NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE : 14-12-2021

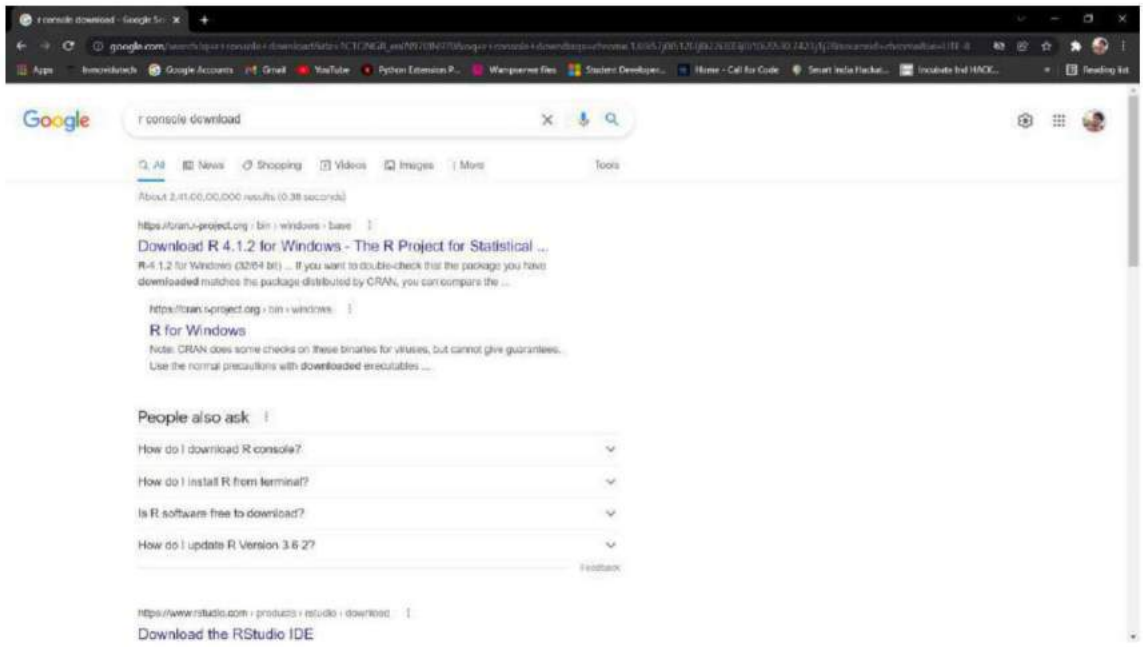
EXPERIMENT NAME: Install R and R Studio and R Basics

Aim:

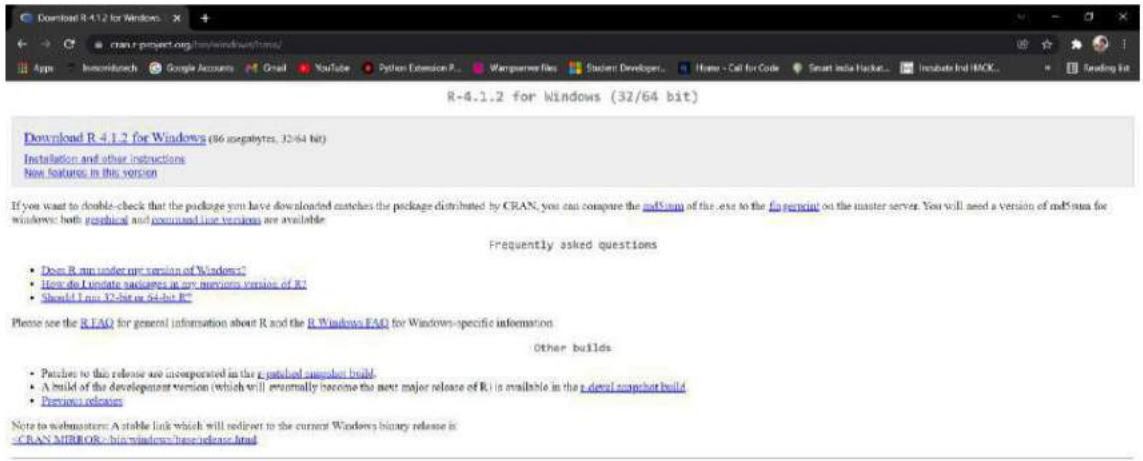
To install R and R Studio in our system and implement some R Basics in R Studio

