

# R Intermediate Short Course

## Session 1 - Data Manipulation

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The University of the West Indies, St Augustine

**Monday 18th July 2022**  
**(5:00pm - 7:00pm)**  
**(online)**

# Opening Items

About Rajesh Lakhani

## **Friendly Open Environment**

Feel free to raise your hand and ask questions

Hopefully open mic as much as possible

More communication is better

Ask away

## **Getting to know One Another**

Start from the participants and go down

- Name
- What you are currently doing: Student, Working...
- Previous Statistical Background?
- Why doing this course/Expected to learn/take away
- Random information about yourself

## Acknowledgements

To Ms. Devika Bhagwandin for course material and assistance.

# Course Introduction

## Course time table:

**Dates:** Monday 18<sup>th</sup> July 2022 - Sunday 24<sup>th</sup> July 2022

**Time:** 5:00pm - 7:00pm

## Course delivery:

Zoom online lectures, [Git and Github](#)

## To access all files visit:

<https://github.com/4Rajesh4/R-intermediate-July-2022>

To get updates you need to create an account and "watch" (top right) the repo (repository).

Email notifications and notifications on the home page (when you sign in or click the autocat mascot), will be visible. Select "all activity".

## **Course Topics**

1. Estimation Procedures
2. Hypothesis Testing - one sample and two samples
3. Correlation
4. Analysis of Variance
5. Simple Linear Regression
6. Extra if time allows

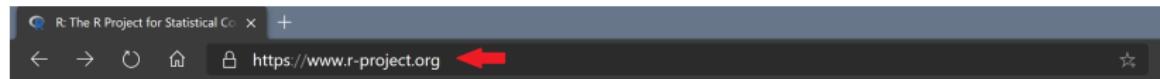
## **Course Prerequisite:**

R Beginner's Course and/or prior statistical knowledge

# Introduction to R

## Steps for downloading R

### STEP 1:



[Home]

[Download](#)

[CRAN](#)

[R Project](#)

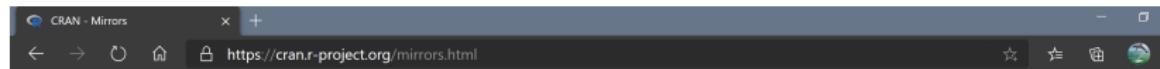
## The R Project for Statistical Computing

### Getting Started

R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To [download R](#), please choose your preferred CRAN mirror.

If you have questions about R like how to download and install the software, or what the license terms are, please read our [answers to frequently asked questions](#) before you send an email.

### STEP 2:



### CRAN Mirrors

The Comprehensive R Archive Network is available at the following URLs, please choose a location close to you. Some statistics on the status of the mirrors can be found here: [main.page](#), [windows.release](#), [windows.old.release](#).

If you want to host a new mirror at your institution, please have a look at the [CRAN Mirror HOWTO](#).

0-Cloud

<https://cloud.r-project.org/>



Algeria

<https://cran.usthb.dz/>

Automatic redirection to servers worldwide, currently sponsored by Rstudio

University of Science and Technology Houari Boumediene

## STEP 3:

### The Comprehensive R Archive Network

#### Download and Install R

Precompiled binary distributions of the base system and contributed packages. **Windows and Mac** users most likely want one of these versions of R:

- [Download R for Linux](#)
- [Download R for \(Mac\) OS X](#)
- [Download R for Windows](#)



R is part of many Linux distributions, you should check with your Linux package management system in addition to the link above.

## STEP 4:

### R for Windows

Subdirectories:

<a href="#">base</a>	Binaries for base distribution. This is what you want to <a href="#">install R for the first time</a> .
<a href="#">contrib</a>	Binaries of contributed CRAN packages (for R >= 2.13.x; managed by Uwe Ligges). There is also information on <a href="#">third party software</a> available for CRAN Windows services and corresponding environment and make variables.
<a href="#">old contrib</a>	Binaries of contributed CRAN packages for outdated versions of R (for R < 2.13.x; managed by Uwe Ligges).



## STEP 5:

### R-4.0.2 for Windows (32/64 bit)



[Download R 4.0.2 for Windows](#) (84 megabytes, 32/64 bit)

[Installation and other instructions](#)

[New features in this version](#)

If you want to double-check that the package you have downloaded matches the package distributed by CRAN, you can compare the [md5sum](#) of the .exe to the [fingerprint](#) on the master server. You will need a version of md5sum for windows: both [graphical](#) and [command line versions](#) are available.

