Project 1

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Session 1 and 2

(Simple) Data entry in R

```
data <- c(1,2,3,4,5,6,7,8,9)
data
```

```
## [1] 1 2 3 4 5 6 7 8 9
```

```
text <- c("a", "b", "c", "d", "e", "f", "g", "h", "i")
text
```

```
## [1] "a" "b" "c" "d" "e" "f" "g" "h" "i"
```

```
# text2 <- c(a, b, c, d, e, f, g, h, i)
 # throws error as without quotes a,b,c,etc are treated as variables but are not defined

data2 <- cbind(data, text)
data2
```

```
##       data text
##  [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"
```

```
# data2 is defined as a two uni-dimensional matrix arrays i.e. data and text
class(data2)
```

```
## [1] "matrix" "array"
```

Arrays and Matrices in R:

```
M <- matrix(
  c(1:9),
  nrow = 3,
  ncol = 3,
  byrow = TRUE
)
```

```
print(M)
```

```
##      [,1] [,2] [,3]
## [1,]    1    2    3
## [2,]    4    5    6
## [3,]    7    8    9
```

```
V <- c(1:12)

# Multidimensional array
MDA <- array(V, dim = c(2,3,2))
print(MDA)
```

```
## , , 1
##
##      [,1] [,2] [,3]
## [1,]    1    3    5
## [2,]    2    4    6
##
## , , 2
##
##      [,1] [,2] [,3]
## [1,]    7    9   11
## [2,]    8   10   12
```

Creating a simple "data.frame" in R

```
df <- data.frame(x=c(1,2,3), y=c(2,3,4), z=c(3,4,5))
print(df)
```

```
##   x y z
## 1 1 2 3
## 2 2 3 4
## 3 3 4 5
```

```
print(class(df))
```

```
## [1] "data.frame"
```

A small but realistic data frame and its use:

```
emp.data <- data.frame(
  emp_id = c(1:5),
  emp_name =c("Rick", "Dan", "Michelle", "Ryan", "Gary"),
  salary = c(623.3, 515.2, 611.0, 729.0, 845.25),
  start_date = as.Date(c("2012-01-01", "2013-09-23", "2014-11-15", "2014-05-
  11", "2015-03-27")),
  stringAsFactors = FALSE
)

#Print the data
print(emp.data)
```

```
##   emp_id emp_name salary start_date stringAsFactors
## 1      1     Rick 623.30 2012-01-01           FALSE
```

```
## 2      2      Dan 515.20 2013-09-23           FALSE
## 3      3 Michelle 611.00 2014-11-15           FALSE
## 4      4     Ryan 729.00       <NA>           FALSE
## 5      5     Gary 845.25 2015-03-27           FALSE
```

Structure and Summary of Sample Data Frame in R:

```
str(emp.data)
```

```
## 'data.frame':    5 obs. of  5 variables:
##  $ emp_id         : int  1 2 3 4 5
##  $ emp_name       : chr  "Rick" "Dan" "Michelle" "Ryan" ...
##  $ salary         : num  623 515 611 729 845
##  $ start_date     : Date, format: "2012-01-01" "2013-09-23" ...
##  $ stringAsFactors: logi  FALSE FALSE FALSE FALSE FALSE
```

Print the Summary

```
print(summary(emp.data))
```

```
##      emp_id    emp_name            salary        start_date
##  Min.   :1   Length:5           Min.   :515.2   Min.   :2012-01-01
##  1st Qu.:2   Class :character   1st Qu.:611.0   1st Qu.:2013-04-18
##  Median :3   Mode  :character   Median :623.3   Median :2014-04-20
##  Mean   :3                      Mean   :664.8   Mean   :2013-12-16
##  3rd Qu.:4                      3rd Qu.:729.0   3rd Qu.:2014-12-18
##  Max.   :5                      Max.   :845.2   Max.   :2015-03-27
##                                                 NA's   :1
##  stringAsFactors
##  Mode :logical
##  FALSE:5
##
##
##
##
##
```

Extract part of data from Data Frame in R: (Very useful when working with large data)

```
result <- data.frame(emp.data$emp_name, emp.data$salary)
print(result)
```

```
##   emp.data.emp_name emp.data.salary
## 1              Rick          623.30
## 2               Dan          515.20
## 3          Michelle          611.00
## 4              Ryan          729.00
## 5              Gary          845.25
```

Extract first two rows

```
result <- emp.data[1:2,]
print(result)
```

```
##   emp_id emp_name salary start_date stringAsFactors
## 1      1     Rick  623.3 2012-01-01           FALSE
## 2      2      Dan  515.2 2013-09-23           FALSE
```

Extract 3rd and 5th row with 2nd and 4th column.

```
result <- emp.data[c(3,5), c(2,4)]
print(result)
```

```
##   emp_name start_date
## 3 Michelle 2014-11-15
## 5     Gary 2015-03-27
```

Add a new column in existing Data Frame:

```
# Add the "dept" column
emp.data$dept <- c("IT", "Operations", "IT", "HR", "Finance")
v <- emp.data
print(v)
```

```
##   emp_id emp_name salary start_date stringAsFactors       dept
## 1      1     Rick 623.30 2012-01-01           FALSE         IT
## 2      2      Dan 515.20 2013-09-23           FALSE Operations
## 3      3 Michelle 611.00 2014-11-15           FALSE         IT
## 4      4     Ryan 729.00       <NA>           FALSE         HR
## 5      5     Gary 845.25 2015-03-27           FALSE    Finance
```

Expand data frame in R (Adding cases):

```
# Create the first data frame.
emp.data <- data.frame(
  emp_id = c(1:5),
  emp_name = c("Rick", "Dan", "Michelle", "Ryan", "Gary"),
  salary = c(623.3, 515.2,611.0, 729.0,843.25),
  start_date = as.Date(c("2012-01-01", "2013-09-23", "2014-11-15", "2014-05-11", "2015-03-27")),
  dept = c("IT", "Operations", "IT", "HR", "Finance"),
  stringsAsFactors = FALSE
)

# Create the second data frame
emp.newdata <- data.frame(
  emp_id = c(6:8),
  emp_name = c("Ramsi", "Pranab", "Tusar"),
  salary = c(578.0,722.5,632.8),
  start_date = as.Date(c("2013-05-21", "2013-07-30", "2014-06-17")),
  dept = c("IT", "Operations","Finance"),
  stringsAsFactors = FALSE
)
emp.data
```

```
##   emp_id emp_name salary start_date       dept
```

```
## 1      1     Rick 623.30 2012-01-01         IT
## 2      2      Dan 515.20 2013-09-23 Operations
## 3      3 Michelle 611.00 2014-11-15         IT
## 4      4     Ryan 729.00 2014-05-11         HR
## 5      5     Gary 843.25 2015-03-27    Finance
```

```
emp.newdata
```

```
##   emp_id emp_name salary start_date       dept
## 1      6    Ramsi  578.0 2013-05-21         IT
## 2      7   Pranab  722.5 2013-07-30 Operations
## 3      8    Tusar  632.8 2014-06-17    Finance
```

Expand data frame in R (rbind is used):

```
# Bind the two data frames.
emp.finaldata <- rbind(emp.data, emp.newdata)
print(emp.finaldata)
```

```
##   emp_id emp_name salary start_date       dept
## 1      1     Rick 623.30 2012-01-01         IT
## 2      2      Dan 515.20 2013-09-23 Operations
## 3      3 Michelle 611.00 2014-11-15         IT
## 4      4     Ryan 729.00 2014-05-11         HR
## 5      5     Gary 843.25 2015-03-27    Finance
## 6      6    Ramsi 578.00 2013-05-21         IT
## 7      7   Pranab 722.50 2013-07-30 Operations
## 8      8    Tusar 632.80 2014-06-17    Finance
```

Import data in R: Text files

Base read.csv function to read csv file:

```
covid.data <- read.csv("~/Desktop/projects/r-starter/covnep_252days.csv")
head(covid.data)
```

```
##        date totalCases newCases totalRecoveries newRecoveries totalDeaths
## 1 1/23/2020          1        1               0             0           0
## 2 1/24/2020          0        0               0             0           0
## 3 1/25/2020          0        0               0             0           0
## 4 1/26/2020          0        0               0             0           0
## 5 1/27/2020          0        0               0             0           0
## 6 1/28/2020          0        0               0             0           0
##   newDeaths
## 1         0
## 2         0
## 3         0
## 4         0
## 5         0
## 6         0
```

Import data in R: Excel files

- Packages:
  - "readxl", "xlxs" packages

Readxl package to read excel files:

- Get summary of this "data.frame" in R!

```
library(readxl)
read_excel("~/Documents/Basic.xlsx")
```

```
## New names:
## * `` -> `...2`
## * `` -> `...3`
## * `` -> `...4`
## * `` -> `...5`
## * `` -> `...6`
```

```
## # A tibble: 14 x 6
##    `Table 1` ...2    ...3  ...4  ...5  ...6
##    <chr>     <chr>   <chr> <lgl> <lgl> <chr>
##  1 <NA>      Item    Name  NA    NA    Amount
##  2 Name:     <NA>    <NA>  NA    NA    Sum:
##  3 Andy      <NA>    <NA>  NA    NA    150
##  4 <NA>      Item 1  Andy  NA    NA    10
##  5 <NA>      Item 2  Andy  NA    NA    20
##  6 <NA>      Item 3  Andy  NA    NA    30
##  7 <NA>      Item 4  Andy  NA    NA    40
##  8 <NA>      Item 5  Andy  NA    NA    50
##  9 Chloe     <NA>    <NA>  NA    NA    125
## 10 <NA>      Item 6  Chloe NA    NA    5
## 11 <NA>      Item 7  Chloe NA    NA    15
## 12 <NA>      Item 8  Chloe NA    NA    25
## 13 <NA>      Item 9  Chloe NA    NA    35
## 14 <NA>      Item 10 Chloe NA    NA    45
```

Session 3

Basics of R

R can do Math!. It follows PEMDAS rule. Parenthesis, Exponents, Multiplication, Division, Addition and Subtraction

```
4 * 6 + 5 #
```

```
## [1] 29
```

```
(4 * 6) + 5 #
```

```
## [1] 29
```

```
4 * (6 + 5) #
```

```
## [1] 44
```

```
(4 + 6)^2 * 5 / 10 + 9 - 1
```

```
## [1] 58
```

Variables in R: assigning and removing

- Variable names can contain any combination of alphanumeric characters along with period(.) and underscore (_) e.g. age.group or age_group

- However, they cannot start with a number or an underscore e.g. _age or 5age
- Best practice is to use actual names, usually nouns for variables instead of single letter e.g. age, sex

```
x <- 2 # (preferred)
x = 2
2 -> x
assign("x", 2)
rm(x)
```

R is case sensitive

```
theVariable <- 17
# will give error if we type: TheVariable or THE VARIABLE
Age <- 50
# will be different for: age or AGE
```

Data Types

Numeric

- Type of data can be checked using class() function
- For numeric "class" and "is.numeric" both works:

```
x <- c(1,2,3,4,5,6,7,8,9)
class(x)
```

```
## [1] "numeric"
```

```
is.numeric(x)
```

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

Integer

- For integer "class" and "is.numeric" both works:

```
x <- c(1:9) # or c(1L:9L)
class(x)
```

```
## [1] "integer"
```

```
X <- c(1L,2L,3L,4L,5L,6L,7L,8L,9L)
is.numeric(x) # R promotes "integers" to "numeric" when needed
```

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

```

#Multiply integer by numeric in decimal values
4L * 2.8
```

R promotes "integers" to "numeric" when needed

```
## [1] 11.2
```

```
class(4L)
```

```
## [1] "integer"
```

```
class(2.8)
```

```
## [1] "numeric"
```

```r
class(4L * 2.8)
```

```
## [1] "numeric"
```

```r
# Divide integer by integer giving decimal value
5L / 2L # Will not promote to numeric here
```

```
## [1] 2.5
```

```r
class(5L)
```

```
## [1] "integer"
```

```r
class(2L)
```

```
## [1] "integer"
```

```r
class(5L / 2L)
```

```
## [1] "numeric"
```

```r
4L * 5L  #Will also not promote here
```

```
## [1] 20
```

```r
2L + 4L + 5L
```

```
## [1] 11
```

```r
class(4L * 5L)
```

```
## [1] "integer"
```

```r
class(2L + 4L + 5L)
```

```
## [1] "integer"
```

```r

x <- "data"
x
```

Character

```
## [1] "data"
```

```r
class(x)
```

```
## [1] "character"
```

```r
nchar(x) # number of characters
```

```
## [1] 4
```

```r
# Factor
y <- factor("data")
y
```

```
## [1] data
## Levels: data
```

```r
class(y)
```

```
## [1] "factor"
```

```r
# nchar(y) # Error in nchar(y) : 'nchar()' requires a character vectors
```

Factors and attributes in R:

```r
gender <- factor(c("male", "female", "female", "male"))
typeof(gender) #datatype
```

```
## [1] "integer"
```

```r
attributes(gender) #Levels and class
```

```
## $levels
## [1] "female" "male"
##
## $class
## [1] "factor"
```

```r
unclass(gender) #Check how it is stored in R
```

```
## [1] 2 1 1 2
## attr(,"levels")
## [1] "female" "male"
```

Date

```r
# Date: to store date
date1 <- as.Date("2023-03-29")
date1
```

```
## [1] "2023-03-29"
```

```r
class(date1)
```

```
## [1] "Date"
```

```r
as.numeric(date1)
```

```
## [1] 19445
```

```r
# POSIXct: To store date and time
# Easier manipulation of date and time objects can be accomplished using "lubridate" and "chron" packag
date2 <- as.POSIXct("2023-03-29 06:30")
date2
```

```
## [1] "2023-03-29 06:30:00 +0545"
```

```r
class(date2)
```

```
## [1] "POSIXct" "POSIXt"
```

```r
as.numeric(date2)
```

```
## [1] 1680050700
```

```r

# TRUE (=1)
# FALSE (=0)

TRUE * 5
```

Logical

```
## [1] 5
```

```
FALSE * 5
```

```
## [1] 0
```

```
#Class and Check
k <- TRUE
class(k)
```

```
## [1] "logical"
```

```
is.logical(k)
```

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

```

2 == 3 # (FALSE)
```

Logical Data Types

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

```
2 != 3 # (TRUE)
```

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

```
2 < 3 # (TRUE)
```

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

```
2 <= 3 # (TRUE)
```

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

```
2 > 3 # (FALSE)
```

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

```
2 >= 3 # (FALSE)
```

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

```
"data" == "stats" # (FALSE, why?)
```

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

```
"data" < "stats" # (TRUE, why?)
```

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

Vectors

A vector is collection of elements, all of the same type.

```

x <- c(1,2,3,4,5,6,7,8,9,10) # x is a vector containing 10 elements
x <- c(1:10) # shortcut for above code
# c stands for "combine"
x * 3 #Multiplication by a scalar
```

Vectors and its operation in R

```
##  [1]  3  6  9 12 15 18 21 24 27 30
```

```
x + 2 #Addition with a scalar
```

```
##  [1]  3  4  5  6  7  8  9 10 11 12
```

```
x - 3 #Subtraction with a scalar
```

```
##  [1] -2 -1  0  1  2  3  4  5  6  7
```

```
x / 4 # Division by a scalar
```

```
##  [1] 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
x^2 #Exponentiation by a scalar
```

```
##  [1]   1   4   9  16  25  36  49  64  81 100
```

```
sqrt(x) #Square root
```

```
##  [1] 1.000000 1.414214 1.732051 2.000000 2.236068 2.449490 2.645751 2.828427
##  [9] 3.000000 3.162278
```

```
#Two vector of equal length
x <- 1:10
y <- -5:4
x+y
```

Extending vector operations in R

```
##  [1] -4 -2  0  2  4  6  8 10 12 14
```

```
x-y
```

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

```
x*y
```

```
##  [1] -5 -8 -9 -8 -5  0  7 16 27 40
```

```
x/y
```

```
##  [1] -0.2 -0.5 -1.0 -2.0 -5.0  Inf  7.0  4.0  3.0  2.5
```

```
x^y
```

```
##  [1] 1.000000e+00 6.250000e-02 3.703704e-02 6.250000e-02 2.000000e-01
##  [6] 1.000000e+00 7.000000e+00 6.400000e+01 7.290000e+02 1.000000e+04
```

```
#Check length of the vector
length(x)
```

```
## [1] 10
```

```
length(y)
```

```
## [1] 10
```

```
length(x+y)
```

```
## [1] 10
```

Extending vector operations in R

```
#Two vectors of unequal length
x <- 1:10
z <-c(1,2)
x+z
```

```
##  [1]  2  4  4  6  6  8  8 10 10 12
```

```
#Two vectors of unequal length
x <- 1:10
w <-c(1,2,3)
x+w
```

```
## Warning in x + w: longer object length is not a multiple of shorter object
## length
```

```
##  [1]  2  4  6  5  7  9  8 10 12 11
```

```
#Comparing vectors
x <= 5
```

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

```
x > y
```

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

```
x < y
```

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

```
# Using "any" and "all"
x <- 10:1
y <- -4:5
any(x<y)
```

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

```
all(x<y)
```

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

```
#Using "nchar"
nchar(y)
```

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

Assessing individual elements of a vector

```
x[1]
```

```
## [1] 10
```

```
# x[1,2] # throws error
x[c(1,2)] # correct syntax to get multiple elements of vector
```

```
## [1] 10  9
```

```
#Giving names to a vector
#Name value pair
c(One="a", Two="y", Last="r")
```

```
##  One  Two Last
##  "a"  "y"  "r"
```

```
#Create vector then name it
w <- 1:3
names(w) <- c("a", "b", "c")
w
```

```
## a b c
## 1 2 3
```

Missing data in R

- R has two types of missing data
  - NA
  - NULL

NA type missing data in R

```
zchar <- c("Hockey", NA,"Cricket")
nchar(z)
```

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

```
z <- c(1,2,NA,8,3,NA,3)
mean(z)
```

```
## [1] NA
```

```
#The "is.na" function tests each element of vector for missingness
is.na(z)
```

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

```
#The na.rm function with =TRUE argument will remove NA so that we can get values for:
mean(z, na.rm=TRUE)
```

```
## [1] 3.4
```

```
var(z, na.rm=TRUE)
```

```
## [1] 7.3
```

```
sd(z, na.rm=TRUE)
```

```
## [1] 2.701851
```

NULL type missing data in R

```
z <- c(1, NULL, 3) # NULL is the absence of anything
is.null(z)
```

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

```
d <- NULL
is.null(d)
```

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

```
is.null(7)
```

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

Pipes in R

```
x <- 1:10
mean(x)
```

```
## [1] 5.5
```

```
library(magrittr)
# Mean of x with pipe:
x %>% mean
```

```
## [1] 5.5
```