INSTALLATION OF R:

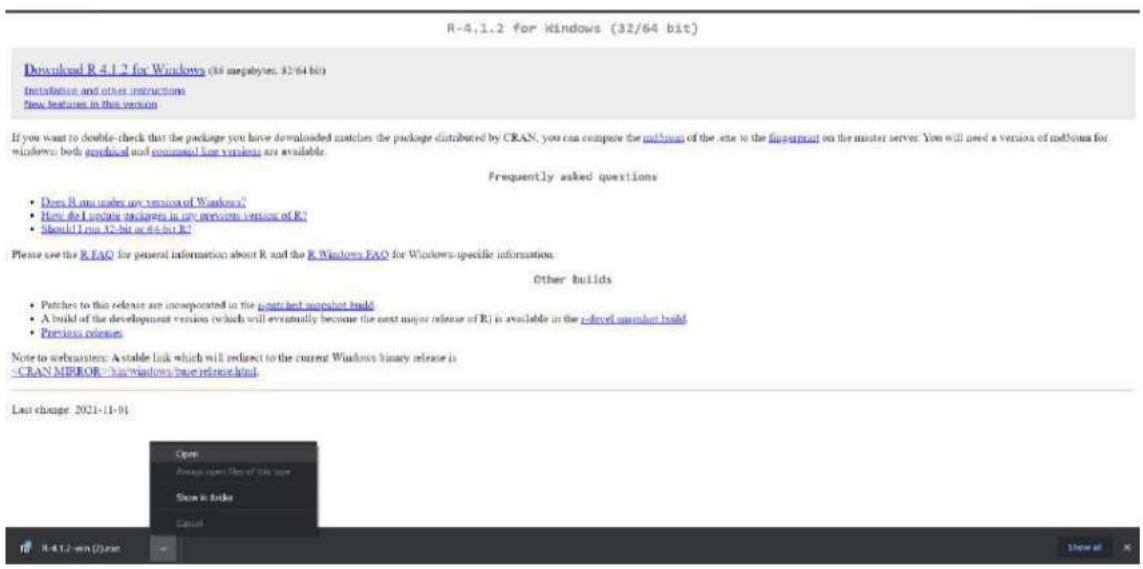
STEP 1: SEARCH FOR R CONSOLE IN GOOGLE / BROWSER