# Introduction to R

## Steps for downloading R Studio

### STEP 1:

The screenshot shows the R Studio homepage with a blue header bar. The header includes the R Studio logo, a navigation menu with links for Products, Solutions, Customers, Resources, About, and Pricing, and a search icon. The word "DOWNLOAD" is highlighted with a red oval. Below the header, the text "Announcing RStudio Connect 1.9.0" is displayed, followed by a description: "Curate content, and tailor the viewer experience, making communication with stakeholders easier than ever." A "LEARN MORE" button is present. The background features a faint image of a person working at a computer.



# Installing R Studio

## Steps for downloading Rstudio

### STEP 2: Selection

R Studio

Products Solutions Customers Resources About Pricing

### Download the RStudio IDE

#### Choose Your Version

The RStudio IDE is a set of integrated tools designed to help you be more productive with R and Python. It includes a console, syntax-highlighting editor that supports direct code execution, and a variety of robust tools for plotting, viewing history, debugging and managing your workspace.

[LEARN MORE ABOUT THE RSTUDIO IDE](#)

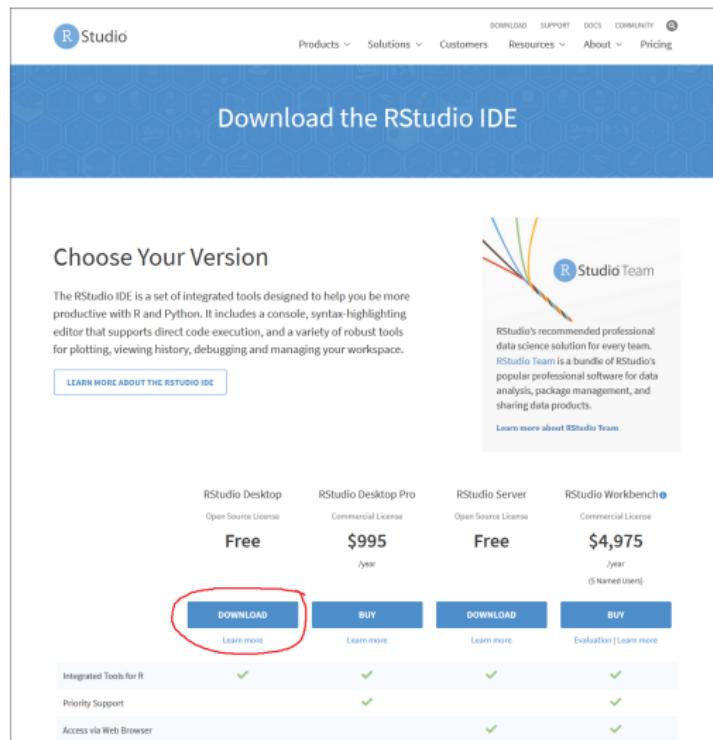
 R Studio Team

RStudio's recommended professional data science solution for every team. RStudio Team is a bundle of RStudio's popular professional software for data analysis, package management, and sharing data products.

[Learn more about RStudio Team](#)

RStudio Desktop	RStudio Desktop Pro	RStudio Server	RStudio Workbench
Open Source License	Commercial License	Open-Source License	Commercial License
<b>Free</b>	<b>\$995</b> /year	<b>Free</b>	<b>\$4,975</b> /year (5 Named Users)
<a href="#">DOWNLOAD</a> <a href="#">Learn more</a>	<a href="#">BUY</a> <a href="#">Learn more</a>	<a href="#">DOWNLOAD</a> <a href="#">Learn more</a>	<a href="#">BUY</a> <a href="#">Evaluation</a>   <a href="#">Learn more</a>

Integrated Tools for R ✓ ✓ ✓ ✓  
Priority Support ✓ ✓ ✓  
Access via Web Browser ✓ ✓



# Installing R Studio

## Steps for downloading Rstudio

### STEP 3: Download

RStudio Desktop 1.4.1717 - [Release Notes](#)

1. [Install R.](#) RStudio requires R 3.0.1+.
2. [Download RStudio Desktop.](#) Recommended for your system:

[DOWNLOAD RSTUDIO FOR WINDOWS  
1.4.1717 | 156.18MB](#)

Requires Windows 10 (64-bit)



#### All Installers

Linux users may need to import RStudio's public code-signing key prior to installation, depending on the operating system's security policy.  
RStudio requires a 64-bit operating system. If you are on a 32 bit system, you can use an [older version of RStudio](#).