Chained pipes in R

```
z <-c(1,2,NA,8,3,NA,3)
sum(is.na(z))
```

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

```
#Pipes, without nesting
z %>% is.na %>% sum
```

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

```
#Additional argument
z %>% mean(na.rm=TRUE)
```

```
## [1] 3.4
```

Advanced data structures in R

```
x <- 10:1
y <- -4:5
q <-c("Hockey", "Football","Baseball", "Kabaddi", "Rugby", "Pingpong", "Basketball","Tennis","Cricket",
theDF <-data.frame(x, y, q)
theDF
```

```
##     x  y          q
## 1  10 -4     Hockey
## 2   9 -3   Football
## 3   8 -2   Baseball
## 4   7 -1    Kabaddi
## 5   6  0      Rugby
## 6   5  1   Pingpong
## 7   4  2 Basketball
## 8   3  3     Tennis
## 9   2  4    Cricket
## 10  1  5 Volleyball
```

Advanced data structures in R

```
theDF <-data.frame(First=x, Second=y, Sport=q)
names(theDF)
```

```
## [1] "First"  "Second" "Sport"
```

```r
names(theDF)[3]
```

```
## [1] "Sport"
```

```r
rownames(theDF)
```

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

```r
rownames(theDF) <- c("One", "Two", "Three", "Four", "Five", "Six", "Seven", "Eight", "Nice", "Ten")
rownames(theDF)
```

```
##  [1] "One"   "Two"   "Three" "Four"  "Five"  "Six"   "Seven" "Eight" "Nice"
## [10] "Ten"
```

```r
# Setting them back to generic index
rownames(theDF) <- NULL
rownames(theDF)
```

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

```r
head(theDF)
```

```
##   First Second    Sport
## 1    10     -4   Hockey
## 2     9     -3 Football
## 3     8     -2 Baseball
## 4     7     -1  Kabaddi
## 5     6      0    Rugby
## 6     5      1 Pingpong
```

```r
head(theDF, n=7)
```

```
##   First Second      Sport
## 1    10     -4     Hockey
## 2     9     -3   Football
## 3     8     -2   Baseball
## 4     7     -1    Kabaddi
## 5     6      0      Rugby
## 6     5      1   Pingpong
## 7     4      2 Basketball
```

```r
tail(theDF)
```

```
##    First Second      Sport
## 5      6      0      Rugby
## 6      5      1   Pingpong
## 7      4      2 Basketball
## 8      3      3     Tennis
## 9      2      4    Cricket
## 10     1      5 Volleyball
```

```r
class(theDF)
```

```
## [1] "data.frame"
```

```r
str(theDF)
```

```
## 'data.frame':    10 obs. of  3 variables:
##  $ First : int  10 9 8 7 6 5 4 3 2 1
##  $ Second: int  -4 -3 -2 -1 0 1 2 3 4 5
##  $ Sport : chr  "Hockey" "Football" "Baseball" "Kabaddi" ...
```

```
theDF[3,2]; theDF[3, 2:3]
```

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

```
##   Second    Sport
## 3     -2 Baseball
```

```
theDF[, 3]; theDF[3,]
```

```
##  [1] "Hockey"     "Football"   "Baseball"   "Kabaddi"    "Rugby"
##  [6] "Pingpong"   "Basketball" "Tennis"     "Cricket"    "Volleyball"
```

```
##   First Second    Sport
## 3     8     -2 Baseball
```

```
theDF[, c("First", "Sport")]
```

```
##    First      Sport
## 1     10     Hockey
## 2      9   Football
## 3      8   Baseball
## 4      7    Kabaddi
## 5      6      Rugby
## 6      5   Pingpong
## 7      4 Basketball
## 8      3     Tennis
## 9      2    Cricket
## 10     1 Volleyball
```

```
theDF[, "Sport", drop=FALSE]
```

```
##         Sport
## 1      Hockey
## 2    Football
## 3    Baseball
## 4     Kabaddi
## 5       Rugby
## 6    Pingpong
## 7  Basketball
## 8      Tennis
## 9     Cricket
## 10 Volleyball
```

Lists in R

Often a container is needed to hold arbitrary objects of either the same type or varying types. R accomplishes this through lists.

```
list1 <- list(1,2,3)
list2 <- list(c(1,2,3))
list3 <- list(c(1,2,3), 3:7)
list4 <- list(theDF, 1:10)
list5 <- list(theDF, 1:10, list3)
names(list5)
```

```
## NULL
```

```r
names(list5) <-c("data.frame","vector", "list")
names(list5)
```

```
## [1] "data.frame" "vector"     "list"
```

```r
list5
```

```
## $data.frame
##    First Second      Sport
## 1     10     -4     Hockey
## 2      9     -3   Football
## 3      8     -2   Baseball
## 4      7     -1    Kabaddi
## 5      6      0      Rugby
## 6      5      1   Pingpong
## 7      4      2 Basketball
## 8      3      3     Tennis
## 9      2      4    Cricket
## 10     1      5 Volleyball
##
## $vector
##  [1]  1  2  3  4  5  6  7  8  9 10
##
## $list
## $list[[1]]
## [1] 1 2 3
##
## $list[[2]]
## [1] 3 4 5 6 7
```

```r
list6 <- list(TheDataFrame=theDF,TheVector=1:10, TheList=list3)
names(list6)
```

```
## [1] "TheDataFrame" "TheVector"    "TheList"
```

Access elements of list

```r
# Specify either the element number or name
list5[[1]]
```

```
##    First Second      Sport
## 1     10     -4     Hockey
## 2      9     -3   Football
## 3      8     -2   Baseball
## 4      7     -1    Kabaddi
## 5      6      0      Rugby
## 6      5      1   Pingpong
## 7      4      2 Basketball
## 8      3      3     Tennis
## 9      2      4    Cricket
## 10     1      5 Volleyball
```

```r
list5[["data.frame"]]
```

```
##    First Second      Sport
## 1     10     -4     Hockey
## 2      9     -3   Football
```

```
## 3      8     -2   Baseball
## 4      7     -1    Kabaddi
## 5      6      0      Rugby
## 6      5      1   Pingpong
## 7      4      2 Basketball
## 8      3      3     Tennis
## 9      2      4    Cricket
## 10     1      5 Volleyball
```

```
#Accessed element manipulation
list5[[1]]$Sport #Sport variable
```

```
##  [1] "Hockey"     "Football"   "Baseball"   "Kabaddi"    "Rugby"
##  [6] "Pingpong"   "Basketball" "Tennis"     "Cricket"    "Volleyball"
```

```
list5[[1]][, "Second"]
```

```
##  [1] -4 -3 -2 -1  0  1  2  3  4  5
```

```
list5[[1]][, "Second", drop=F]
```

```
##    Second
## 1      -4
## 2      -3
## 3      -2
## 4      -1
## 5       0
## 6       1
## 7       2
## 8       3
## 9       4
## 10      5
```

```
length(list5)
```

```
## [1] 3
```

```
#Adding new element
list5[[4]] <- 2
list5[["NewElement"]] <-3:6
names(list5) ; list5;
```

```
## [1] "data.frame" "vector"     "list"       ""           "NewElement"
```

```
## $data.frame
##    First Second      Sport
## 1     10     -4     Hockey
## 2      9     -3   Football
## 3      8     -2   Baseball
## 4      7     -1    Kabaddi
## 5      6      0      Rugby
## 6      5      1   Pingpong
## 7      4      2 Basketball
## 8      3      3     Tennis
## 9      2      4    Cricket
## 10     1      5 Volleyball
##
## $vector
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10
##
## $list
## $list[[1]]
## [1] 1 2 3
##
## $list[[2]]
## [1] 3 4 5 6 7
##
##
## [[4]]
## [1] 2
##
## $NewElement
## [1] 3 4 5 6
```

Matrices in R

- This is a similar to a data.frame
- It is rectangular with rows and columns except that every single element must be the same type, most commonly all numerics

```
A <- matrix(1:10, nrow=5)
B <- matrix(21:30, nrow=5)
C <- matrix(21:40, nrow=2)
nrow(A)
```

```
## [1] 5
```

```
ncol(B)
```

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

```
dim(C)
```

```
## [1]  2 10
```

```
A + B; A * B; A - B; A = B;
```

```
##      [,1] [,2]
## [1,]   22   32
## [2,]   24   34
## [3,]   26   36
## [4,]   28   38
## [5,]   30   40
```

```
##      [,1] [,2]
## [1,]   21  156
## [2,]   44  189
## [3,]   69  224
## [4,]   96  261
## [5,]  125  300
```

```
##      [,1] [,2]
## [1,]  -20  -20
## [2,]  -20  -20
## [3,]  -20  -20
## [4,]  -20  -20
## [5,]  -20  -20
```

Matrix multiplication and names in R

```
# Number of columns of the left hand matrix to be same as number of rows of right hand matrix
A %*% C # will work
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
## [1,] 1013 1107 1201 1295 1389 1483 1577 1671 1765  1859
## [2,] 1056 1154 1252 1350 1448 1546 1644 1742 1840  1938
## [3,] 1099 1201 1303 1405 1507 1609 1711 1813 1915  2017
## [4,] 1142 1248 1354 1460 1566 1672 1778 1884 1990  2096
## [5,] 1185 1295 1405 1515 1625 1735 1845 1955 2065  2175
```

```
# A %*% B # will not work

# Both A and B are 5 x 2 matrices so we will transpose B
A %*% t(B)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,] 1117 1164 1211 1258 1305
## [2,] 1164 1213 1262 1311 1360
## [3,] 1211 1262 1313 1364 1415
## [4,] 1258 1311 1364 1417 1470
## [5,] 1305 1360 1415 1470 1525
```

```
# Column/row names of matrix:
colnames(A)
```

```
## NULL
```

```
colnames(A) <- c("Left", "Right")
rownames(A) <- c("1st", "2nd", "3rd", "4th", "5th")
t(A)
```

```
##       1st 2nd 3rd 4th 5th
## Left   21  22  23  24  25
## Right  26  27  28  29  30
```

```
colnames(B) <- c("First","Second")
rownames(B) <- c("One", "Two", "Three", "Four", "Five")
```

Arrays in R

- An array is essentially a multidimensional vector

```
theArray <- array(1:12,
dim=c(2,3,2)) # 2 dimensional matrices both with 2 rows and 3 columns

theArray [1, , ] # 1st row of both
```

```
##      [,1] [,2]
## [1,]    1    7
## [2,]    3    9
## [3,]    5   11
```

```
theArray[1, ,1] # 1st row of first
```

```
## [1] 1 3 5
```

```
theArray[,1,] # 1st column of both
```

```
##      [,1] [,2]
## [1,]    1    7
## [2,]    2    8
```

WEB SCRAPING WITH R

Load in the Iris data from internet:

```
iris <- read.csv(url("http://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data"), header
head(iris)
```

```
##    V1  V2  V3  V4          V5
## 1 5.1 3.5 1.4 0.2 Iris-setosa
## 2 4.9 3.0 1.4 0.2 Iris-setosa
## 3 4.7 3.2 1.3 0.2 Iris-setosa
## 4 4.6 3.1 1.5 0.2 Iris-setosa
## 5 5.0 3.6 1.4 0.2 Iris-setosa
## 6 5.4 3.9 1.7 0.4 Iris-setosa
```

```
names(iris) <- c("Sepal.Length", "Sepal.Width", "Petal.Length", "Petal.Width", "Species")
iris
```

Add column names for V1, V2, V3, V4 and V5 columns to the Iris data

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width         Species
## 1            5.1         3.5          1.4         0.2     Iris-setosa
## 2            4.9         3.0          1.4         0.2     Iris-setosa
## 3            4.7         3.2          1.3         0.2     Iris-setosa
## 4            4.6         3.1          1.5         0.2     Iris-setosa
## 5            5.0         3.6          1.4         0.2     Iris-setosa
## 6            5.4         3.9          1.7         0.4     Iris-setosa
## 7            4.6         3.4          1.4         0.3     Iris-setosa
## 8            5.0         3.4          1.5         0.2     Iris-setosa
## 9            4.4         2.9          1.4         0.2     Iris-setosa
## 10           4.9         3.1          1.5         0.1     Iris-setosa
## 11           5.4         3.7          1.5         0.2     Iris-setosa
## 12           4.8         3.4          1.6         0.2     Iris-setosa
## 13           4.8         3.0          1.4         0.1     Iris-setosa
## 14           4.3         3.0          1.1         0.1     Iris-setosa
## 15           5.8         4.0          1.2         0.2     Iris-setosa
## 16           5.7         4.4          1.5         0.4     Iris-setosa
## 17           5.4         3.9          1.3         0.4     Iris-setosa
## 18           5.1         3.5          1.4         0.3     Iris-setosa
## 19           5.7         3.8          1.7         0.3     Iris-setosa
## 20           5.1         3.8          1.5         0.3     Iris-setosa
## 21           5.4         3.4          1.7         0.2     Iris-setosa
## 22           5.1         3.7          1.5         0.4     Iris-setosa
## 23           4.6         3.6          1.0         0.2     Iris-setosa
## 24           5.1         3.3          1.7         0.5     Iris-setosa
## 25           4.8         3.4          1.9         0.2     Iris-setosa
## 26           5.0         3.0          1.6         0.2     Iris-setosa
## 27           5.0         3.4          1.6         0.4     Iris-setosa
```

```
## 28          5.2         3.5          1.5         0.2     Iris-setosa
## 29          5.2         3.4          1.4         0.2     Iris-setosa
## 30          4.7         3.2          1.6         0.2     Iris-setosa
## 31          4.8         3.1          1.6         0.2     Iris-setosa
## 32          5.4         3.4          1.5         0.4     Iris-setosa
## 33          5.2         4.1          1.5         0.1     Iris-setosa
## 34          5.5         4.2          1.4         0.2     Iris-setosa
## 35          4.9         3.1          1.5         0.1     Iris-setosa
## 36          5.0         3.2          1.2         0.2     Iris-setosa
## 37          5.5         3.5          1.3         0.2     Iris-setosa
## 38          4.9         3.1          1.5         0.1     Iris-setosa
## 39          4.4         3.0          1.3         0.2     Iris-setosa
## 40          5.1         3.4          1.5         0.2     Iris-setosa
## 41          5.0         3.5          1.3         0.3     Iris-setosa
## 42          4.5         2.3          1.3         0.3     Iris-setosa
## 43          4.4         3.2          1.3         0.2     Iris-setosa
## 44          5.0         3.5          1.6         0.6     Iris-setosa
## 45          5.1         3.8          1.9         0.4     Iris-setosa
## 46          4.8         3.0          1.4         0.3     Iris-setosa
## 47          5.1         3.8          1.6         0.2     Iris-setosa
## 48          4.6         3.2          1.4         0.2     Iris-setosa
## 49          5.3         3.7          1.5         0.2     Iris-setosa
## 50          5.0         3.3          1.4         0.2     Iris-setosa
## 51          7.0         3.2          4.7         1.4 Iris-versicolor
## 52          6.4         3.2          4.5         1.5 Iris-versicolor
## 53          6.9         3.1          4.9         1.5 Iris-versicolor
## 54          5.5         2.3          4.0         1.3 Iris-versicolor
## 55          6.5         2.8          4.6         1.5 Iris-versicolor
## 56          5.7         2.8          4.5         1.3 Iris-versicolor
## 57          6.3         3.3          4.7         1.6 Iris-versicolor
## 58          4.9         2.4          3.3         1.0 Iris-versicolor
## 59          6.6         2.9          4.6         1.3 Iris-versicolor
## 60          5.2         2.7          3.9         1.4 Iris-versicolor
## 61          5.0         2.0          3.5         1.0 Iris-versicolor
## 62          5.9         3.0          4.2         1.5 Iris-versicolor
## 63          6.0         2.2          4.0         1.0 Iris-versicolor
## 64          6.1         2.9          4.7         1.4 Iris-versicolor
## 65          5.6         2.9          3.6         1.3 Iris-versicolor
## 66          6.7         3.1          4.4         1.4 Iris-versicolor
## 67          5.6         3.0          4.5         1.5 Iris-versicolor
## 68          5.8         2.7          4.1         1.0 Iris-versicolor
## 69          6.2         2.2          4.5         1.5 Iris-versicolor
## 70          5.6         2.5          3.9         1.1 Iris-versicolor
## 71          5.9         3.2          4.8         1.8 Iris-versicolor
## 72          6.1         2.8          4.0         1.3 Iris-versicolor
## 73          6.3         2.5          4.9         1.5 Iris-versicolor
## 74          6.1         2.8          4.7         1.2 Iris-versicolor
## 75          6.4         2.9          4.3         1.3 Iris-versicolor
## 76          6.6         3.0          4.4         1.4 Iris-versicolor
## 77          6.8         2.8          4.8         1.4 Iris-versicolor
## 78          6.7         3.0          5.0         1.7 Iris-versicolor
## 79          6.0         2.9          4.5         1.5 Iris-versicolor
## 80          5.7         2.6          3.5         1.0 Iris-versicolor
## 81          5.5         2.4          3.8         1.1 Iris-versicolor
```

