 Min. :3.000 Min. :1.000  
1st Qu.:0.0000 1st Qu.:3.000 1st Qu.:2.000  
Median :0.0000 Median :4.000 Median :2.000  
Mean   :0.4062 Mean   :3.688 Mean   :2.812  
3rd Qu.:1.0000 3rd Qu.:4.000 3rd Qu.:4.000  
Max.   :1.0000 Max.   :5.000 Max.   :8.000
```

## Access Items

We can use single brackets [ ], double brackets [[ ]] or \$ to access columns from a data frame.

```
df[1]
```

```
→ A  
data.frame:  
4 × 1
```

### Names

```
<chr>
```

```
janak
```

```
Ram
```

```
Sita
```

```
Shiv
```

```
df[["Marks"]]
```

```
→ 67 · 55 · 89 · 98
```

```
df[["Names"]][3]
```

```
→ 'Sita'
```

```
df$Addr
```

```
→ 'dcl' · 'india' · 'mithila' · 'kailash'
```

```
# access specific cols (2nd and 3rd)  
nndf <- df[2:3]  
nndf
```

```
→ A data.frame: 4 ×  
2
```

```
Addr  isFine
```

```
<chr>  <lgl>
```

```
dcl    TRUE
```

```
india   TRUE
```

```
mithila FALSE
```

```
kailash FALSE
```

## Add Rows

Use the `rbind()` function to add new rows in a Data Frame.

```
df
```

→ A data.frame: 4 × 4

Names	Addr	isFine	Marks
<chr>	<chr>	<lgl>	<dbl>
janak	dcl	TRUE	67
Ram	india	TRUE	55
Sita	mithila	FALSE	89
Shiv	kailash	FALSE	98

```
new_df <- rbind(df, c("Shyan", "UP", FALSE, 99))  
new_df
```

→ A data.frame: 5 × 4

Names	Addr	isFine	Marks
<chr>	<chr>	<chr>	<chr>
janak	dcl	TRUE	67
Ram	india	TRUE	55
Sita	mithila	FALSE	89
Shiv	kailash	FALSE	98
Shyan	UP	FALSE	99

## Add Columns

Use the `cbind()` function to add new columns in a Data Frame

```
df
```

→ A data.frame: 4 × 4

Names	Addr	isFine	Marks
<chr>	<chr>	<lgl>	<dbl>
janak	dcl	TRUE	67
Ram	india	TRUE	55
Sita	mithila	FALSE	89
Shiv	kailash	FALSE	98

```
ddf <- cbind(df, Country = c("Nepal", "India", "Nepal", "India"))
ddf
```

→ A data.frame: 4 × 5

Names	Addr	isFine	Marks	Country
<chr>	<chr>	<lgl>	<dbl>	<chr>
janak	dcl	TRUE	67	Nepal
Ram	india	TRUE	55	India
Sita	mithila	FALSE	89	Nepal
Shiv	kailash	FALSE	98	India

## Remove Rows and Columns

Use the `c()` function to remove rows and columns in a Data Frame

```
df
```

→ A data.frame: 4 × 4

Names	Addr	isFine	Marks
<chr>	<chr>	<lgl>	<dbl>
janak	dcl	TRUE	67
Ram	india	TRUE	55
Sita	mithila	FALSE	89
Shiv	kailash	FALSE	98

```
# remove first row
r_df <- df[-c(1), ]
r_df
```

→ A data.frame: 3 × 4

	Names	Addr	isFine	Marks
	<chr>	<chr>	<lgl>	<dbl>
2	Ram	india	TRUE	55
3	Sita	mithila	FALSE	89
4	Shiv	kailash	FALSE	98

```
# remove second col  
c_df <- df[,-c(2)]  
c_df
```

→ A data.frame: 4 × 3

Names isFine Marks

<chr>	<lgl>	<dbl>
janak	TRUE	67
Ram	TRUE	55
Sita	FALSE	89
Shiv	FALSE	98

## Amount of Rows and Columns

```
dim(df)
```

→ 4 · 4

```
length(df)
```

→ 4

```
# no of column
```

```
ncol(df)
```

→ 4

```
# no of rows
```

```
nrow(df)
```

→ 4

## Combining Data Frames

- Use the rbind() function to combine two or more data frames in R vertically
- And use the cbind() function to combine two or more data frames in R horizontally

## Structure Data

```
str(mtcars)
→ 'data.frame': 32 obs. of 11 variables:
 $ mpg : num 21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
 $ cyl : num 6 6 4 6 8 6 8 4 4 6 ...
 $ disp: num 160 160 108 258 360 ...
 $ hp : num 110 110 93 110 175 105 245 62 95 123 ...
 $ drat: num 3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
 $ wt : num 2.62 2.88 2.32 3.21 3.44 ...
 $ qsec: num 16.5 17 18.6 19.4 17 ...
 $ vs : num 0 0 1 1 0 1 0 1 1 1 ...
 $ am : num 1 1 1 0 0 0 0 0 0 0 ...
 $ gear: num 4 4 4 3 3 3 3 4 4 4 ...
 $ carb: num 4 4 1 1 2 1 4 2 2 4 ...
```

## ▼ 5. Factors

Factors are used to categorize data. Examples of factors are:

- Gender: Male/Female
- Music: Rock, Pop, Classic, Rap

To create a factor, use the `factor()` function and add a vector as argument

```
country <- c("Nepal", "India", "Nepal", "Nepal", "Pakistan")
```

```
c_factor <- factor(country)
c_factor
```

```
→ Nepal · India · Nepal · Nepal · Pakistan
▶ Levels:
```

```
# we can see/access levels of this factor
levels(c_factor)
```

```
→ 'India' · 'Nepal' · 'Pakistan'
```

```
is.factor(country)
```

```
→ FALSE
```

```
is.factor(c_factor)
```

```
→ TRUE
```