OS	Download	Size	SHA-256
Windows 10	<a href="#">RStudio-1.4.1717.exe</a>	156.18 MB	71b36e64
macOS 10.14+	<a href="#">RStudio-1.4.1717.dmg</a>	203.06 MB	2cf2549d
Ubuntu 18/Debian 10	<a href="#">rstudio-1.4.1717-amd64.deb</a>	122.51 MB	e27b2645
Fedor 19/Red Hat 7	<a href="#">rstudio-1.4.1717-x86_64.rpm</a>	138.42 MB	64fe2be0
Fedor 28/Red Hat 8	<a href="#">rstudio-1.4.1717-x86_64.rpm</a>	138.39 MB	c76f620a
Debian 9	<a href="#">rstudio-1.4.1717-amd64.deb</a>	123.29 MB	e4ea3a60
OpenSUSE 15	<a href="#">rstudio-1.4.1717-x86_64.rpm</a>	123.15 MB	e69d55db

#### Zip/Tarballs

OS	Zip/Tar	Size	SHA-256
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# Working in RStudio

## Change Appearance

Tools -> Global Options -> Appearance

## Rearrange Layout

Tools -> Global Options -> Pane Layout

### To do:

Click on the Environment, History, Connections... and change to Console.

## Working Directory

Written below the Console

getwd() to verify New Method to change working directory:

Navigate in the **Files Pane** to find required folder then:

More -> Set as working Directory

# Playing around

## Using a script in R

1. Create: File → New Script
2. Save: Save the script created upon closing
3. Re-open: File → Open Script

## Installing Packages

Before using a package, the package must first be installed into R then loaded. Packages can be installed one of the three following ways:

1. Using the `install` command i.e.

```
> install.packages("package name")
```

2. Searching for the package and installing within R i.e.

Package → Install package(s)... → O-Cloud [https]

3. Downloading the package from an online search then installing into R.

First download the package as a zipped file from a search engine.

Then in R: Package → Install package(s) from local files...

# Script VS Console (Limited Practical List)

## Script:

- ▶ Does not run code on "enter"
- ▶ You must manually press the 'run button' or 'control + enter key'
- ▶ Easy to save work
- ▶ Facilitates many lines of code
- ▶ ...

## Console:

- ▶ Runs code on "enter"
- ▶ Easy for quick calculations and verification, use case
- ▶ Up arrow on keyboard pulls up the previous commands
- ▶ Clt + L will clear the console
- ▶ ...

# Nice Stuff

- ▶ The Course Outline is a markdown file
  - ▶ Add color
  - ▶ Bold
  - ▶ Italics
- ▶ Anything else
- ▶ Website:
- ▶ Projects in R Studio

# Let's get into code

## Simple Operations in R

```
> 1 + 2          #Addition  
> 1 - 2          #Subtraction  
> 5 * 2          #Multiplication  
> 1/2            #Division  
> 2 ^ 4           #Power
```

## Entering data in R

Data can be entered into R in three common ways:

(Also refer to R script)

### 1. Manually

```
> x = c(1, 2, 3, 4, 5, 6)      #Column vector  
> y = t(x)                      #Row vector (transpose  
                                of a column vector)  
  
> z = matrix(x, nrow=2, ncol=3, byrow=T/F)  
                                #2x3 matrix
```

```
> r1 = c(1, 2, 3, 4, 5)
> r2 = c(6, 7, 8, 9, 10)
> table1 = rbind(r1, r2)           #combine by rows
> table2 = cbind(r1, r2)           #combine by columns
                                  #manually create table
> colnames(table1) = c("A", "B", "C", "D", "E")
> rownames(table2) = c("A", "B", "C", "D", "E")
```

### **Exercise:**

Create label the matrix with the columns as Hi When Five Zoo Final, and the rows as Trinidad, Tobago.

## **2. Importing a data set**

Before reading a data file into R, the working directory must be changed. The working directory should be set to the location of the data set. This can be done by: File → Change dir...

Examples of 3 common types of data files:

### i. Tab delimited file

```
> data1 = read.table("name.txt", header=T/F)
```

## ii. Comma delimited or csv file

```
> data2 = read.csv("name.csv", header=T/F)
```

## iii. Excel workbook

R requires the package readxl to read excel files

```
> install.packages("readxl")
> library(readxl)
> data3 = read_excel("name.xlsx")
```

## 3. Built-in data set

R has several built-in data sets. These are listed in: > data()

The data sets need not be loaded or entered manually and can be used directly example > AirPassengers

Further information on the data is obtained by: > ?AirPassengers

# Data Manipulation

We can extract rows and columns of interest from a data set.

Consider the R built-in data set women (also see R output in next slide).

Suppose we are interested in the height variable. This can be extracted in the following ways.

1. Using *attach* command:

```
> attach(women)  
> height
```

2. Using \$ operator:

```
> women$height
```

3. Using square brackets [ ]:

Data in R is of the form data[row, column].