```
## 82          5.5         2.4          3.7         1.0 Iris-versicolor
## 83          5.8         2.7          3.9         1.2 Iris-versicolor
## 84          6.0         2.7          5.1         1.6 Iris-versicolor
## 85          5.4         3.0          4.5         1.5 Iris-versicolor
## 86          6.0         3.4          4.5         1.6 Iris-versicolor
## 87          6.7         3.1          4.7         1.5 Iris-versicolor
## 88          6.3         2.3          4.4         1.3 Iris-versicolor
## 89          5.6         3.0          4.1         1.3 Iris-versicolor
## 90          5.5         2.5          4.0         1.3 Iris-versicolor
## 91          5.5         2.6          4.4         1.2 Iris-versicolor
## 92          6.1         3.0          4.6         1.4 Iris-versicolor
## 93          5.8         2.6          4.0         1.2 Iris-versicolor
## 94          5.0         2.3          3.3         1.0 Iris-versicolor
## 95          5.6         2.7          4.2         1.3 Iris-versicolor
## 96          5.7         3.0          4.2         1.2 Iris-versicolor
## 97          5.7         2.9          4.2         1.3 Iris-versicolor
## 98          6.2         2.9          4.3         1.3 Iris-versicolor
## 99          5.1         2.5          3.0         1.1 Iris-versicolor
## 100         5.7         2.8          4.1         1.3 Iris-versicolor
## 101         6.3         3.3          6.0         2.5  Iris-virginica
## 102         5.8         2.7          5.1         1.9  Iris-virginica
## 103         7.1         3.0          5.9         2.1  Iris-virginica
## 104         6.3         2.9          5.6         1.8  Iris-virginica
## 105         6.5         3.0          5.8         2.2  Iris-virginica
## 106         7.6         3.0          6.6         2.1  Iris-virginica
## 107         4.9         2.5          4.5         1.7  Iris-virginica
## 108         7.3         2.9          6.3         1.8  Iris-virginica
## 109         6.7         2.5          5.8         1.8  Iris-virginica
## 110         7.2         3.6          6.1         2.5  Iris-virginica
## 111         6.5         3.2          5.1         2.0  Iris-virginica
## 112         6.4         2.7          5.3         1.9  Iris-virginica
## 113         6.8         3.0          5.5         2.1  Iris-virginica
## 114         5.7         2.5          5.0         2.0  Iris-virginica
## 115         5.8         2.8          5.1         2.4  Iris-virginica
## 116         6.4         3.2          5.3         2.3  Iris-virginica
## 117         6.5         3.0          5.5         1.8  Iris-virginica
## 118         7.7         3.8          6.7         2.2  Iris-virginica
## 119         7.7         2.6          6.9         2.3  Iris-virginica
## 120         6.0         2.2          5.0         1.5  Iris-virginica
## 121         6.9         3.2          5.7         2.3  Iris-virginica
## 122         5.6         2.8          4.9         2.0  Iris-virginica
## 123         7.7         2.8          6.7         2.0  Iris-virginica
## 124         6.3         2.7          4.9         1.8  Iris-virginica
## 125         6.7         3.3          5.7         2.1  Iris-virginica
## 126         7.2         3.2          6.0         1.8  Iris-virginica
## 127         6.2         2.8          4.8         1.8  Iris-virginica
## 128         6.1         3.0          4.9         1.8  Iris-virginica
## 129         6.4         2.8          5.6         2.1  Iris-virginica
## 130         7.2         3.0          5.8         1.6  Iris-virginica
## 131         7.4         2.8          6.1         1.9  Iris-virginica
## 132         7.9         3.8          6.4         2.0  Iris-virginica
## 133         6.4         2.8          5.6         2.2  Iris-virginica
## 134         6.3         2.8          5.1         1.5  Iris-virginica
## 135         6.1         2.6          5.6         1.4  Iris-virginica
```

```
## 136          7.7         3.0          6.1         2.3  Iris-virginica
## 137          6.3         3.4          5.6         2.4  Iris-virginica
## 138          6.4         3.1          5.5         1.8  Iris-virginica
## 139          6.0         3.0          4.8         1.8  Iris-virginica
## 140          6.9         3.1          5.4         2.1  Iris-virginica
## 141          6.7         3.1          5.6         2.4  Iris-virginica
## 142          6.9         3.1          5.1         2.3  Iris-virginica
## 143          5.8         2.7          5.1         1.9  Iris-virginica
## 144          6.8         3.2          5.9         2.3  Iris-virginica
## 145          6.7         3.3          5.7         2.5  Iris-virginica
## 146          6.7         3.0          5.2         2.3  Iris-virginica
## 147          6.3         2.5          5.0         1.9  Iris-virginica
## 148          6.5         3.0          5.2         2.0  Iris-virginica
## 149          6.2         3.4          5.4         2.3  Iris-virginica
## 150          5.9         3.0          5.1         1.8  Iris-virginica
```

Saving the data frame as "csv" file in laptop:

```
write.csv(iris, "iris.csv") #Will save CSV file in working directory
```

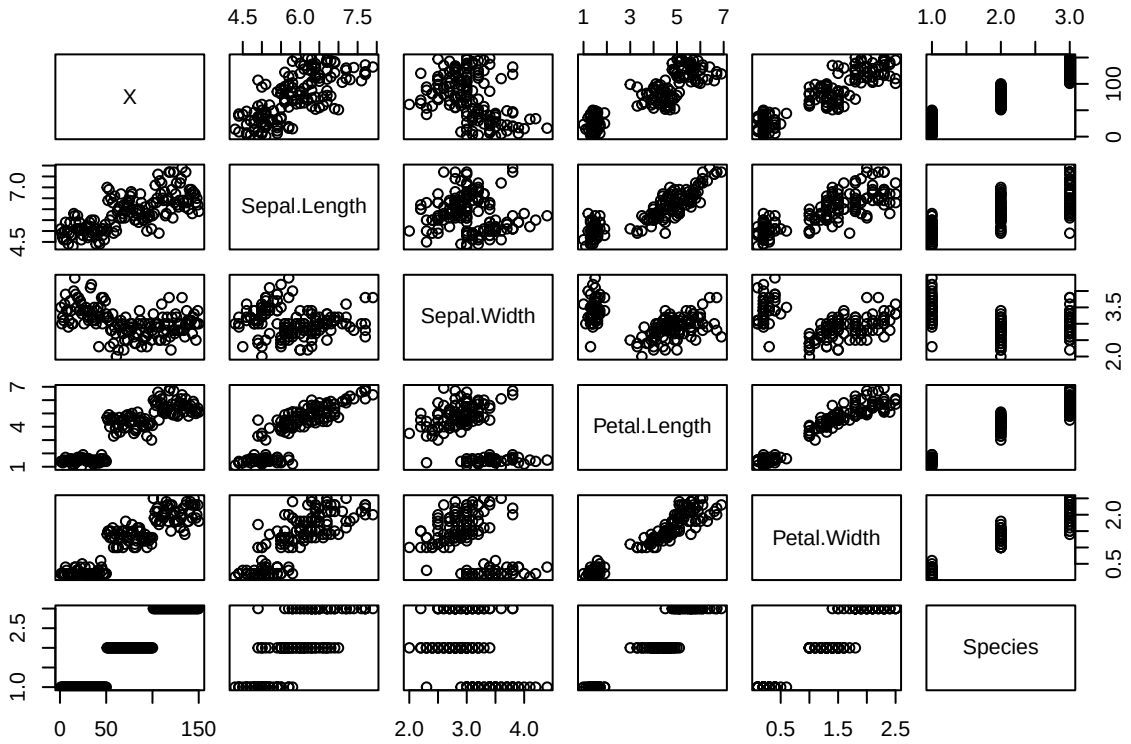
store the current directory

```
initial.dir <- getwd()
# change to the new Test directory
setwd("~/Desktop/projects/r-starter")

# load the necessary libraries
library(magrittr) #for pipes

# set the output file (it will bypass R and R Studio)
sink("session3.out")
# load the dataset from Test folder
iris <- read.csv("iris.csv")

# Do the analysis
plot(iris)
```




```
summary(iris)
iris %$% cor(Sepal.Length, Sepal.Width)
# close the output file
sink()

# unload the libraries
detach("package:magrittr")

# change back to the original directory
setwd(initial.dir)
```

Using forward pipe operator/s in R:

library(magrittr) required!

```
library(magrittr)

# Compute the square root of `iris$Sepal.Length` and assign it to the new variable
iris$Sepal.Length.SQRT <- iris$Sepal.Length %>% sqrt()

# Compute the square root of `iris$Sepal.Length` and assign it to the same variable
iris$Sepal.Length %<>% sqrt

# Return `Sepal.Length`
iris$Sepal.Length
```

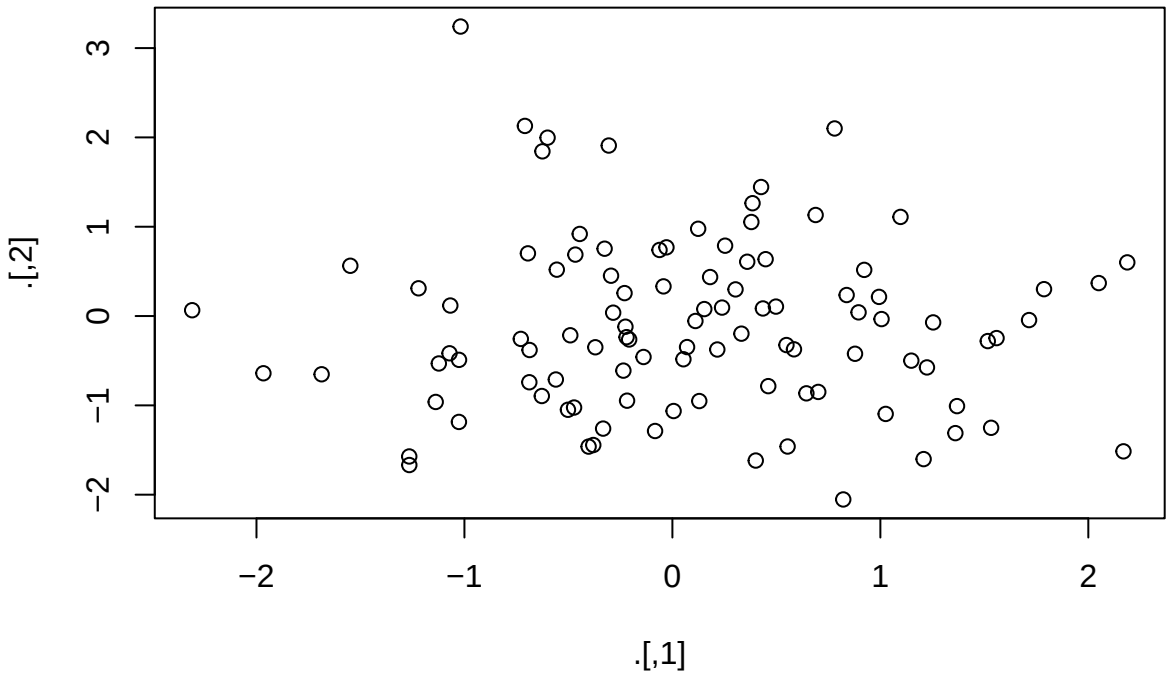
```
##   [1] 2.258318 2.213594 2.167948 2.144761 2.236068 2.323790 2.144761 2.236068
##   [9] 2.097618 2.213594 2.323790 2.190890 2.190890 2.073644 2.408319 2.387467
##  [17] 2.323790 2.258318 2.387467 2.258318 2.323790 2.258318 2.144761 2.258318
##  [25] 2.190890 2.236068 2.236068 2.280351 2.280351 2.167948 2.190890 2.323790
##  [33] 2.280351 2.345208 2.213594 2.236068 2.345208 2.213594 2.097618 2.258318
```

```
##  [41] 2.236068 2.121320 2.097618 2.236068 2.258318 2.190890 2.258318 2.144761
##  [49] 2.302173 2.236068 2.645751 2.529822 2.626785 2.345208 2.549510 2.387467
##  [57] 2.509980 2.213594 2.569047 2.280351 2.236068 2.428992 2.449490 2.469818
##  [65] 2.366432 2.588436 2.366432 2.408319 2.489980 2.366432 2.428992 2.469818
##  [73] 2.509980 2.469818 2.529822 2.569047 2.607681 2.588436 2.449490 2.387467
##  [81] 2.345208 2.345208 2.408319 2.449490 2.323790 2.449490 2.588436 2.509980
##  [89] 2.366432 2.345208 2.345208 2.469818 2.408319 2.236068 2.366432 2.387467
##  [97] 2.387467 2.489980 2.258318 2.387467 2.509980 2.408319 2.664583 2.509980
## [105] 2.549510 2.756810 2.213594 2.701851 2.588436 2.683282 2.549510 2.529822
## [113] 2.607681 2.387467 2.408319 2.529822 2.549510 2.774887 2.774887 2.449490
## [121] 2.626785 2.366432 2.774887 2.509980 2.588436 2.683282 2.489980 2.469818
## [129] 2.529822 2.683282 2.720294 2.810694 2.529822 2.509980 2.469818 2.774887
## [137] 2.509980 2.529822 2.449490 2.626785 2.588436 2.626785 2.408319 2.607681
## [145] 2.588436 2.588436 2.509980 2.549510 2.489980 2.428992
```

The "tee" pipe operator "%T%":

library(magrittr) required!

```
set.seed(123)
rnorm(200) %>%
matrix(ncol = 2) %T>%
plot %>%
colSums
```




```
## [1]   9.040591 -10.754680
```

The exposing pipe operator "%$%":

library(magrittr) required!

```
iris %>%
subset(Sepal.Length > mean(Sepal.Length)) %$%
cor(Sepal.Length, Sepal.Width)
```

```
## [1] 0.3365679
```

```
# The %$% operation comes handy for functions where "data" argument is not required/used like built-in
cor(iris$Sepal.Length, iris$Sepal.Width)
```

```
## [1] -0.114702
```

Functions in R: Built-in functions

```
# round()
round(3.1415)
```

```
## [1] 3
```

```
round(3.1415, digits = 2)
```

```
## [1] 3.14
```

```
# factorial()
factorial(3)
```

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

```
factorial(2*3)
```

```
## [1] 720
```

```
# mean()
mean(1:6)
```

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

```
mean(c(1:30))
```

```
## [1] 15.5
```

"Sample" function: Random sampling without or with replacement in R

```
die <- 1:6
sample(x = die, size = 1)
```

```
## [1] 3
```

```
sample(x = die, size = 1)
```

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

```
sample (x = die, size = 1, replace=TRUE)
```

```
## [1] 5
```

```
sample(x = die, size = 2)
```

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

```
sample(x = die, size = 2)
```

```
## [1] 4 2
```

```
sample(x = die, size = 2, replace=TRUE)
```

```
## [1] 6 2
```

"Sample" function to split a datafile into train and test datasets

```
# Make sure to have "iris.csv" datafile in the working directory and use read.csv to import it in R Stu
read.csv("iris.csv")
```

```
##       X Sepal.Length Sepal.Width Petal.Length Petal.Width         Species
## 1     1          5.1         3.5          1.4         0.2     Iris-setosa
## 2     2          4.9         3.0          1.4         0.2     Iris-setosa
## 3     3          4.7         3.2          1.3         0.2     Iris-setosa
## 4     4          4.6         3.1          1.5         0.2     Iris-setosa
## 5     5          5.0         3.6          1.4         0.2     Iris-setosa
## 6     6          5.4         3.9          1.7         0.4     Iris-setosa
## 7     7          4.6         3.4          1.4         0.3     Iris-setosa
## 8     8          5.0         3.4          1.5         0.2     Iris-setosa
## 9     9          4.4         2.9          1.4         0.2     Iris-setosa
## 10   10          4.9         3.1          1.5         0.1     Iris-setosa
## 11   11          5.4         3.7          1.5         0.2     Iris-setosa
## 12   12          4.8         3.4          1.6         0.2     Iris-setosa
## 13   13          4.8         3.0          1.4         0.1     Iris-setosa
## 14   14          4.3         3.0          1.1         0.1     Iris-setosa
## 15   15          5.8         4.0          1.2         0.2     Iris-setosa
## 16   16          5.7         4.4          1.5         0.4     Iris-setosa
## 17   17          5.4         3.9          1.3         0.4     Iris-setosa
## 18   18          5.1         3.5          1.4         0.3     Iris-setosa
## 19   19          5.7         3.8          1.7         0.3     Iris-setosa
## 20   20          5.1         3.8          1.5         0.3     Iris-setosa
## 21   21          5.4         3.4          1.7         0.2     Iris-setosa
## 22   22          5.1         3.7          1.5         0.4     Iris-setosa
## 23   23          4.6         3.6          1.0         0.2     Iris-setosa
## 24   24          5.1         3.3          1.7         0.5     Iris-setosa
## 25   25          4.8         3.4          1.9         0.2     Iris-setosa
## 26   26          5.0         3.0          1.6         0.2     Iris-setosa
## 27   27          5.0         3.4          1.6         0.4     Iris-setosa
## 28   28          5.2         3.5          1.5         0.2     Iris-setosa
## 29   29          5.2         3.4          1.4         0.2     Iris-setosa
## 30   30          4.7         3.2          1.6         0.2     Iris-setosa
## 31   31          4.8         3.1          1.6         0.2     Iris-setosa
## 32   32          5.4         3.4          1.5         0.4     Iris-setosa
## 33   33          5.2         4.1          1.5         0.1     Iris-setosa
## 34   34          5.5         4.2          1.4         0.2     Iris-setosa
## 35   35          4.9         3.1          1.5         0.1     Iris-setosa
## 36   36          5.0         3.2          1.2         0.2     Iris-setosa
## 37   37          5.5         3.5          1.3         0.2     Iris-setosa
## 38   38          4.9         3.1          1.5         0.1     Iris-setosa
## 39   39          4.4         3.0          1.3         0.2     Iris-setosa
## 40   40          5.1         3.4          1.5         0.2     Iris-setosa
## 41   41          5.0         3.5          1.3         0.3     Iris-setosa
## 42   42          4.5         2.3          1.3         0.3     Iris-setosa
## 43   43          4.4         3.2          1.3         0.2     Iris-setosa
## 44   44          5.0         3.5          1.6         0.6     Iris-setosa
## 45   45          5.1         3.8          1.9         0.4     Iris-setosa
## 46   46          4.8         3.0          1.4         0.3     Iris-setosa
## 47   47          5.1         3.8          1.6         0.2     Iris-setosa
## 48   48          4.6         3.2          1.4         0.2     Iris-setosa
```

```
## 49   49          5.3         3.7          1.5         0.2     Iris-setosa
## 50   50          5.0         3.3          1.4         0.2     Iris-setosa
## 51   51          7.0         3.2          4.7         1.4 Iris-versicolor
## 52   52          6.4         3.2          4.5         1.5 Iris-versicolor
## 53   53          6.9         3.1          4.9         1.5 Iris-versicolor
## 54   54          5.5         2.3          4.0         1.3 Iris-versicolor
## 55   55          6.5         2.8          4.6         1.5 Iris-versicolor
## 56   56          5.7         2.8          4.5         1.3 Iris-versicolor
## 57   57          6.3         3.3          4.7         1.6 Iris-versicolor
## 58   58          4.9         2.4          3.3         1.0 Iris-versicolor
## 59   59          6.6         2.9          4.6         1.3 Iris-versicolor
## 60   60          5.2         2.7          3.9         1.4 Iris-versicolor
## 61   61          5.0         2.0          3.5         1.0 Iris-versicolor
## 62   62          5.9         3.0          4.2         1.5 Iris-versicolor
## 63   63          6.0         2.2          4.0         1.0 Iris-versicolor
## 64   64          6.1         2.9          4.7         1.4 Iris-versicolor
## 65   65          5.6         2.9          3.6         1.3 Iris-versicolor
## 66   66          6.7         3.1          4.4         1.4 Iris-versicolor
## 67   67          5.6         3.0          4.5         1.5 Iris-versicolor
## 68   68          5.8         2.7          4.1         1.0 Iris-versicolor
## 69   69          6.2         2.2          4.5         1.5 Iris-versicolor
## 70   70          5.6         2.5          3.9         1.1 Iris-versicolor
## 71   71          5.9         3.2          4.8         1.8 Iris-versicolor
## 72   72          6.1         2.8          4.0         1.3 Iris-versicolor
## 73   73          6.3         2.5          4.9         1.5 Iris-versicolor
## 74   74          6.1         2.8          4.7         1.2 Iris-versicolor
## 75   75          6.4         2.9          4.3         1.3 Iris-versicolor
## 76   76          6.6         3.0          4.4         1.4 Iris-versicolor
## 77   77          6.8         2.8          4.8         1.4 Iris-versicolor
## 78   78          6.7         3.0          5.0         1.7 Iris-versicolor
## 79   79          6.0         2.9          4.5         1.5 Iris-versicolor
## 80   80          5.7         2.6          3.5         1.0 Iris-versicolor
## 81   81          5.5         2.4          3.8         1.1 Iris-versicolor
## 82   82          5.5         2.4          3.7         1.0 Iris-versicolor
## 83   83          5.8         2.7          3.9         1.2 Iris-versicolor
## 84   84          6.0         2.7          5.1         1.6 Iris-versicolor
## 85   85          5.4         3.0          4.5         1.5 Iris-versicolor
## 86   86          6.0         3.4          4.5         1.6 Iris-versicolor
## 87   87          6.7         3.1          4.7         1.5 Iris-versicolor
## 88   88          6.3         2.3          4.4         1.3 Iris-versicolor
## 89   89          5.6         3.0          4.1         1.3 Iris-versicolor
## 90   90          5.5         2.5          4.0         1.3 Iris-versicolor
## 91   91          5.5         2.6          4.4         1.2 Iris-versicolor
## 92   92          6.1         3.0          4.6         1.4 Iris-versicolor
## 93   93          5.8         2.6          4.0         1.2 Iris-versicolor
## 94   94          5.0         2.3          3.3         1.0 Iris-versicolor
## 95   95          5.6         2.7          4.2         1.3 Iris-versicolor
## 96   96          5.7         3.0          4.2         1.2 Iris-versicolor
## 97   97          5.7         2.9          4.2         1.3 Iris-versicolor
## 98   98          6.2         2.9          4.3         1.3 Iris-versicolor
## 99   99          5.1         2.5          3.0         1.1 Iris-versicolor
## 100 100          5.7         2.8          4.1         1.3 Iris-versicolor
## 101 101          6.3         3.3          6.0         2.5  Iris-virginica
## 102 102          5.8         2.7          5.1         1.9  Iris-virginica
```

```
## 103 103          7.1         3.0          5.9         2.1  Iris-virginica
## 104 104          6.3         2.9          5.6         1.8  Iris-virginica
## 105 105          6.5         3.0          5.8         2.2  Iris-virginica
## 106 106          7.6         3.0          6.6         2.1  Iris-virginica
## 107 107          4.9         2.5          4.5         1.7  Iris-virginica
## 108 108          7.3         2.9          6.3         1.8  Iris-virginica
## 109 109          6.7         2.5          5.8         1.8  Iris-virginica
## 110 110          7.2         3.6          6.1         2.5  Iris-virginica
## 111 111          6.5         3.2          5.1         2.0  Iris-virginica
## 112 112          6.4         2.7          5.3         1.9  Iris-virginica
## 113 113          6.8         3.0          5.5         2.1  Iris-virginica
## 114 114          5.7         2.5          5.0         2.0  Iris-virginica
## 115 115          5.8         2.8          5.1         2.4  Iris-virginica
## 116 116          6.4         3.2          5.3         2.3  Iris-virginica
## 117 117          6.5         3.0          5.5         1.8  Iris-virginica
## 118 118          7.7         3.8          6.7         2.2  Iris-virginica
## 119 119          7.7         2.6          6.9         2.3  Iris-virginica
## 120 120          6.0         2.2          5.0         1.5  Iris-virginica
## 121 121          6.9         3.2          5.7         2.3  Iris-virginica
## 122 122          5.6         2.8          4.9         2.0  Iris-virginica
## 123 123          7.7         2.8          6.7         2.0  Iris-virginica
## 124 124          6.3         2.7          4.9         1.8  Iris-virginica
## 125 125          6.7         3.3          5.7         2.1  Iris-virginica
## 126 126          7.2         3.2          6.0         1.8  Iris-virginica
## 127 127          6.2         2.8          4.8         1.8  Iris-virginica
## 128 128          6.1         3.0          4.9         1.8  Iris-virginica
## 129 129          6.4         2.8          5.6         2.1  Iris-virginica
## 130 130          7.2         3.0          5.8         1.6  Iris-virginica
## 131 131          7.4         2.8          6.1         1.9  Iris-virginica
## 132 132          7.9         3.8          6.4         2.0  Iris-virginica
## 133 133          6.4         2.8          5.6         2.2  Iris-virginica
## 134 134          6.3         2.8          5.1         1.5  Iris-virginica
## 135 135          6.1         2.6          5.6         1.4  Iris-virginica
## 136 136          7.7         3.0          6.1         2.3  Iris-virginica
## 137 137          6.3         3.4          5.6         2.4  Iris-virginica
## 138 138          6.4         3.1          5.5         1.8  Iris-virginica
## 139 139          6.0         3.0          4.8         1.8  Iris-virginica
## 140 140          6.9         3.1          5.4         2.1  Iris-virginica
## 141 141          6.7         3.1          5.6         2.4  Iris-virginica
## 142 142          6.9         3.1          5.1         2.3  Iris-virginica
## 143 143          5.8         2.7          5.1         1.9  Iris-virginica
## 144 144          6.8         3.2          5.9         2.3  Iris-virginica
## 145 145          6.7         3.3          5.7         2.5  Iris-virginica
## 146 146          6.7         3.0          5.2         2.3  Iris-virginica
## 147 147          6.3         2.5          5.0         1.9  Iris-virginica
## 148 148          6.5         3.0          5.2         2.0  Iris-virginica
## 149 149          6.2         3.4          5.4         2.3  Iris-virginica
## 150 150          5.9         3.0          5.1         1.8  Iris-virginica
```

```r
# We can do the 70:30 random split of iris data frame as follow:
set.seed(123)
tt.sample <- sample(c(TRUE, FALSE), nrow(iris), replace=T, prob=c(0.7,0.3))
train <- iris[tt.sample, ]
test <- iris[!tt.sample, ]
```

User-defined function in R:

```
my_function <- function() {}
```

User-defined function 1: roll()

```
roll <- function() {
  die <- 1:6
  dice <- sample(die, size = 2, replace = TRUE)
  sum(dice)
}
roll()
```

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

```
roll()
```

```
## [1] 4
```

```
roll()
```

```
## [1] 7
```

User-defined function 2: roll2()

```
roll2 <- function(dice = 1:6) {
  dice <- sample(dice, size = 2, replace = TRUE)
  sum(dice)
}
roll2()
```

```
## [1] 12
```

```
roll2()
```

```
## [1] 5
```

```
roll2()
```

```
## [1] 11
```

User-defined function 3: roll3(data?)

```
roll3 <- function(dice) {
  dice <- sample(dice, size = 2, replace = TRUE)
  sum(dice)
}

roll3(1:6)
```

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

```
roll3(1:12)
```

```
## [1] 16
```

```
roll3(1:24)
```

```
## [1] 33
```

More Functions

```
best_practice <- c("Let", "the", "computer", "do", "the", "work")
print_words <- function(sentence) {
  print(sentence[1])
  print(sentence[2])
  print(sentence[3])
  print(sentence[4])
  print(sentence[5])
  print(sentence[6])
}
print_words(best_practice)
```

```
## [1] "Let"
## [1] "the"
## [1] "computer"
## [1] "do"
## [1] "the"
## [1] "work"
```

```
print_words(best_practice[-6])
```

```
## [1] "Let"
## [1] "the"
## [1] "computer"
## [1] "do"
## [1] "the"
## [1] NA
```

```
best_practice[-6]
```

```
## [1] "Let"      "the"      "computer" "do"       "the"
```

We can use functions with "for" loop in R!

```
print_words <- function(sentence) {
  for (word in sentence) {
    print(word)
  }
}
print_words(best_practice)
```

```
## [1] "Let"
## [1] "the"
## [1] "computer"
## [1] "do"
## [1] "the"
## [1] "work"
```

```
print_words(best_practice[-6])
```

```
## [1] "Let"
## [1] "the"
## [1] "computer"
## [1] "do"
## [1] "the"
```

```
best_practice[-6]
```

```
## [1] "Let"      "the"      "computer" "do"       "the"
```

Condition: if and else

```
#Checking values of y with x:
# if (y < 20) {
#   x <- "Too low"
# } else {
#  x <- "Too high"
# }

#Will this work?
check.y <- function(y) {
  if (y < 20) {
    print("Too Low")
  } else {
    print("Two high")
  }
}

check.y(10)
```

```
## [1] "Too Low"
```

```
check.y(30)
```

```
## [1] "Two high"
```

Creating binary variables with "ifelse"

```
y <- 1:40
ifelse(y<20, "Too low", "Too high")
```

```
##  [1] "Too low"  "Too low"  "Too low"  "Too low"  "Too low"  "Too low"
##  [7] "Too low"  "Too low"  "Too low"  "Too low"  "Too low"  "Too low"
## [13] "Too low"  "Too low"  "Too low"  "Too low"  "Too low"  "Too low"
## [19] "Too low"  "Too high" "Too high" "Too high" "Too high" "Too high"
## [25] "Too high" "Too high" "Too high" "Too high" "Too high" "Too high"
## [31] "Too high" "Too high" "Too high" "Too high" "Too high" "Too high"
## [37] "Too high" "Too high" "Too high" "Too high"
```

```
# It's a logical as:
ifelse(y<20, TRUE, FALSE)
```

```
##  [1]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE
## [13]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE
## [25] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [37] FALSE FALSE FALSE FALSE
```

```
y <- 1:40
ifelse(y<20, 1, 0)
```

```
##  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [39] 0 0
```

Multiple conditions:

```
if (this) {
# do that
} else if (that) {
# do something else
} else if (that) {
# do something else
} else
# remaining
}
```

```
check.x <- function(x=1:99){
  if (x<20){
    print("Less than 20")} else{
      if (x<40) {
        print("20-39")
      } else {
        if (x<100) {
          print("41-99")
        }
     }
   }
}
check.x(15)
```

```
## [1] "Less than 20"
```

```
check.x(30)
```

```
## [1] "20-39"
```

```
check.x(45)
```

```
## [1] "41-99"
```

Multiple Conditions: combining "ifelse"

```
x <- 1:99
x1 <- ifelse(x<20, 1,0) #Binary numbers
x2.1 <- ifelse(x<20, "<20", "20+") #Binary text
# x2.2 # ? For x between 20 and less than 40
# x2.3 # ? For x between 40 and less than 100

x3 <- ifelse(x<20,1,ifelse(x<40,2,3))
x3
```

```
##  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
## [39] 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
## [77] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
```

```
table(x3)
```

```
## x3
##  1  2  3
## 19 20 60
```

```
#This code shows how Petal. Length categories was created from Petal. Length variable of iris data fram
iris <- within(iris, {
  Petal.cat <- NA
  Petal.cat[Petal.Length <1.6] <- "Small"
  Petal.cat[Petal.Length >=1.6 &
  Petal.Length<5.1] <- "Medium"
  Petal.cat[Petal.Length >=5.1] <- "Large"
})
#The 1.6=Q1 and 5.1=Q3 were obtained from the "summary" of the Petal.Lenght variable i.e. summary(iris$
iris$Petal.cat
```

```
##   [1] "Small"  "Small"  "Small"  "Small"  "Small"  "Medium" "Small"  "Small"
##   [9] "Small"  "Small"  "Small"  "Medium" "Small"  "Small"  "Small"  "Small"
##  [17] "Small"  "Small"  "Medium" "Small"  "Medium" "Small"  "Small"  "Medium"
##  [25] "Medium" "Medium" "Medium" "Small"  "Small"  "Medium" "Medium" "Small"
##  [33] "Small"  "Small"  "Small"  "Small"  "Small"  "Small"  "Small"  "Small"
##  [41] "Small"  "Small"  "Small"  "Medium" "Medium" "Small"  "Medium" "Small"
##  [49] "Small"  "Small"  "Medium" "Medium" "Medium" "Medium" "Medium" "Medium"
##  [57] "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium"
##  [65] "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium"
##  [73] "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium"
##  [81] "Medium" "Medium" "Medium" "Large"  "Medium" "Medium" "Medium" "Medium"
##  [89] "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium" "Medium"
##  [97] "Medium" "Medium" "Medium" "Medium" "Large"  "Large"  "Large"  "Large"
## [105] "Large"  "Large"  "Medium" "Large"  "Large"  "Large"  "Large"  "Large"
## [113] "Large"  "Medium" "Large"  "Large"  "Large"  "Large"  "Large"  "Medium"
## [121] "Large"  "Medium" "Large"  "Medium" "Large"  "Large"  "Medium" "Medium"
## [129] "Large"  "Large"  "Large"  "Large"  "Large"  "Large"  "Large"  "Large"
## [137] "Large"  "Large"  "Medium" "Large"  "Large"  "Large"  "Large"  "Large"
## [145] "Large"  "Large"  "Medium" "Large"  "Large"  "Large"
```

```
table(iris$Petal.cat)
```

```
##
##  Large Medium  Small
##     42     71     37
```

Multiple Conditions: If, else if, else if, else if

```
if (temp <= 0) {
"freezing"}
else if (temp <= 10) {
"cold"}
else if (temp <= 20) {
"cool"}
else if (temp <= 30) {
"warm"}
else {
"hot"}
```

```
temp_description <- function(temp) {
  if (temp <= 0) {
    "freezing"
  } else if (temp <= 10) {
    "cold"
```

```
  } else if (temp <= 20) {
    "cool"
  } else if (temp <= 30) {
    "warm"
  } else {
    "hot"
  }
}

# Example usage:
temp_description(0)
```

```
## [1] "freezing"
```

```
temp_description(10)
```

```
## [1] "cold"
```

```
temp_description(15)
```

```
## [1] "cool"
```

```
temp_description(25)
```

```
## [1] "warm"
```

```
temp_description(35)
```

```
## [1] "hot"
```

Scraping Covid data from Wikipedia and html parsing

```
library(rvest)
library(dbplyr)

url <- "https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Nepal#Data"

covid_data <- read_html(url)

table_data <- covid_data %>% html_nodes(".COVID-19_pandemic_data_Nepal_medical_cases table") %>% html_t

head(table_data)
```

```
## [[1]]
## # A tibble: 496 x 14
##    Date   `Confirmed cases` `Confirmed cases` `Confirmed cases` Recoveries
##    <chr>  <chr>             <chr>             <chr>             <chr>
##  1 Date   Total             New               Active            Total
##  2 23 Jan 1                 +1                1                 0
##  3 24 Jan 1                 0                 1                 0
##  4 25 Jan 1                 0                 1                 0
##  5 26 Jan 1                 0                 1                 0
##  6 27 Jan 1                 0                 1                 0
##  7 28 Jan 1                 0                 1                 0
##  8 29 Jan 1                 0                 0                 1
##  9 30 Jan 1                 0                 0                 1
## 10 31 Jan 1                 0                 0                 1
```

```
## # i 486 more rows
## # i 9 more variables: Recoveries <chr>, Deaths <chr>, Deaths <chr>,
## #   `RT-PCR tests` <chr>, `RT-PCR tests` <chr>, TPR <chr>, RR <chr>, CFR <chr>,
## #   Ref. <chr>
```

```
table_df <- as.data.frame(table_data)
table_df
```

```
##       Date Confirmed.cases Confirmed.cases.1 Confirmed.cases.2 Recoveries
## 1     Date           Total               New            Active      Total
## 2   23 Jan               1                +1                 1          0
## 3   24 Jan               1                 0                 1          0
## 4   25 Jan               1                 0                 1          0
## 5   26 Jan               1                 0                 1          0
## 6   27 Jan               1                 0                 1          0
## 7   28 Jan               1                 0                 1          0
## 8   29 Jan               1                 0                 0          1
## 9   30 Jan               1                 0                 0          1
## 10  31 Jan               1                 0                 0          1
## 11   1 Feb               1                 0                 0          1
## 12   2 Feb               1                 0                 0          1
## 13   3 Feb               1                 0                 0          1
## 14   4 Feb               1                 0                 0          1
## 15   5 Feb               1                 0                 0          1
## 16   6 Feb               1                 0                 0          1
## 17   7 Feb               1                 0                 0          1
## 18   8 Feb               1                 0                 0          1
## 19   9 Feb               1                 0                 0          1
## 20  10 Feb               1                 0                 0          1
## 21  11 Feb               1                 0                 0          1
## 22  12 Feb               1                 0                 0          1
## 23  13 Feb               1                 0                 0          1
## 24  14 Feb               1                 0                 0          1
## 25  15 Feb               1                 0                 0          1
## 26  16 Feb               1                 0                 0          1
## 27  17 Feb               1                 0                 0          1
## 28  18 Feb               1                 0                 0          1
## 29  19 Feb               1                 0                 0          1
## 30  20 Feb               1                 0                 0          1
## 31  21 Feb               1                 0                 0          1
## 32  22 Feb               1                 0                 0          1
## 33  23 Feb               1                 0                 0          1
## 34  24 Feb               1                 0                 0          1
## 35  25 Feb               1                 0                 0          1
## 36  26 Feb               1                 0                 0          1
## 37  27 Feb               1                 0                 0          1
## 38  28 Feb               1                 0                 0          1
## 39  29 Feb               1                 0                 0          1
## 40   1 Mar               1                 0                 0          1
## 41   2 Mar               1                 0                 0          1
## 42   3 Mar               1                 0                 0          1
## 43   4 Mar               1                 0                 0          1
## 44   5 Mar               1                 0                 0          1
## 45   6 Mar               1                 0                 0          1
## 46   7 Mar               1                 0                 0          1
```

```
## 47   8 Mar                1                 0                 0          1
## 48   9 Mar                1                 0                 0          1
## 49  10 Mar                1                 0                 0          1
## 50  11 Mar                1                 0                 0          1
## 51  12 Mar                1                 0                 0          1
## 52  13 Mar                1                 0                 0          1
## 53  14 Mar                1                 0                 0          1
## 54  15 Mar                1                 0                 0          1
## 55  16 Mar                1                 0                 0          1
## 56  17 Mar                1                 0                 0          1
## 57  18 Mar                1                 0                 0          1
## 58  19 Mar                1                 0                 0          1
## 59  20 Mar                1                 0                 0          1
## 60  21 Mar                1                 0                 0          1
## 61  22 Mar                1                 0                 0          1
## 62  23 Mar                2                +1                 1          1
## 63  24 Mar                2                 0                 1          1
## 64  25 Mar                3                +1                 2          1
## 65  26 Mar                3                 0                 2          1
## 66  27 Mar                4                +1                 3          1
## 67  28 Mar                5                +1                 4          1
## 68  29 Mar                5                 0                 4          1
## 69  30 Mar                5                 0                 4          1
## 70  31 Mar                5                 0                 4          1
## 71   1 Apr                5                 0                 4          1
## 72   2 Apr                6                +1                 5          1
## 73   3 Apr                6                 0                 5          1
## 74   4 Apr                9                +3                 8          1
## 75   5 Apr                9                 0                 8          1
## 76   6 Apr                9                 0                 8          1
## 77   7 Apr                9                 0                 8          1
## 78   8 Apr                9                 0                 8          1
## 79   9 Apr                9                 0                 8          1
## 80  10 Apr                9                 0                 8          1
## 81  11 Apr                9                 0                 8          1
## 82  12 Apr               12                +3                11          1
## 83  13 Apr               14                +2                13          1
## 84  14 Apr               16                +2                15          1
## 85  15 Apr               16                 0                15          1
## 86  16 Apr               16                 0                14          2
## 87  17 Apr               30               +14                28          2
## 88  18 Apr               31                +1                29          2
## 89  19 Apr               31                 0                27          4
## 90  20 Apr               31                 0                27          4
## 91  21 Apr               42               +11                38          4
## 92  22 Apr               45                +3                38          7
## 93  23 Apr               48                +3                39          9
## 94  24 Apr               49                +1                39         10
## 95  25 Apr               49                 0                37         12
## 96  26 Apr               52                +3                36         16
## 97  27 Apr               52                 0                36         16
## 98  28 Apr               54                +2                38         16
## 99  29 Apr               57                +3                41         16
## 100 30 Apr               57                 0                41         16
```