Here, height is in column 1 and we require all the rows therefore,

```
> women[, 1]
```



## R R Console

```
> women
   height weight
1      58     115
2      59     117
3      60     120
4      61     123
5      62     126
6      63     129
7      64     132
8      65     135
9      66     139
10     67     142
11     68     146
12     69     150
13     70     154
14     71     159
15     72     164
> attach(women)
> height
[1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
> women$height
[1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
> women[,1]
[1] 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
> |
```

Using the square brackets we can also extract rows as well as a range of both rows and columns.

```
> women[1:5,]           #first 5 rows  
> women[8, 2]           #row 8 and column 2
```

```
R Console  
> women[1:5]  
   height weight  
1     58    115  
2     59    117  
3     60    120  
4     61    123  
5     62    126  
> women[8,2]  
[1] 135
```

After the variable of interest is extracted, operations can be performed.

## Simple commands

```
> mean(height)                      #mean  
> var(height)                       #sample variance  
> sd(height)                        #standard deviation
```

What does var(women\$height) do?

What does var(women[, 1]) do?

```
> hist(height, main = "Histogram")    #histogram  
> max(height)                      #maximum  
> min(height)                       #minimum
```

## Sorting and Ordering data

Using the weight variable of the *women* data set,

```
> order(weight)                     #order of magnitude  
> weight[order(weight)]            #ascending order  
> sort(weight, decreasing=T/F)     #orders data
```

## Package *data.table* :

```
> install.packages("data.table")
> library(data.table)

> women = as.data.table(women)
> women[which(height == 59)]
> women[which(weight > 150)]
> women[which(weight < 120)]
```

The screenshot shows the R Console window with the title "R Console". The console displays the following R code and its resulting data frames:

```
> women=as.data.table(women)
> women[which(height == 59)]
  height weight
1:     59     117
> women[which(weight > 150)]
  height weight
1:     70     154
2:     71     159
3:     72     164
> women[which(weight < 120)]
  height weight
1:     58     115
2:     59     117
```

## Worked Example:

Consider the *Diet.csv* data set provided,

- a) Suppose we wish to determine the percentage of persons that gained weight after dieting.

Step 1: First read the data file into R.

```
> diet = read.csv("Diet.csv", header = T)
> attach(diet)
> dim(diet)                      #dimension of data set
[1] 78    7
```

Step 2: Find the difference in weight after the diet.

```
> diff = pre.weight - weight6weeks
```

Step 3: Sort the persons that gained weight i.e. those with a negative weight difference.

```
> weightgain = which(diff < 0)
```

Step 4: Determine the number of persons who gained weight, followed by the related percentage.

```
> length(weightgain)
```

```
[1] 4
```

```
> (4/78) * 100
```

```
[1] 5.128205
```

4b) Supposed we want to construct a pie chart to show the percentage of persons that did not gain weight according to the type of diet.

Step 1: Create a data set that includes the difference in weight.

```
> dietnew = cbind(diet, diff)
```

Step 2: Sort the persons which did not gain weight i.e. those with a weight difference  $\geq 0$ .

```
> dietnew = as.data.table(dietnew)
```

```
> no.gain = dietnew[which(diff >= 0)]
```

```
> attach(no.gain)
```

### Step 3: Calculate Percentages

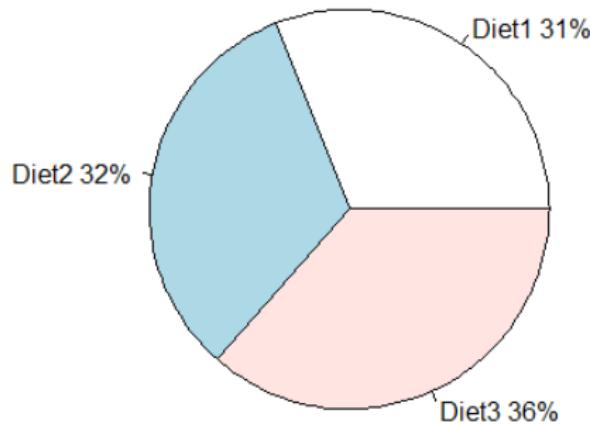
```
> diet1 = length(which(Diet == 1))/length(Diet)
> diet2 = length(which(Diet == 2))/length(Diet)
> diet3 = length(which(Diet == 3))/length(Diet)
> pct = c(diet1, diet2, diet3) * 100
> percent = paste(round(pct), "%", sep="")
                           #round off and add % symbol
```

### Step 4: Construct Pie Chart

```
> Diet = table(Diet)
> diet.label = c("Diet1", "Diet2", "Diet3")
> labels = paste(diet.label, percent)
> pie(Diet, labels, main = "Persons who did not
gain weight")
```

Also see R script for colour options and legend.

### Persons who did not gain weight



Note that the percentages can also be found by:

```
> Diet = table(no.gain$Diet)  
> pct = (Diet/sum(Diet))*100
```

# Closing for Day 1

- ▶ See R Code for more tweaks
- ▶ Tomorrow we look at estimation and Hypothesis Testing
- ▶ Thank you