```
## 101  1 May              59              +2              43          16
## 102  2 May              59               0              43          16
## 103  3 May              75             +16              59          16
## 104  4 May              75               0              59          16
## 105  5 May              82              +7              66          16
## 106  6 May              99             +17              77          22
## 107  7 May             101              +2              79          22
## 108  8 May             102              +1              71          31
## 109  9 May             109              +7              78          31
## 110 10 May             110              +1              79          31
## 111 11 May             134             +24             101          33
## 112 12 May             217             +83             184          33
## 113 13 May             243             +26             208          35
## 114 14 May             249              +6             214          35
## 115 15 May             267             +18             231          36
## 116 16 May             281             +14             244          36
## 117 17 May             295             +14             257          36
## 118 18 May             375             +80             337          36
## 119 19 May             402             +27             363          37
## 120 20 May             427             +25             380          45
## 121 21 May             457             +30             405          49
## 122 22 May             516             +59             443          70
## 123 23 May             584             +68             511          70
## 124 24 May             603             +19             513          87
## 125 25 May             682             +79             566         112
## 126 26 May             772             +90             613         155
## 127 27 May             886            +114             699         183
## 128 28 May           1,042            +156             850         187
## 129 29 May           1,212            +170           1,000         206
## 130 30 May           1,401            +189           1,176         219
## 131 31 May           1,572            +171           1,344         220
## 132  1 Jun           1,811            +239           1,582         221
## 133  2 Jun           2,099            +288           1,825         266
## 134  3 Jun           2,300            +201           2,013         278
## 135  4 Jun           2,634            +334           2,334         290
## 136  5 Jun           2,912            +278           2,568         333
## 137  6 Jun           3,235            +323           2,857         365
## 138  7 Jun           3,448            +213           2,968         467
## 139  8 Jun           3,762            +314           3,260         488
## 140  9 Jun           4,085            +323           3,486         584
## 141 10 Jun           4,364            +279           3,675         674
## 142 11 Jun           4,614            +250           3,738         861
## 143 12 Jun           5,062            +448           4,169         877
## 144 13 Jun           5,335            +273           4,404         913
## 145 14 Jun           5,760            +425           4,767         974
## 146 15 Jun           6,211            +451           5,151       1,041
## 147 16 Jun           6,591            +380           5,414       1,158
## 148 17 Jun           7,177            +586           5,990       1,167
## 149 18 Jun           7,848            +671           6,640       1,186
## 150 19 Jun           8,274            +426           6,850       1,402
## 151 20 Jun           8,605            +331           7,005       1,578
## 152 21 Jun           9,026            +421           7,231       1,772
## 153 22 Jun           9,561            +535           7,390       2,148
## 154 23 Jun          10,099            +538           7,851       2,224
```

```
## 155 24 Jun          10,728          +629           8,366      2,338
## 156 25 Jun          11,162          +434           8,486      2,650
## 157 26 Jun          11,755          +593           9,030      2,698
## 158 27 Jun          12,309          +554           9,447      2,834
## 159 28 Jun          12,772          +463           9,731      3,013
## 160 29 Jun          13,248          +476          10,085      3,134
## 161 30 Jun          13,564          +316          10,341      3,194
## 162  1 Jul          14,046          +482          10,360      3,656
## 163  2 Jul          14,519          +473           9,168      5,320
## 164  3 Jul          15,259          +740           9,084      6,143
## 165  4 Jul          15,491          +232           9,042      6,415
## 166  5 Jul          15,784          +293           9,203      6,547
## 167  6 Jul          15,964          +180           9,118      6,811
## 168  7 Jul          16,168          +204           8,634      7,499
## 169  8 Jul          16,423          +255           8,636      7,752
## 170  9 Jul          16,531          +108           8,605      7,891
## 171 10 Jul          16,649          +118           8,603      8,011
## 172 11 Jul          16,719           +70           8,239      8,442
## 173 12 Jul          16,801           +82           8,174      8,589
## 174 13 Jul          16,945          +144           6,613     10,294
## 175 14 Jul          17,061          +116           6,695     10,328
## 176 15 Jul          17,177          +116           6,113     11,025
## 177 16 Jul          17,344          +167           6,056     11,249
## 178 17 Jul          17,445          +101           5,871     11,534
## 179 18 Jul          17,502           +57           5,825     11,637
## 180 19 Jul          17,658          +156           5,923     11,695
## 181 20 Jul          17,844          +186           5,936     11,868
## 182 21 Jul          17,994          +150           5,477     12,477
## 183 22 Jul          18,094          +100           5,368     12,684
## 184 23 Jul          18,241          +147           5,358     12,840
## 185 24 Jul          18,374          +133           5,383     12,947
## 186 25 Jul          18,483          +109           5,385     13,053
## 187 26 Jul          18,613          +130           5,440     13,128
## 188 27 Jul          18,752          +139           4,950     13,754
## 189 28 Jul          19,063          +311           5,139     13,875
## 190 29 Jul          19,273          +210           5,203     14,021
## 191 30 Jul          19,547          +274           5,247     14,248
## 192 31 Jul          19,771          +224           5,316     14,399
## 193  1 Aug          20,086          +315           5,538     14,492
## 194  2 Aug          20,332          +246           5,672     14,603
## 195  3 Aug          20,750          +418           5,732     14,961
## 196  4 Aug          21,009          +259           5,925     15,026
## 197  5 Aug          21,390          +381           6,174     15,156
## 198  6 Aug          21,750          +360           6,296     15,389
## 199  7 Aug          22,214          +464           6,330     15,814
## 200  8 Aug          22,592          +378           6,206     16,313
## 201  9 Aug          22,972          +380           6,544     16,353
## 202 10 Aug          23,310          +338           6,738     16,493
## 203 11 Aug          23,948          +638           7,201     16,664
## 204 12 Aug          24,432          +484           7,613     16,728
## 205 13 Aug          24,957          +525           8,025     16,837
## 206 14 Aug          25,551          +594           8,375     17,077
## 207 15 Aug          26,019          +468           8,716     17,201
## 208 16 Aug          26,660          +641           9,221     17,335
```

```
## 209 17 Aug          27,241            +581           9,639     17,495
## 210 18 Aug          28,257          +1,016          10,563     17,580
## 211 19 Aug          28,938            +681          11,118     17,700
## 212 20 Aug          29,645            +707          11,555     17,964
## 213 21 Aug          30,483            +838          12,132     18,214
## 214 22 Aug          31,117            +634          12,621     18,350
## 215 23 Aug          31,935            +818          13,155     18,631
## 216 24 Aug          32,678            +743          13,715     18,806
## 217 25 Aug          33,533            +855          14,250     19,119
## 218 26 Aug          34,418            +885          14,739     19,504
## 219 27 Aug          35,529          +1,111          15,273     20,073
## 220 28 Aug          36,456            +927          16,019     20,242
## 221 29 Aug          37,340            +884          16,578     20,555
## 222 30 Aug          38,561          +1,221          17,518     20,822
## 223 31 Aug          39,460            +899          17,822     21,410
## 224  1 Sep          40,529          +1,069          18,112     22,178
## 225  2 Sep          41,649          +1,120          18,108     23,290
## 226  3 Sep          42,877          +1,228          18,413     24,207
## 227  4 Sep          44,236          +1,359          18,404     25,561
## 228  5 Sep          45,277          +1,041          17,870     27,127
## 229  6 Sep          46,257            +980          17,027     28,941
## 230  7 Sep          47,236            +979          16,259     30,677
## 231  8 Sep          48,138            +902          14,868     32,964
## 232  9 Sep          49,219          +1,081          15,025     33,882
## 233 10 Sep          50,465          +1,246          14,448     35,700
## 234 11 Sep          51,919          +1,454          14,925     36,672
## 235 12 Sep          53,120          +1,201          15,260     37,524
## 236 13 Sep          54,159          +1,039          15,117     38,697
## 237 14 Sep          55,329          +1,170          15,393     39,576
## 238 15 Sep          56,788          +1,459          15,779     40,638
## 239 16 Sep          58,327          +1,539          16,242     41,706
## 240 17 Sep          59,573          +1,246          16,241     42,949
## 241 18 Sep          61,593          +2,020          17,383     43,820
## 242 19 Sep          62,797          +1,204          17,129     45,267
## 243 20 Sep          64,122          +1,325          17,478     46,233
## 244 21 Sep          65,276          +1,154          17,611     47,238
## 245 22 Sep          66,632          +1,356          18,142     48,061
## 246 23 Sep          67,804          +1,172          17,414     49,954
## 247 24 Sep          69,301          +1,497          18,437     50,411
## 248 25 Sep          70,614          +1,313          18,289     51,866
## 249 26 Sep          71,821          +1,207          18,341     53,013
## 250 27 Sep          73,394          +1,573          19,019     53,898
## 251 28 Sep          74,745          +1,351          19,624     54,640
## 252 29 Sep          76,258          +1,513          20,396     55,371
## 253 30 Sep          77,817          +1,559          20,891     56,428
## 254  1 Oct          79,728          +1,911          21,830     57,389
## 255  2 Oct          82,450          +2,722          21,234     60,696
## 256  3 Oct          84,570          +2,120          21,302     62,740
## 257  4 Oct          86,823          +2,253          22,219     64,069
## 258  5 Oct          89,263          +2,440          23,507     65,202
## 259  6 Oct          90,814          +1,551          22,709     67,542
## 260  7 Oct          94,253          +3,439          25,007     68,668
## 261  8 Oct          98,617          +4,364          26,684     71,343
## 262  9 Oct         100,676          +2,059          27,053     73,023
```

```
## 263 10 Oct         105,684          +5,008          30,818     74,252
## 264 11 Oct         107,755          +2,071          31,315     75,804
## 265 12 Oct         111,802          +4,047          33,880     77,277
## 266 13 Oct         115,358          +3,556          35,915     78,780
## 267 14 Oct         117,996          +2,638          36,367     80,954
## 268 15 Oct         121,745          +3,749          36,533     84,518
## 269 16 Oct         126,137          +4,392          37,382     88,040
## 270 17 Oct         129,304          +3,167          38,737     89,840
## 271 18 Oct         132,246          +2,942          39,341     92,166
## 272 19 Oct         136,036          +3,790          40,778     94,501
## 273 20 Oct         139,129          +3,093          41,755     96,609
## 274 21 Oct         144,872          +5,743          44,476     99,605
## 275 22 Oct         148,509          +3,637          44,877    102,820
## 276 23 Oct         153,008          +4,499          46,691    105,488
## 277 24 Oct         155,233          +2,225          46,057    108,334
## 278 25 Oct         158,089          +2,856          45,572    111,670
## 279 26 Oct         159,830          +1,741          43,293    115,675
## 280 27 Oct         160,400            +570          40,681    118,843
## 281 28 Oct         162,354          +1,954          39,643    121,824
## 282 29 Oct         164,718          +2,364          38,952    124,862
## 283 30 Oct         168,235          +3,517          38,357    128,958
## 284 31 Oct         170,743          +2,508          38,584    131,222
## 285  1 Nov         173,567          +2,824          37,765    134,842
## 286  2 Nov         176,500          +2,933          37,524    137,992
## 287  3 Nov         179,614          +3,114          37,476    141,134
## 288  4 Nov         182,923          +3,309          36,911    144,978
## 289  5 Nov         185,974          +3,051          36,514    148,408
## 290  6 Nov         188,883          +2,909          34,905    152,908
## 291  7 Nov         191,636          +2,753          35,435    155,114
## 292  8 Nov         194,453          +2,817          35,419    157,926
## 293  9 Nov         197,024          +2,571          36,174    159,724
## 294 10 Nov         199,760          +2,736          38,035    160,577
## 295 11 Nov         202,329          +2,569          38,912    162,243
## 296 12 Nov         204,242          +1,913          38,461    164,592
## 297 13 Nov         206,353          +2,111          37,022    168,129
## 298 14 Nov         208,299          +1,946          36,452    170,632
## 299 15 Nov         209,776          +1,477          35,125    173,430
## 300 16 Nov         210,973          +1,197          33,379    176,364
## 301 17 Nov         211,475            +502          30,986    179,242
## 302 18 Nov         212,917          +1,442          28,878    182,780
## 303 19 Nov         215,020          +2,103          28,106    185,638
## 304 20 Nov         216,965          +1,945          24,665    191,002
## 305 21 Nov         218,639          +1,674          24,009    193,325
## 306 22 Nov         220,308          +1,669          19,963    199,024
## 307 23 Nov         222,288          +1,980          18,884    202,067
## 308 24 Nov         224,078          +1,790          17,859    204,858
## 309 25 Nov         226,026          +1,948          16,639    207,998
## 310 26 Nov         227,640          +1,614          16,793    209,435
## 311 27 Nov         229,343          +1,703          17,237    210,671
## 312 28 Nov         230,723          +1,380          18,083    211,186
## 313 29 Nov         231,978          +1,255          17,909    212,590
## 314 30 Nov         233,452          +1,474          17,423    214,521
## 315  1 Dec         234,756          +1,304          16,633    216,594
## 316  2 Dec         236,246          +1,490          16,547    218,161
```

```
## 317  3 Dec         237,589          +1,343          15,766    220,272
## 318  4 Dec         238,861          +1,272          15,447    221,847
## 319  5 Dec         239,885          +1,024          14,255    224,053
## 320  6 Dec         240,981          +1,096          13,582    225,805
## 321  7 Dec         241,995          +1,014          12,948    227,433
## 322  8 Dec         243,377          +1,382          12,686    229,054
## 323  9 Dec         244,433          +1,056          12,245    230,537
## 324 10 Dec         245,650          +1,217          12,386    231,601
## 325 11 Dec         246,694          +1,044          12,148    232,872
## 326 12 Dec         247,593            +899          11,673    234,231
## 327 13 Dec         248,423            +830          10,994    235,731
## 328 14 Dec         249,244            +821          10,955    236,573
## 329 15 Dec         250,180            +936           9,881    238,569
## 330 16 Dec         250,916            +736           9,757    239,416
## 331 17 Dec         251,692            +776           9,580    240,363
## 332 18 Dec         252,474            +782           9,317    241,392
## 333 19 Dec         253,184            +710           8,840    242,567
## 334 20 Dec         253,772            +588           8,320    243,664
## 335 21 Dec         254,514            +742           7,976    244,743
## 336 22 Dec         255,236            +722           7,729    245,709
## 337 23 Dec         255,979            +743           7,515    246,661
## 338 24 Dec         256,592            +613           7,384    247,400
## 339 25 Dec         257,200            +608           7,092    248,292
## 340 26 Dec         257,700            +500           6,749    249,132
## 341 27 Dec         258,181            +481           6,493    249,863
## 342 28 Dec         258,840            +659           6,427    250,581
## 343 29 Dec         259,548            +708           6,396    251,312
## 344 30 Dec         260,059            +511           6,300    251,912
## 345 31 Dec         260,593            +534           6,378    252,359
## 346  1 Jan         261,019            +426           6,048    253,107
## 347  2 Jan         261,438            +419           5,711    253,857
## 348  3 Jan         261,859            +421           5,487    254,494
## 349  4 Jan         262,262            +403           5,289    255,088
## 350  5 Jan         262,784            +522           5,225    255,666
## 351  6 Jan         263,193            +409           5,133    256,161
## 352  7 Jan         263,605            +412           5,058    256,644
## 353  8 Jan         264,159            +554           5,021    257,229
## 354  9 Jan         264,521            +362           4,681    257,928
## 355 10 Jan         264,780            +259           4,422    258,441
## 356 11 Jan         265,268            +488           4,373    258,968
## 357 12 Jan         265,698            +430           4,408    259,358
## 358 13 Jan         266,143            +445           4,434    259,772
## 359 14 Jan         266,546            +403           4,426    260,177
## 360 15 Jan         266,816            +270           4,301    260,567
## 361 16 Jan         267,056            +240           4,058    261,044
## 362 17 Jan         267,322            +266           3,919    261,444
## 363 18 Jan         267,644            +322           3,861    261,818
## 364 19 Jan         267,992            +348           3,764    262,259
## 365 20 Jan         268,310            +318           3,693    262,642
## 366 21 Jan         268,646            +336           3,799    262,868
## 367 22 Jan         268,948            +302           3,614    263,348
## 368 23 Jan         269,180            +232           3,452    263,734
## 369 24 Jan         269,450            +270           3,312    264,137
## 370 25 Jan         269,789            +339           3,240    264,538
```

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## 371 26 Jan         270,092          +303          3,252    264,823
## 372 27 Jan         270,375          +283          3,286    265,069
## 373 28 Jan         270,588          +213          3,203    265,365
## 374 29 Jan         270,745          +157          3,022    265,698
## 375 30 Jan         270,854          +109          2,779    266,048
## 376 31 Jan         270,959          +105          2,594    266,336
## 377  1 Feb         271,118          +159          2,489    266,600
## 378  2 Feb         271,289          +171          2,400    266,859
## 379  3 Feb         271,431          +142          2,335    267,065
## 380  4 Feb         271,602          +171          2,277    267,292
## 381  5 Feb         271,707          +105          2,108    267,564
## 382  6 Feb         271,806           +99          1,959    267,812
## 383  7 Feb         271,925          +119          1,815    268,072
## 384  8 Feb         272,055          +130          1,744    268,266
## 385  9 Feb         272,215          +160          1,737    268,431
## 386 10 Feb         272,349          +134          1,753    268,549
## 387 11 Feb         272,430           +81          1,718    268,660
## 388 12 Feb         272,557          +127          1,707    268,796
## 389 13 Feb         272,614           +57          1,631    268,929
## 390 14 Feb         272,718          +104          1,604    269,060
## 391 15 Feb         272,840          +122          1,581    269,204
## 392 16 Feb         272,945          +105          1,587    269,303
## 393 17 Feb         273,070          +125          1,621    269,394
## 394 18 Feb         273,166           +96          1,603    269,505
## 395 19 Feb         273,263           +97          1,583    269,619
## 396 20 Feb         273,351           +88          1,535    269,755
## 397 21 Feb         273,431           +80          1,494    269,876
## 398 22 Feb         273,556          +125          1,529    269,966
## 399 23 Feb         273,666          +110          1,533    270,068
## 400 24 Feb         273,760           +94            937    270,139
## 401 25 Feb         273,872          +112            964    270,223
## 402 26 Feb         273,984          +112            936    270,277
## 403 27 Feb         274,065           +81            967    270,325
## 404 28 Feb         274,143           +78            962    270,407
## 405  1 Mar         274,216           +73            968    270,471
## 406  2 Mar         274,294           +78            974    270,543
## 407  3 Mar         274,381           +87            998    270,605
## 408  4 Mar         274,488          +107          1,027    270,683
## 409  5 Mar         274,608          +120            832    270,766
## 410  6 Mar         274,655           +47            817    270,828
## 411  7 Mar         274,721           +66            825    270,886
## 412  8 Mar         274,810           +89            872    270,927
## 413  9 Mar         274,869           +59            870    270,987
## 414 10 Mar         274,973          +104            911    271,050
## 415 11 Mar         275,070           +97            942    271,116
## 416 12 Mar         275,118           +48            989    271,117
## 417 13 Mar         275,178           +60            915    271,249
## 418 14 Mar         275,231           +53            891    271,326
## 419 15 Mar         275,310           +79            895    271,401
## 420 16 Mar         275,424          +114            915    271,495
## 421 17 Mar         275,518           +94            954    271,550
## 422 18 Mar         275,625          +107          1,000    271,610
## 423 19 Mar         275,750          +125          1,001    271,733
## 424 20 Mar         275,829           +79            998    271,815
```

```
## 425 21 Mar         275,906              +77              969    271,921
## 426 22 Mar         276,056             +150            1,017    272,020
## 427 23 Mar         276,244             +188            1,128    272,097
## 428 24 Mar         276,389             +145            1,182    272,187
## 429 25 Mar         276,509             +120            1,217    272,272
## 430 26 Mar         276,665             +156            1,299    272,342
## 431 27 Mar         276,750              +85            1,288    272,435
## 432 28 Mar         276,839              +89            1,282    272,530
## 433 29 Mar         276,980             +141            1,341    272,612
## 434 30 Mar         277,147             +167            1,390    272,727
## 435 31 Mar         277,309             +162            1,493    272,786
## 436  1 Apr         277,461             +152            1,579    272,851
## 437  2 Apr         277,640             +179            1,647    272,962
## 438  3 Apr         277,768             +128            1,613    273,123
## 439  4 Apr         277,944             +176            1,672    273,240
## 440  5 Apr         278,210             +266            1,832    273,342
## 441  6 Apr         278,470             +260            1,979    273,455
## 442  7 Apr         278,768             +298            2,201    273,529
## 443  8 Apr         279,100             +332            2,454    273,608
## 444  9 Apr         279,388             +288            2,615    273,735
## 445 10 Apr         279,725             +337            2,800    273,886
## 446 11 Apr         280,028             +303            2,961    274,027
## 447 12 Apr         280,524             +496            3,306    274,165
## 448 13 Apr         280,984             +460            3,608    274,318
## 449 14 Apr         281,564             +580            4,056    274,447
## 450 15 Apr         282,054             +490            4,384    274,604
## 451 16 Apr         282,890             +836            5,008    274,812
## 452 17 Apr         283,658             +768            5,545    275,038
## 453 18 Apr         284,673           +1,015            6,290    275,300
## 454 19 Apr         285,900           +1,227            7,254    275,555
## 455 20 Apr         287,567           +1,667            8,659    275,806
## 456 21 Apr         289,787           +2,220           10,582    276,093
## 457 22 Apr         292,152           +2,365           12,690    276,345
## 458 23 Apr         294,601           +2,449           14,724    276,755
## 459 24 Apr         297,087           +2,486           16,828    277,123
## 460 25 Apr         300,119           +3,032           19,382    277,573
## 461 26 Apr         303,561           +3,442           22,434    277,951
## 462 27 Apr         307,925           +4,364           26,225    278,506
## 463 28 Apr         312,699           +4,774           30,209    279,279
## 464 29 Apr         317,530           +4,831           34,117    280,167
## 465 30 Apr         323,187           +5,657           38,813    281,095
## 466  1 May         328,893           +5,706           43,213    282,382
## 467  2 May         336,030           +7,137           48,711    283,994
## 468  3 May         343,418           +7,388           54,041    286,015
## 469  4 May         351,005           +7,587           59,798    287,790
## 470  5 May         359,610           +8,605           66,352    289,783
## 471  6 May         368,580           +8,970           72,561    292,490
## 472  7 May         377,603           +9,023           78,629    295,395
## 473  8 May         385,890           +8,287           83,493    298,765
## 474  9 May         394,667           +8,777           88,160    302,787
## 475 10 May         403,794           +9,127           93,141    306,794
## 476 11 May         413,111           +9,317           97,008    312,019
## 477 12 May         422,349           +9,238          101,634    316,463
## 478 13 May         431,191           +8,842          105,207    321,518
```

```
## 479 14 May         439,658            +8,467           107,336    327,653
## 480 15 May         447,704            +8,046           109,740    333,108
## 481 16 May         455,020            +7,316           110,263    339,756
## 482 17 May         464,218            +9,198           113,480    345,523
## 483 18 May         472,354            +8,136           114,529    352,414
## 484 19 May         480,418            +8,064           114,358    360,403
## 485 20 May         488,645            +8,227           115,852    366,946
## 486 21 May         497,052            +8,407           116,192    374,836
## 487 22 May         505,643            +8,591           115,806    383,684
## 488 23 May         513,241            +7,598           115,547    391,348
## 489 24 May         520,461            +7,220           115,447    398,483
## 490 25 May         528,848            +8,387           117,261    404,887
## 491 26 May         535,525            +6,677           117,077    411,603
## 492 27 May         542,256            +6,731           116,476    418,829
## 493 28 May         549,111            +6,855           113,394    428,670
## 494 29 May         553,422            +4,311           111,509    434,750
## 495 30 May         557,124            +3,702           108,897    440,955
## 496 31 May         561,302            +4,178           106,470    447,446
##     Recoveries.1 Deaths Deaths.1 RT.PCR.tests RT.PCR.tests.1    TPR     RR
## 1            New  Total      New        Total            New    TPR     RR
## 2              0      0        0                                    0%
## 3              0      0        0                                    0%
## 4              0      0        0                                    0%
## 5              0      0        0                                    0%
## 6              0      0        0                                    0%
## 7              0      0        0            3                33.33%     0%
## 8             +1      0        0            4              +1    25%   100%
## 9              0      0        0            5              +1    20%   100%
## 10             0      0        0            5               0    20%   100%
## 11             0      0        0                                   100%
## 12             0      0        0            5                   20%   100%
## 13             0      0        0                                   100%
## 14             0      0        0           14                7.14%   100%
## 15             0      0        0           14               0  7.14%   100%
## 16             0      0        0           18              +4  5.56%   100%
## 17             0      0        0           18               0  5.56%   100%
## 18             0      0        0                                   100%
## 19             0      0        0           18                5.56%   100%
## 20             0      0        0           18               0  5.56%   100%
## 21             0      0        0           18               0  5.56%   100%
## 22             0      0        0           20              +2  5.00%   100%
## 23             0      0        0           24              +4  4.17%   100%
## 24             0      0        0           24               0  4.17%   100%
## 25             0      0        0                                   100%
## 26             0      0        0           34                2.94%   100%
## 27             0      0        0           34               0  2.94%   100%
## 28             0      0        0           35              +1  2.86%   100%
## 29             0      0        0          210            +175  0.48%   100%
## 30             0      0        0          212              +2  0.47%   100%
## 31             0      0        0                                   100%
## 32             0      0        0                                   100%
## 33             0      0        0          216                0.46%   100%
## 34             0      0        0          217              +1  0.46%   100%
## 35             0      0        0          217               0  0.46%   100%
```

```
## 36          0     0     0         221          +4  0.45%   100%
## 37          0     0     0         221           0  0.45%   100%
## 38          0     0     0         224          +3  0.45%   100%
## 39          0     0     0                           100%
## 40          0     0     0         243              0.41%   100%
## 41          0     0     0         425        +182  0.24%   100%
## 42          0     0     0         433          +8  0.23%   100%
## 43          0     0     0         433           0  0.23%   100%
## 44          0     0     0                           100%
## 45          0     0     0         437              0.23%   100%
## 46          0     0     0                           100%
## 47          0     0     0                           100%
## 48          0     0     0                           100%
## 49          0     0     0         445              0.22%   100%
## 50          0     0     0         447          +2  0.22%   100%
## 51          0     0     0         450          +3  0.22%   100%
## 52          0     0     0         456          +6  0.22%   100%
## 53          0     0     0                           100%
## 54          0     0     0         467              0.21%   100%
## 55          0     0     0         478         +11  0.21%   100%
## 56          0     0     0         496         +18  0.20%   100%
## 57          0     0     0         512         +16  0.20%   100%
## 58          0     0     0         529         +17  0.19%   100%
## 59          0     0     0         546         +17  0.18%   100%
## 60          0     0     0                           100%
## 61          0     0     0         572              0.17%   100%
## 62          0     0     0         610         +38  0.33%    50%
## 63          0     0     0         610           0  0.33%    50%
## 64          0     0     0         687         +77  0.44% 33.33%
## 65          0     0     0         758         +71  0.40% 33.33%
## 66          0     0     0         802         +44  0.50%    25%
## 67          0     0     0         875         +73  0.57%    20%
## 68          0     0     0         917         +42  0.55%    20%
## 69          0     0     0         993         +76  0.50%    20%
## 70          0     0     0       1,060         +67  0.47%    20%
## 71          0     0     0       1,145         +85  0.44%    20%
## 72          0     0     0       1,185         +40  0.51% 16.67%
## 73          0     0     0       1,264         +79  0.47% 16.67%
## 74          0     0     0       1,521        +257  0.59% 11.11%
## 75          0     0     0       1,642        +121  0.55% 11.11%
## 76          0     0     0       1,890        +248  0.48% 11.11%
## 77          0     0     0       2,122        +232  0.42% 11.11%
## 78          0     0     0       2,366        +244  0.38% 11.11%
## 79          0     0     0       2,895        +529  0.31% 11.11%
## 80          0     0     0       3,525        +630  0.26% 11.11%
## 81          0     0     0       4,426        +901  0.20% 11.11%
## 82          0     0     0       5,184        +758  0.23%  8.33%
## 83          0     0     0       5,691        +507  0.25%  7.14%
## 84          0     0     0       6,299        +608  0.25%  6.25%
## 85          0     0     0       6,871        +572  0.23%  6.25%
## 86         +1     0     0       7,240        +369  0.22% 12.50%
## 87          0     0     0       7,458        +218  0.40%  6.67%
## 88          0     0     0       8,013        +555  0.39%  6.45%
## 89         +2     0     0       8,081         +68  0.38% 12.90%
```

```
## 90              0      0        0        8,414          +333  0.37% 12.90%
## 91              0      0        0        8,763          +349  0.48%  9.52%
## 92             +3      0        0        9,014          +251  0.50% 15.56%
## 93             +2      0        0        9,200          +186  0.52% 18.75%
## 94             +1      0        0        9,406          +206  0.52% 20.41%
## 95             +2      0        0        9,666          +260  0.51% 24.49%
## 96             +4      0        0        9,931          +265  0.52% 30.77%
## 97              0      0        0       10,471          +540  0.50% 30.77%
## 98              0      0        0       10,807          +336  0.50% 29.63%
## 99              0      0        0       11,524          +717  0.49% 28.07%
## 100             0      0        0       12,011          +487  0.47% 28.07%
## 101             0      0        0       12,577          +566  0.47% 27.12%
## 102             0      0        0       13,098          +521  0.45% 27.12%
## 103             0      0        0       13,424          +326  0.56% 21.33%
## 104             0      0        0       13,640          +216  0.55% 21.33%
## 105             0      0        0       13,850          +210  0.59% 19.51%
## 106            +6      0        0       14,096          +246  0.70% 22.22%
## 107             0      0        0       14,511          +415  0.70% 21.78%
## 108            +9      0        0       15,492          +981  0.66% 30.39%
## 109             0      0        0       16,309          +817  0.67% 28.44%
## 110             0      0        0       16,898          +589  0.65% 28.18%
## 111            +2      0        0       17,809          +911  0.75% 24.63%
## 112             0      0        0       18,964        +1,155  1.14% 15.21%
## 113            +2      0        0       21,340        +2,376  1.14% 14.40%
## 114             0      0        0       22,664        +1,324  1.10% 14.06%
## 115            +1      0        0       23,914        +1,250  1.12% 13.48%
## 116             0      1       +1       26,691        +2,777  1.05% 12.81%
## 117             0      2       +1       28,161        +1,470  1.05% 12.20%
## 118             0      2        0       30,724        +2,563  1.22%  9.60%
## 119            +1      2        0       33,006        +2,282  1.22%  9.20%
## 120            +8      2        0       35,494        +2,488  1.20% 10.54%
## 121            +4      3       +1       38,737        +3,243  1.18% 10.72%
## 122           +21      3        0       42,517        +3,780  1.21% 13.57%
## 123             0      3        0       45,957        +3,440  1.27% 11.99%
## 124           +17      3        0       48,815        +2,858  1.24% 14.43%
## 125           +25      4       +1       51,642        +2,827  1.32% 16.42%
## 126           +43      4        0       54,697        +3,055  1.41% 20.08%
## 127           +28      4        0       58,277        +3,580  1.52% 20.65%
## 128            +4      5       +1       60,916        +2,639  1.71% 17.95%
## 129           +19      6       +1       64,154        +3,238  1.89% 17.00%
## 130           +13      6        0       66,729        +2,575  2.10% 15.63%
## 131            +1      8       +2       69,587        +2,858  2.26% 13.99%
## 132            +1      8        0       71,903        +2,316  2.52% 12.20%
## 133           +45      8        0       75,343        +3,440  2.79% 12.67%
## 134           +12      9       +1       80,267        +4,924  2.87% 12.09%
## 135           +12     10       +1       84,134        +3,867  3.13% 11.01%
## 136           +43     11       +1       88,366        +4,232  3.30% 11.44%
## 137           +32     13       +2       92,477        +4,111  3.50% 11.28%
## 138          +102     13        0       96,205        +3,728  3.58% 13.54%
## 139           +21     14       +1      100,971        +4,766  3.73% 12.97%
## 140           +96     15       +1      106,330        +5,359  3.84% 14.30%
## 141           +90     15        0      110,744        +4,414  3.94% 15.44%
## 142          +187     15        0      115,937        +5,193  3.98% 18.66%
## 143           +16     16       +1      121,862        +5,925  4.15% 17.33%
```

```
## 144          +36     18       +2      127,288         +5,426  4.19% 17.11%
## 145          +61     19       +1      133,377         +6,089  4.32% 16.91%
## 146          +67     19        0      138,683         +5,306  4.48% 16.76%
## 147         +117     19        0      143,738         +5,055  4.59% 17.57%
## 148           +9     20       +1      149,772         +6,034  4.79% 16.26%
## 149          +19     22       +2      155,518         +5,746  5.05% 15.11%
## 150         +216     22        0      161,749         +6,231  5.12% 16.94%
## 151         +176     22        0      169,165         +7,416  5.09% 18.34%
## 152         +194     23       +1      175,173         +6,008  5.15% 19.63%
## 153         +376     23        0      181,371         +6,198  5.27% 22.47%
## 154          +76     24       +1      186,366         +4,995  5.42% 22.02%
## 155         +114     24        0      193,194         +6,828  5.55% 21.79%
## 156         +312     26       +2      199,737         +6,543  5.59% 23.74%
## 157          +48     27       +1      206,271         +6,534  5.70% 22.95%
## 158         +136     28       +1      210,877         +4,606  5.84% 23.02%
## 159         +179     28        0      215,839         +4,962  5.92% 23.59%
## 160         +121     29       +1      223,630         +7,791  5.92% 23.66%
## 161          +60     29        0      228,341         +4,711  5.94% 23.55%
## 162         +462     30       +1      233,227         +4,886  6.02% 26.03%
## 163       +1,664     31       +1      237,764         +4,537  6.11% 36.64%
## 164         +823     32       +1      242,247         +4,483  6.30% 40.26%
## 165         +272     34       +2      246,297         +4,050  6.29% 41.41%
## 166         +132     34        0      251,007         +4,710  6.29% 41.48%
## 167         +264     35       +1      255,728         +4,721  6.24% 42.66%
## 168         +688     35        0      261,861         +6,133  6.17% 46.38%
## 169         +253     35        0      266,557         +4,696  6.16% 47.20%
## 170         +139     35        0      271,145         +4,588  6.10% 47.73%
## 171         +120     35        0      275,951         +4,806  6.03% 48.12%
## 172         +431     38       +3      279,599         +3,648  5.98% 50.49%
## 173         +147     38        0      283,515         +3,916  5.93% 51.12%
## 174       +1,705     38        0      289,371         +5,856  5.86% 60.75%
## 175          +34     38        0      293,739         +4,368  5.81% 60.54%
## 176         +697     39       +1      298,829         +5,090  5.75% 64.18%
## 177         +224     39        0      303,810         +4,981  5.71% 64.86%
## 178         +285     40       +1      308,498         +4,688  5.65% 66.12%
## 179         +103     40        0      311,829         +3,331  5.61% 66.49%
## 180          +58     40        0      315,570         +3,741  5.60% 66.23%
## 181         +173     40        0      319,872         +4,302  5.58% 66.51%
## 182         +609     40        0      323,835         +3,963  5.56% 69.34%
## 183         +207     42       +2      327,614         +3,779  5.52% 70.10%
## 184         +156     43       +1      331,095         +3,481  5.51% 70.39%
## 185         +107     44       +1      335,082         +3,987  5.48% 70.46%
## 186         +106     45       +1      339,157         +4,075  5.45% 70.62%
## 187          +75     45        0      342,457         +3,300  5.44% 70.53%
## 188         +626     48       +3      347,275         +4,818  5.40% 73.35%
## 189         +121     49       +1      352,307         +5,032  5.41% 72.78%
## 190         +146     49        0      358,344         +6,037  5.38% 72.75%
## 191         +227     52       +3      364,648         +6,304  5.36% 72.89%
## 192         +151     56       +4      375,416        +10,768  5.27% 72.83%
## 193          +93     56        0      382,409         +6,993  5.25% 72.15%
## 194         +111     57       +1      391,270         +8,861  5.20% 71.82%
## 195         +358     57        0      398,907         +7,637  5.20% 72.10%
## 196          +65     58       +1      406,594         +7,687  5.17% 71.52%
## 197         +130     60       +2      412,953         +6,359  5.18% 70.86%
```

```
## 198        +233     65       +5      419,575        +6,622  5.18% 70.75%
## 199        +425     70       +5      427,501        +7,926  5.20% 71.19%
## 200        +499     73       +3      435,289        +7,788  5.19% 72.21%
## 201         +40     75       +2      443,804        +8,515  5.18% 71.19%
## 202        +140     79       +4      452,236        +8,432  5.15% 70.76%
## 203        +171     83       +4      462,698       +10,462  5.18% 69.58%
## 204         +64     91       +8      473,179       +10,481  5.16% 68.47%
## 205        +109     95       +4      483,038        +9,859  5.17% 67.46%
## 206        +240     99       +4      494,613       +11,575  5.17% 66.83%
## 207        +124    102       +3      505,660       +11,047  5.15% 66.11%
## 208        +134    104       +2      517,907       +12,247  5.15% 65.02%
## 209        +160    107       +3      529,427       +11,520  5.15% 64.22%
## 210         +85    114       +7      542,866       +13,439  5.21% 62.21%
## 211        +120    120       +6      554,388       +11,522  5.22% 61.17%
## 212        +264    126       +6      566,220       +11,832  5.24% 60.60%
## 213        +250    137      +11      579,899       +13,679  5.26% 59.75%
## 214        +136    146       +9      592,418       +12,519  5.25% 58.97%
## 215        +281    149       +3      600,444        +8,026  5.32% 58.34%
## 216        +175    157       +8      610,469       +10,025  5.35% 57.55%
## 217        +313    164       +7      621,901       +11,432  5.39% 57.02%
## 218        +385    175      +11      635,252       +13,351  5.42% 56.67%
## 219        +569    183       +8      647,881       +12,629  5.48% 56.50%
## 220        +169    195      +12      658,110       +10,229  5.54% 55.52%
## 221        +313    207      +12      669,626       +11,516  5.58% 55.05%
## 222        +267    221      +14      682,343       +12,717  5.65% 54.00%
## 223        +588    228       +7      693,472       +11,129  5.69% 54.26%
## 224        +768    239      +11      705,560       +12,088  5.74% 54.72%
## 225      +1,112    251      +12      718,439       +12,879  5.80% 55.92%
## 226        +917    257       +6      731,852       +13,413  5.86% 56.46%
## 227      +1,354    271      +14      745,490       +13,638  5.93% 57.78%
## 228      +1,566    280       +9      757,963       +12,473  5.97% 59.91%
## 229      +1,814    289       +9      768,345       +10,382  6.02% 62.57%
## 230      +1,736    300      +11      777,563        +9,218  6.07% 64.94%
## 231      +2,287    306       +6      788,174       +10,611  6.11% 68.48%
## 232        +918    312       +6      799,341       +11,167  6.16% 68.84%
## 233      +1,818    317       +5      810,485       +11,144  6.23% 70.74%
## 234        +972    322       +5      821,186       +10,701  6.32% 70.63%
## 235        +852    336      +14      831,362       +10,176  6.39% 70.64%
## 236      +1,173    345       +9      840,527        +9,165  6.44% 71.45%
## 237        +879    360      +15      851,405       +10,878  6.50% 71.53%
## 238      +1,062    371      +11      861,780       +10,375  6.59% 71.56%
## 239      +1,068    379       +8      872,274       +10,494  6.69% 71.50%
## 240      +1,243    383       +4      882,915       +10,641  6.75% 72.09%
## 241        +871    390       +7      894,373       +11,458  6.89% 71.14%
## 242      +1,447    401      +11      904,706       +10,333  6.94% 72.08%
## 243        +966    411      +10      914,290        +9,584  7.01% 72.10%
## 244      +1,005    427      +16      923,823        +9,533  7.07% 72.37%
## 245        +823    429       +2      934,977       +11,154  7.13% 72.13%
## 246      +1,893    436       +7      944,474        +9,497  7.18% 73.67%
## 247        +457    453      +17      955,923       +11,449  7.25% 72.74%
## 248      +1,455    459       +6      968,185       +12,262  7.29% 73.45%
## 249      +1,147    467       +8      978,204       +10,019  7.34% 73.81%
## 250        +885    477      +10      988,327       +10,123  7.43% 73.44%
## 251        +742    481       +4      998,407       +10,080  7.49% 73.10%
```

```
## 252        +731    491      +10    1,009,298        +10,891  7.56% 72.61%
## 253      +1,057    498       +7    1,021,503        +12,205  7.62% 72.51%
## 254        +961    509      +11    1,033,947        +12,444  7.71% 71.98%
## 255      +3,307    520      +11    1,048,686        +14,739  7.86% 73.62%
## 256      +2,044    528       +8    1,061,664        +12,978  7.97% 74.19%
## 257      +1,329    535       +7    1,074,448        +12,784  8.08% 73.79%
## 258      +1,133    554      +19    1,088,229        +13,781  8.20% 73.04%
## 259      +2,340    563       +9    1,099,276        +11,047  8.26% 74.37%
## 260      +1,126    578      +15    1,113,486        +14,210  8.46% 72.85%
## 261      +2,675    590      +12    1,131,958        +18,472  8.71% 72.34%
## 262      +1,680    600      +10    1,145,237        +13,279  8.79% 72.53%
## 263      +1,229    614      +14    1,164,557        +19,320  9.08% 70.26%
## 264      +1,552    636      +22    1,176,984        +12,427  9.16% 70.35%
## 265      +1,473    645       +9    1,191,514        +14,530  9.38% 69.12%
## 266      +1,503    663      +18    1,207,091        +15,577  9.56% 68.29%
## 267      +2,174    675      +12    1,221,038        +13,947  9.66% 68.61%
## 268      +3,564    694      +19    1,237,636        +16,598  9.84% 69.42%
## 269      +3,522    715      +21    1,254,167        +16,531 10.06% 69.80%
## 270      +1,800    727      +12    1,269,605        +15,438 10.18% 69.48%
## 271      +2,326    739      +12    1,283,354        +13,749 10.30% 69.69%
## 272      +2,335    757      +18    1,300,918        +17,564 10.46% 69.47%
## 273      +2,108    765       +8    1,314,779        +13,861 10.58% 69.44%
## 274      +2,996    791      +26    1,334,897        +20,118 10.85% 68.75%
## 275      +3,215    812      +21    1,350,152        +15,255 11.00% 69.23%
## 276      +2,668    829      +17    1,367,016        +16,864 11.19% 68.94%
## 277      +2,846    842      +13    1,380,862        +13,846 11.24% 69.79%
## 278      +3,336    847       +5    1,393,173        +12,311 11.35% 70.64%
## 279      +4,005    862      +15    1,398,179         +5,006 11.43% 72.37%
## 280      +3,168    876      +14    1,400,694         +2,515 11.45% 74.09%
## 281      +2,981    887      +11    1,409,295         +8,601 11.52% 75.04%
## 282      +3,038    904      +17    1,419,064         +9,769 11.61% 75.80%
## 283      +4,096    920      +16    1,434,053        +14,989 11.73% 76.65%
## 284      +2,264    937      +17    1,443,343         +9,290 11.83% 76.85%
## 285      +3,620    960      +23    1,456,366        +13,023 11.92% 77.69%
## 286      +3,150    984      +24    1,469,812        +13,446 12.01% 78.18%
## 287      +3,142  1,004      +20    1,480,978        +11,166 12.13% 78.58%
## 288      +3,844  1,034      +30    1,494,122        +13,144 12.24% 79.26%
## 289      +3,430  1,052      +18    1,507,190        +13,068 12.34% 79.80%
## 290      +4,500  1,070      +18    1,517,343        +10,153 12.45% 80.95%
## 291      +2,206  1,087      +17    1,527,766        +10,423 12.54% 80.94%
## 292      +2,812  1,108      +21    1,540,077        +12,311 12.63% 81.22%
## 293      +1,798  1,126      +18    1,551,254        +11,177 12.70% 81.07%
## 294        +853  1,148      +22    1,564,214        +12,960 12.77% 80.38%
## 295      +1,666  1,174      +26    1,574,295        +10,081 12.85% 80.19%
## 296      +2,349  1,189      +15    1,584,317        +10,022 12.89% 80.59%
## 297      +3,537  1,202      +13    1,593,850         +9,533 12.95% 81.48%
## 298      +2,503  1,215      +13    1,602,603         +8,753 13.00% 81.92%
## 299      +2,798  1,221       +6    1,609,079         +6,476 13.04% 82.67%
## 300      +2,934  1,230       +9    1,613,911         +4,832 13.07% 83.60%
## 301      +2,878  1,247      +17    1,617,023         +3,112 13.08% 84.76%
## 302      +3,538  1,259      +12    1,623,754         +6,731 13.11% 85.85%
## 303      +2,858  1,276      +17    1,633,559         +9,805 13.16% 86.34%
## 304      +5,364  1,298      +22    1,643,899        +10,340 13.20% 88.03%
## 305      +2,323  1,305       +7    1,652,043         +8,144 13.23% 88.42%
```

```
## 306      +5,699  1,321     +16    1,660,075        +8,032 13.27% 90.34%
## 307      +3,043  1,337     +16    1,670,456       +10,381 13.31% 90.90%
## 308      +2,791  1,361     +24    1,681,299       +10,843 13.33% 91.42%
## 309      +3,140  1,389     +28    1,690,509        +9,210 13.37% 92.02%
## 310      +1,437  1,412     +23    1,700,000        +9,491 13.39% 92.00%
## 311      +1,236  1,435     +23    1,710,460       +10,460 13.41% 91.86%
## 312        +515  1,454     +19    1,719,828        +9,368 13.42% 91.53%
## 313      +1,404  1,479     +25    1,727,836        +8,008 13.43% 91.64%
## 314      +1,931  1,508     +29    1,737,747        +9,911 13.43% 91.89%
## 315      +2,073  1,529     +21    1,746,330        +8,583 13.44% 92.26%
## 316      +1,567  1,538      +9    1,754,630        +8,300 13.46% 92.34%
## 317      +2,111  1,551     +13    1,763,919        +9,289 13.47% 92.71%
## 318      +1,575  1,567     +16    1,771,950        +8,031 13.48% 92.88%
## 319      +2,206  1,577     +10    1,778,024        +6,074 13.49% 93.40%
## 320      +1,752  1,594     +17    1,784,519        +6,495 13.50% 93.70%
## 321      +1,628  1,614     +20    1,790,739        +6,220 13.51% 93.98%
## 322      +1,621  1,637     +23    1,799,686        +8,947 13.52% 94.11%
## 323      +1,483  1,651     +14    1,805,972        +6,286 13.53% 94.32%
## 324      +1,064  1,663     +12    1,813,204        +7,232 13.55% 94.28%
## 325      +1,271  1,674     +11    1,820,618        +7,414 13.55% 94.40%
## 326      +1,359  1,689     +15    1,825,860        +5,242 13.56% 94.60%
## 327      +1,500  1,698      +9    1,831,041        +5,181 13.57% 94.89%
## 328        +842  1,716     +18    1,836,464        +5,423 13.57% 94.92%
## 329      +1,996  1,730     +14    1,843,581        +7,117 13.57% 95.36%
## 330        +847  1,743     +13    1,849,136        +5,555 13.57% 95.42%
## 331        +947  1,749      +6    1,855,724        +6,588 13.56% 95.50%
## 332      +1,029  1,765     +16    1,861,430        +5,706 13.56% 95.61%
## 333      +1,175  1,777     +12    1,866,210        +4,780 13.57% 95.81%
## 334      +1,097  1,788     +11    1,870,830        +4,620 13.56% 96.02%
## 335      +1,079  1,795      +7    1,877,181        +6,351 13.56% 96.16%
## 336        +966  1,798      +3    1,884,181        +7,000 13.55% 96.27%
## 337        +952  1,803      +5    1,890,740        +6,559 13.54% 96.36%
## 338        +739  1,808      +5    1,896,250        +5,510 13.53% 96.42%
## 339        +892  1,816      +8    1,900,392        +4,142 13.53% 96.54%
## 340        +840  1,819      +3    1,905,826        +5,434 13.52% 96.68%
## 341        +731  1,825      +6    1,909,654        +3,828 13.52% 96.78%
## 342        +718  1,832      +7    1,915,232        +5,578 13.51% 96.81%
## 343        +731  1,840      +8    1,921,367        +6,135 13.51% 96.83%
## 344        +600  1,847      +7    1,926,477        +5,110 13.50% 96.87%
## 345        +447  1,856      +9    1,932,477        +6,000 13.48% 96.84%
## 346        +748  1,864      +8    1,937,702        +5,225 13.47% 96.97%
## 347        +750  1,870      +6    1,942,702        +5,000 13.46% 97.10%
## 348        +637  1,878      +8    1,948,502        +5,800 13.44% 97.19%
## 349        +594  1,885      +7    1,952,903        +4,401 13.43% 97.26%
## 350        +578  1,893      +8    1,957,454        +4,551 13.42% 97.29%
## 351        +495  1,899      +6    1,964,160        +6,706 13.40% 97.33%
## 352        +483  1,903      +4    1,969,292        +5,132 13.39% 97.36%
## 353        +585  1,909      +6    1,974,561        +5,269 13.38% 97.38%
## 354        +699  1,912      +3    1,978,847        +4,286 13.37% 97.51%
## 355        +513  1,917      +5    1,982,246        +3,399 13.36% 97.61%
## 356        +527  1,927     +10    1,987,555        +5,309 13.35% 97.63%
## 357        +390  1,932      +5    1,992,855        +5,300 13.33% 97.61%
## 358        +414  1,937      +5    1,997,009        +4,154 13.33% 97.61%
## 359        +405  1,943      +6    2,002,041        +5,032 13.31% 97.61%
```

```
## 360        +390  1,948       +5    2,005,125        +3,084 13.31% 97.66%
## 361        +477  1,954       +6    2,008,944        +3,819 13.29% 97.75%
## 362        +400  1,959       +5    2,012,452        +3,508 13.28% 97.80%
## 363        +374  1,965       +6    2,016,758        +4,306 13.27% 97.82%
## 364        +441  1,969       +4    2,021,714        +4,956 13.26% 97.86%
## 365        +383  1,975       +6    2,026,726        +5,012 13.24% 97.89%
## 366        +226  1,979       +4    2,031,756        +5,030 13.22% 97.85%
## 367        +480  1,986       +7    2,035,301        +3,545 13.21% 97.92%
## 368        +386  1,994       +8    2,038,842        +3,541 13.20% 97.98%
## 369        +403  2,001       +7    2,043,255        +4,413 13.19% 98.03%
## 370        +401  2,011      +10    2,048,113        +4,858 13.17% 98.05%
## 371        +285  2,017       +6    2,052,687        +4,574 13.16% 98.05%
## 372        +246  2,020       +3    2,057,069        +4,382 13.14% 98.04%
## 373        +296  2,020       +0    2,060,860        +3,791 13.13% 98.07%
## 374        +333  2,025       +5    2,064,081        +3,221 13.12% 98.14%
## 375        +350  2,027       +2    2,067,699        +3,618 13.10% 98.23%
## 376        +288  2,029       +2    2,071,007        +3,308 13.08% 98.29%
## 377        +264  2,029       +0    2,075,152        +4,145 13.06% 98.33%
## 378        +259  2,030       +1    2,078,098        +2,946 13.05% 98.37%
## 379        +206  2,031       +1    2,081,695        +3,597 13.04% 98.39%
## 380        +227  2,033       +2    2,085,573        +3,878 13.02% 98.41%
## 381        +272  2,035       +2    2,088,372        +2,799 13.01% 98.48%
## 382        +248  2,035       +0    2,091,166        +2,794 13.00% 98.53%
## 383        +260  2,038       +3    2,093,417        +2,251 12.99% 98.58%
## 384        +194  2,045       +7    2,096,750        +3,333 12.98% 98.61%
## 385        +165  2,047       +2    2,101,059        +4,309 12.96% 98.61%
## 386        +118  2,047       +0    2,104,626        +3,567 12.94% 98.60%
## 387        +111  2,052       +5    2,107,649        +3,023 12.93% 98.62%
## 388        +136  2,054       +2    2,111,649        +4,000 12.91% 98.62%
## 389        +133  2,054       +0    2,113,549        +1,900 12.90% 98.65%
## 390        +131  2,054       +0    2,117,050        +3,501 12.88% 98.66%
## 391        +144  2,055       +1    2,120,591        +3,541 12.87% 98.67%
## 392         +99  2,055       +0    2,123,951        +3,360 12.85% 98.67%
## 393         +91  2,055       +0    2,127,789        +3,838 12.83% 98.65%
## 394        +111  2,058       +3    2,131,330        +3,541 12.82% 98.66%
## 395        +114  2,061       +3    2,134,261        +2,931 12.80% 98.67%
## 396        +136  2,061       +0    2,136,309        +2,048 12.80% 98.68%
## 397        +121  2,061       +0    2,139,634        +3,325 12.78% 98.70%
## 398         +90  2,061       +0    2,143,315        +3,681 12.76% 98.69%
## 399        +102  2,065       +4    2,146,533        +3,218 12.75% 98.69%
## 400         +71  2,684     +619    2,150,225        +3,692 12.73% 98.68%
## 401         +84  2,685       +1    2,153,636        +3,411 12.72% 98.67%
## 402         +54  2,771      +86    2,157,580        +3,944 12.70% 98.65%
## 403         +48  2,773       +2    2,160,404        +2,824 12.69% 98.64%
## 404         +82  2,774       +1    2,162,936        +2,532 12.67% 98.64%
## 405         +64  2,777       +3    2,165,985        +3,049 12.66% 98.63%
## 406         +72  2,777       +0    2,170,112        +4,127 12.64% 98.63%
## 407         +62  2,778       +1    2,173,511        +3,399 12.62% 98.62%
## 408         +78  2,778       +0    2,179,047        +5,536 12.60% 98.61%
## 409         +83  3,010     +232    2,185,190        +6,143 12.57% 98.60%
## 410         +62  3,010       +0    2,188,725        +3,535 12.55% 98.61%
## 411         +58  3,010       +0    2,192,836        +4,111 12.53% 98.60%
## 412         +41  3,011       +1    2,197,235        +4,399 12.51% 98.59%
## 413         +60  3,012       +1    2,199,950        +2,715 12.49% 98.59%
```

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## 414          +63  3,012       +0    2,203,438        +3,488 12.48% 98.57%
## 415          +66  3,012       +0    2,207,922        +4,484 12.46% 98.56%
## 416           +1  3,012       +0    2,210,434        +2,512 12.45% 98.55%
## 417         +132  3,014       +2    2,212,796        +2,362 12.44% 98.57%
## 418          +77  3,014       +0    2,215,411        +2,615 12.42% 98.58%
## 419          +75  3,014       +0    2,218,722        +3,311 12.41% 98.58%
## 420          +94  3,014       +0    2,221,512        +2,790 12.40% 98.57%
## 421          +55  3,014       +0    2,224,293        +2,781 12.39% 98.56%
## 422          +60  3,015       +1    2,227,547        +3,254 12.37% 98.54%
## 423         +123  3,016       +1    2,230,708        +3,161 12.36% 98.54%
## 424          +82  3,016       +0    2,233,345        +2,637 12.35% 98.54%
## 425         +106  3,016       +0    2,236,526        +3,181 12.34% 98.56%
## 426          +99  3,019       +3    2,240,998        +4,472 12.32% 98.54%
## 427          +77  3,019       +0    2,245,030        +4,032 12.30% 98.50%
## 428          +90  3,020       +1    2,248,993        +3,963 12.29% 98.48%
## 429          +85  3,020       +0    2,251,884        +2,891 12.28% 98.47%
## 430          +70  3,024       +4    2,256,300        +4,416 12.26% 98.44%
## 431          +93  3,027       +3    2,259,045        +2,745 12.25% 98.44%
## 432          +95  3,027       +0    2,261,146        +2,101 12.24% 98.44%
## 433          +82  3,027       +0    2,264,268        +3,122 12.23% 98.42%
## 434         +115  3,030       +3    2,267,408        +3,140 12.22% 98.41%
## 435          +59  3,030       +0    2,271,327        +3,919 12.21% 98.37%
## 436          +65  3,031       +1    2,275,540        +4,213 12.19% 98.34%
## 437         +111  3,031       +0    2,279,105        +3,565 12.18% 98.32%
## 438         +161  3,032       +1    2,281,832        +2,727 12.17% 98.33%
## 439         +117  3,032       +0    2,285,288        +3,456 12.16% 98.31%
## 440         +102  3,036       +4    2,289,824        +4,536 12.15% 98.25%
## 441         +113  3,036       +0    2,294,067        +4,243 12.14% 98.20%
## 442          +74  3,038       +2    2,298,167        +4,100 12.13% 98.12%
## 443          +79  3,038       +0    2,302,173        +4,006 12.12% 98.03%
## 444         +127  3,038       +0    2,306,244        +4,071 12.11% 97.98%
## 445         +151  3,039       +1    2,309,776        +3,532 12.11% 97.91%
## 446         +141  3,040       +1    2,312,901        +3,125 12.11% 97.86%
## 447         +138  3,053      +13    2,317,284        +4,383 12.11% 97.73%
## 448         +153  3,058       +5    2,321,670        +4,386 12.10% 97.63%
## 449         +129  3,061       +3    2,325,959        +4,289 12.11% 97.47%
## 450         +157  3,066       +5    2,329,547        +3,588 12.11% 97.36%
## 451         +208  3,070       +4    2,335,084        +5,537 12.11% 97.14%
## 452         +226  3,075       +5    2,340,417        +5,333 12.12% 96.96%
## 453         +262  3,083       +8    2,345,501        +5,084 12.14% 96.71%
## 454         +255  3,091       +8    2,352,502        +7,001 12.15% 96.38%
## 455         +251  3,102      +11    2,360,557        +8,055 12.18% 95.91%
## 456         +287  3,112      +10    2,369,401        +8,844 12.23% 95.27%
## 457         +252  3,117       +5    2,379,402       +10,001 12.28% 94.59%
## 458         +410  3,122       +5    2,388,200        +8,798 12.34% 93.94%
## 459         +368  3,136      +14    2,395,725        +7,525 12.40% 93.28%
## 460         +450  3,164      +28    2,405,017        +9,292 12.48% 92.49%
## 461         +378  3,176      +12    2,417,417       +12,400 12.56% 91.56%
## 462         +555  3,194      +18    2,432,089       +14,672 12.66% 90.45%
## 463         +773  3,211      +17    2,445,968       +13,879 12.78% 89.31%
## 464         +888  3,246      +35    2,458,565       +12,597 12.92% 88.23%
## 465         +928  3,279      +33    2,473,956       +15,391 13.06% 86.98%
## 466       +1,287  3,298      +19    2,488,359       +14,403 13.22% 85.86%
## 467       +1,612  3,325      +27    2,504,476       +16,117 13.42% 84.51%
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## 468       +2,021  3,362      +37    2,521,164       +16,688 13.62% 83.28%
## 469       +1,775  3,417      +55    2,537,295       +16,131 13.83% 81.99%
## 470       +1,993  3,475      +58    2,558,051       +20,756 14.06% 80.58%
## 471       +2,707  3,529      +54    2,578,418       +20,367 14.29% 79.36%
## 472       +2,905  3,579      +50    2,598,405       +19,987 14.53% 78.23%
## 473       +3,370  3,632      +53    2,615,720       +17,315 14.75% 77.42%
## 474       +4,022  3,720      +88    2,634,504       +18,784 14.98% 76.72%
## 475       +4,007  3,859     +139    2,652,130       +17,626 15.23% 75.98%
## 476       +5,225  4,084     +225    2,672,726       +20,596 15.46% 75.53%
## 477       +4,444  4,252     +168    2,693,088       +20,362 15.68% 74.93%
## 478       +5,055  4,466     +214    2,712,562       +19,474 15.90% 74.57%
## 479       +6,135  4,669     +203    2,733,510       +20,948 16.08% 74.52%
## 480       +5,455  4,856     +187    2,751,481       +17,971 16.27% 74.40%
## 481       +6,648  5,001     +145    2,770,980       +19,499 16.42% 74.67%
## 482       +5,767  5,215     +214    2,792,673       +21,693 16.62% 74.43%
## 483       +6,891  5,411     +196    2,812,959       +20,286 16.79% 74.61%
## 484       +7,989  5,657     +246    2,834,098       +21,139 16.95% 75.02%
## 485       +6,543  5,847     +190    2,855,793       +21,695 17.11% 75.09%
## 486       +7,890  6,024     +177    2,878,146       +22,353 17.27% 75.41%
## 487       +8,848  6,153     +129    2,897,503       +19,357 17.45% 75.88%
## 488       +7,664  6,346     +193    2,916,468       +18,965 17.60% 76.25%
## 489       +7,135  6,531     +185    2,936,314       +19,846 17.72% 76.56%
## 490       +6,404  6,700     +169    2,958,620       +22,306 17.87% 76.56%
## 491       +6,716  6,845     +145    2,977,650       +19,030 17.98% 76.86%
## 492       +7,226  6,951     +106    2,998,064       +20,414 18.09% 77.24%
## 493       +9,841  7,047      +96    3,017,377       +19,313 18.20% 78.07%
## 494       +6,080  7,163     +116    3,031,383       +14,006 18.26% 78.56%
## 495       +6,205  7,272     +109    3,042,369       +10,986 18.31% 79.15%
## 496       +6,491  7,386     +114    3,057,424       +15,055 18.36% 79.72%
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## 465 1.01%
## 466 1.00%
## 467 0.99%
## 468 0.98%
## 469 0.97%
## 470 0.97%
## 471 0.96%
## 472 0.95%
## 473 0.94%
## 474 0.94%
## 475 0.96%
## 476 0.99%
## 477 1.01%
## 478 1.04%
## 479 1.06%
## 480 1.08%
## 481 1.10%
## 482 1.12%
## 483 1.15%
## 484 1.18%
## 485 1.20%
## 486 1.21%
## 487 1.22%
## 488 1.24%
## 489 1.25%
## 490 1.27%
## 491 1.28%
## 492 1.28%
## 493 1.28%
## 494 1.29%
## 495 1.31%
## 496 1.32%
```

```
names(table_df)
```

```
##  [1] "Date"              "Confirmed.cases"   "Confirmed.cases.1"
##  [4] "Confirmed.cases.2" "Recoveries"        "Recoveries.1"
##  [7] "Deaths"            "Deaths.1"          "RT.PCR.tests"
## [10] "RT.PCR.tests.1"    "TPR"               "RR"
## [13] "CFR"               "Ref."
```

```
table_df$Date
```

```
##   [1] "Date"   "23 Jan" "24 Jan" "25 Jan" "26 Jan" "27 Jan" "28 Jan" "29 Jan"
##   [9] "30 Jan" "31 Jan" "1 Feb"  "2 Feb"  "3 Feb"  "4 Feb"  "5 Feb"  "6 Feb"
##  [17] "7 Feb"  "8 Feb"  "9 Feb"  "10 Feb" "11 Feb" "12 Feb" "13 Feb" "14 Feb"
##  [25] "15 Feb" "16 Feb" "17 Feb" "18 Feb" "19 Feb" "20 Feb" "21 Feb" "22 Feb"
```

```
##  [33] "23 Feb" "24 Feb" "25 Feb" "26 Feb" "27 Feb" "28 Feb" "29 Feb" "1 Mar"
##  [41] "2 Mar"  "3 Mar"  "4 Mar"  "5 Mar"  "6 Mar"  "7 Mar"  "8 Mar"  "9 Mar"
##  [49] "10 Mar" "11 Mar" "12 Mar" "13 Mar" "14 Mar" "15 Mar" "16 Mar" "17 Mar"
##  [57] "18 Mar" "19 Mar" "20 Mar" "21 Mar" "22 Mar" "23 Mar" "24 Mar" "25 Mar"
##  [65] "26 Mar" "27 Mar" "28 Mar" "29 Mar" "30 Mar" "31 Mar" "1 Apr"  "2 Apr"
##  [73] "3 Apr"  "4 Apr"  "5 Apr"  "6 Apr"  "7 Apr"  "8 Apr"  "9 Apr"  "10 Apr"
##  [81] "11 Apr" "12 Apr" "13 Apr" "14 Apr" "15 Apr" "16 Apr" "17 Apr" "18 Apr"
##  [89] "19 Apr" "20 Apr" "21 Apr" "22 Apr" "23 Apr" "24 Apr" "25 Apr" "26 Apr"
##  [97] "27 Apr" "28 Apr" "29 Apr" "30 Apr" "1 May"  "2 May"  "3 May"  "4 May"
## [105] "5 May"  "6 May"  "7 May"  "8 May"  "9 May"  "10 May" "11 May" "12 May"
## [113] "13 May" "14 May" "15 May" "16 May" "17 May" "18 May" "19 May" "20 May"
## [121] "21 May" "22 May" "23 May" "24 May" "25 May" "26 May" "27 May" "28 May"
## [129] "29 May" "30 May" "31 May" "1 Jun"  "2 Jun"  "3 Jun"  "4 Jun"  "5 Jun"
## [137] "6 Jun"  "7 Jun"  "8 Jun"  "9 Jun"  "10 Jun" "11 Jun" "12 Jun" "13 Jun"
## [145] "14 Jun" "15 Jun" "16 Jun" "17 Jun" "18 Jun" "19 Jun" "20 Jun" "21 Jun"
## [153] "22 Jun" "23 Jun" "24 Jun" "25 Jun" "26 Jun" "27 Jun" "28 Jun" "29 Jun"
## [161] "30 Jun" "1 Jul"  "2 Jul"  "3 Jul"  "4 Jul"  "5 Jul"  "6 Jul"  "7 Jul"
## [169] "8 Jul"  "9 Jul"  "10 Jul" "11 Jul" "12 Jul" "13 Jul" "14 Jul" "15 Jul"
## [177] "16 Jul" "17 Jul" "18 Jul" "19 Jul" "20 Jul" "21 Jul" "22 Jul" "23 Jul"
## [185] "24 Jul" "25 Jul" "26 Jul" "27 Jul" "28 Jul" "29 Jul" "30 Jul" "31 Jul"
## [193] "1 Aug"  "2 Aug"  "3 Aug"  "4 Aug"  "5 Aug"  "6 Aug"  "7 Aug"  "8 Aug"
## [201] "9 Aug"  "10 Aug" "11 Aug" "12 Aug" "13 Aug" "14 Aug" "15 Aug" "16 Aug"
## [209] "17 Aug" "18 Aug" "19 Aug" "20 Aug" "21 Aug" "22 Aug" "23 Aug" "24 Aug"
## [217] "25 Aug" "26 Aug" "27 Aug" "28 Aug" "29 Aug" "30 Aug" "31 Aug" "1 Sep"
## [225] "2 Sep"  "3 Sep"  "4 Sep"  "5 Sep"  "6 Sep"  "7 Sep"  "8 Sep"  "9 Sep"
## [233] "10 Sep" "11 Sep" "12 Sep" "13 Sep" "14 Sep" "15 Sep" "16 Sep" "17 Sep"
## [241] "18 Sep" "19 Sep" "20 Sep" "21 Sep" "22 Sep" "23 Sep" "24 Sep" "25 Sep"
## [249] "26 Sep" "27 Sep" "28 Sep" "29 Sep" "30 Sep" "1 Oct"  "2 Oct"  "3 Oct"
## [257] "4 Oct"  "5 Oct"  "6 Oct"  "7 Oct"  "8 Oct"  "9 Oct"  "10 Oct" "11 Oct"
## [265] "12 Oct" "13 Oct" "14 Oct" "15 Oct" "16 Oct" "17 Oct" "18 Oct" "19 Oct"
## [273] "20 Oct" "21 Oct" "22 Oct" "23 Oct" "24 Oct" "25 Oct" "26 Oct" "27 Oct"
## [281] "28 Oct" "29 Oct" "30 Oct" "31 Oct" "1 Nov"  "2 Nov"  "3 Nov"  "4 Nov"
## [289] "5 Nov"  "6 Nov"  "7 Nov"  "8 Nov"  "9 Nov"  "10 Nov" "11 Nov" "12 Nov"
## [297] "13 Nov" "14 Nov" "15 Nov" "16 Nov" "17 Nov" "18 Nov" "19 Nov" "20 Nov"
## [305] "21 Nov" "22 Nov" "23 Nov" "24 Nov" "25 Nov" "26 Nov" "27 Nov" "28 Nov"
## [313] "29 Nov" "30 Nov" "1 Dec"  "2 Dec"  "3 Dec"  "4 Dec"  "5 Dec"  "6 Dec"
## [321] "7 Dec"  "8 Dec"  "9 Dec"  "10 Dec" "11 Dec" "12 Dec" "13 Dec" "14 Dec"
## [329] "15 Dec" "16 Dec" "17 Dec" "18 Dec" "19 Dec" "20 Dec" "21 Dec" "22 Dec"
## [337] "23 Dec" "24 Dec" "25 Dec" "26 Dec" "27 Dec" "28 Dec" "29 Dec" "30 Dec"
## [345] "31 Dec" "1 Jan"  "2 Jan"  "3 Jan"  "4 Jan"  "5 Jan"  "6 Jan"  "7 Jan"
## [353] "8 Jan"  "9 Jan"  "10 Jan" "11 Jan" "12 Jan" "13 Jan" "14 Jan" "15 Jan"
## [361] "16 Jan" "17 Jan" "18 Jan" "19 Jan" "20 Jan" "21 Jan" "22 Jan" "23 Jan"
## [369] "24 Jan" "25 Jan" "26 Jan" "27 Jan" "28 Jan" "29 Jan" "30 Jan" "31 Jan"
## [377] "1 Feb"  "2 Feb"  "3 Feb"  "4 Feb"  "5 Feb"  "6 Feb"  "7 Feb"  "8 Feb"
## [385] "9 Feb"  "10 Feb" "11 Feb" "12 Feb" "13 Feb" "14 Feb" "15 Feb" "16 Feb"
## [393] "17 Feb" "18 Feb" "19 Feb" "20 Feb" "21 Feb" "22 Feb" "23 Feb" "24 Feb"
## [401] "25 Feb" "26 Feb" "27 Feb" "28 Feb" "1 Mar"  "2 Mar"  "3 Mar"  "4 Mar"
## [409] "5 Mar"  "6 Mar"  "7 Mar"  "8 Mar"  "9 Mar"  "10 Mar" "11 Mar" "12 Mar"
## [417] "13 Mar" "14 Mar" "15 Mar" "16 Mar" "17 Mar" "18 Mar" "19 Mar" "20 Mar"
## [425] "21 Mar" "22 Mar" "23 Mar" "24 Mar" "25 Mar" "26 Mar" "27 Mar" "28 Mar"
## [433] "29 Mar" "30 Mar" "31 Mar" "1 Apr"  "2 Apr"  "3 Apr"  "4 Apr"  "5 Apr"
## [441] "6 Apr"  "7 Apr"  "8 Apr"  "9 Apr"  "10 Apr" "11 Apr" "12 Apr" "13 Apr"
## [449] "14 Apr" "15 Apr" "16 Apr" "17 Apr" "18 Apr" "19 Apr" "20 Apr" "21 Apr"
## [457] "22 Apr" "23 Apr" "24 Apr" "25 Apr" "26 Apr" "27 Apr" "28 Apr" "29 Apr"
```

```
## [465] "30 Apr" "1 May"  "2 May"  "3 May"  "4 May"  "5 May"  "6 May"  "7 May"
## [473] "8 May"  "9 May"  "10 May" "11 May" "12 May" "13 May" "14 May" "15 May"
## [481] "16 May" "17 May" "18 May" "19 May" "20 May" "21 May" "22 May" "23 May"
## [489] "24 May" "25 May" "26 May" "27 May" "28 May" "29 May" "30 May" "31 May"
```

```
head(table_data)
```

```
## [[1]]
## # A tibble: 496 x 14
##    Date   `Confirmed cases` `Confirmed cases` `Confirmed cases` Recoveries
##    <chr>  <chr>             <chr>             <chr>             <chr>
##  1 Date   Total             New               Active            Total
##  2 23 Jan 1                 +1                1                 0
##  3 24 Jan 1                 0                 1                 0
##  4 25 Jan 1                 0                 1                 0
##  5 26 Jan 1                 0                 1                 0
##  6 27 Jan 1                 0                 1                 0
##  7 28 Jan 1                 0                 1                 0
##  8 29 Jan 1                 0                 0                 1
##  9 30 Jan 1                 0                 0                 1
## 10 31 Jan 1                 0                 0                 1
## # i 486 more rows
## # i 9 more variables: Recoveries <chr>, Deaths <chr>, Deaths <chr>,
## #   `RT-PCR tests` <chr>, `RT-PCR tests` <chr>, TPR <chr>, RR <chr>, CFR <chr>,
## #   Ref. <chr>
```

```
names(table_df)
```

```
##  [1] "Date"              "Confirmed.cases"   "Confirmed.cases.1"
##  [4] "Confirmed.cases.2" "Recoveries"        "Recoveries.1"
##  [7] "Deaths"            "Deaths.1"          "RT.PCR.tests"
## [10] "RT.PCR.tests.1"    "TPR"               "RR"
## [13] "CFR"               "Ref."
```

```
table.tibble <- tibble::as_tibble(table_df)
```