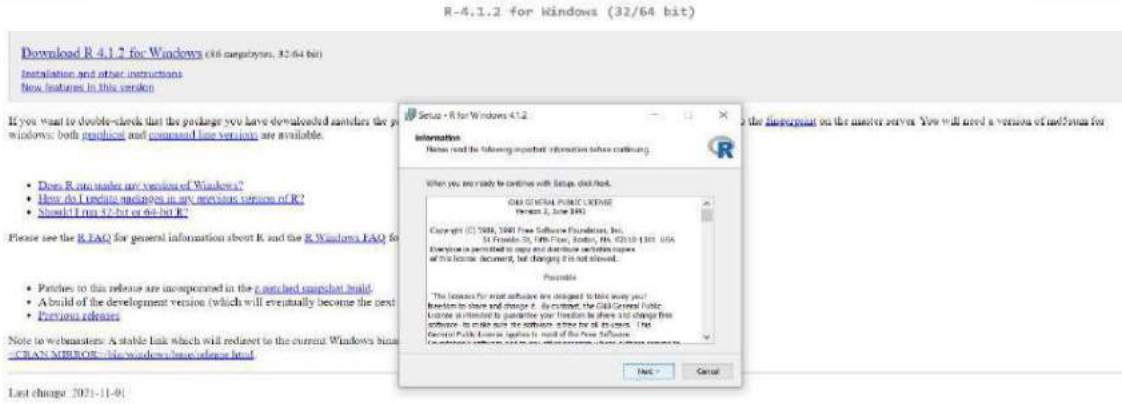
STEP 2: DOWNLOAD R 4.1.2 FOR WINDOWS



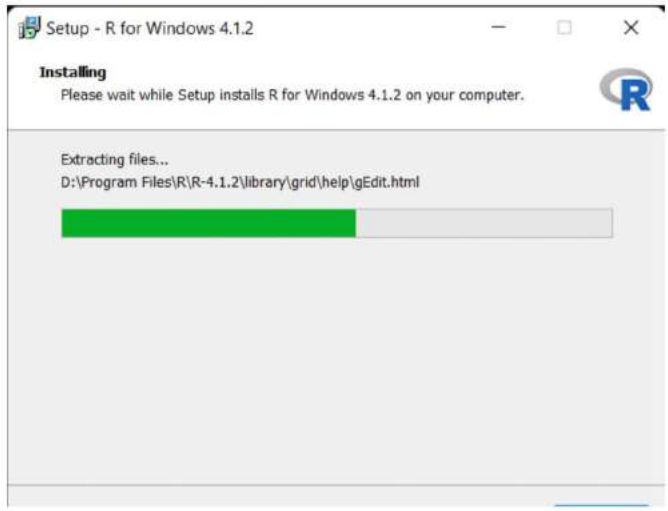
STEP 3: OPEN THE SET-UP DIALOGUE BOX



STEP 4: GO THROUGH THE SET-UP PROCESS



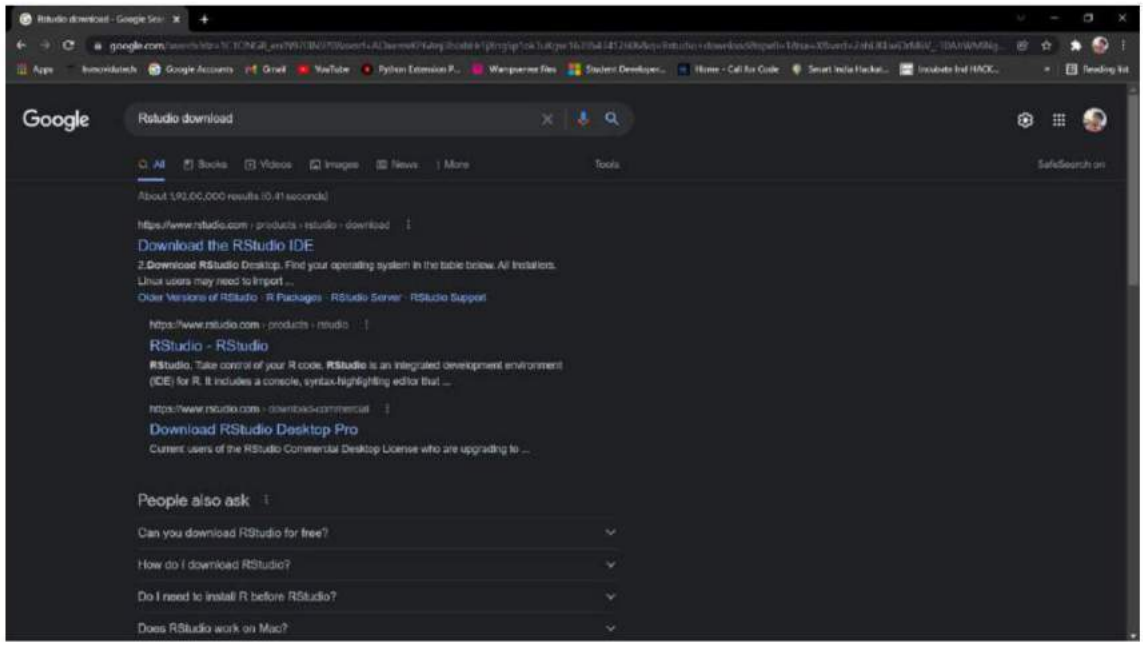
STEP 5: WAIT FOR THE INSTALLATION PROCESS



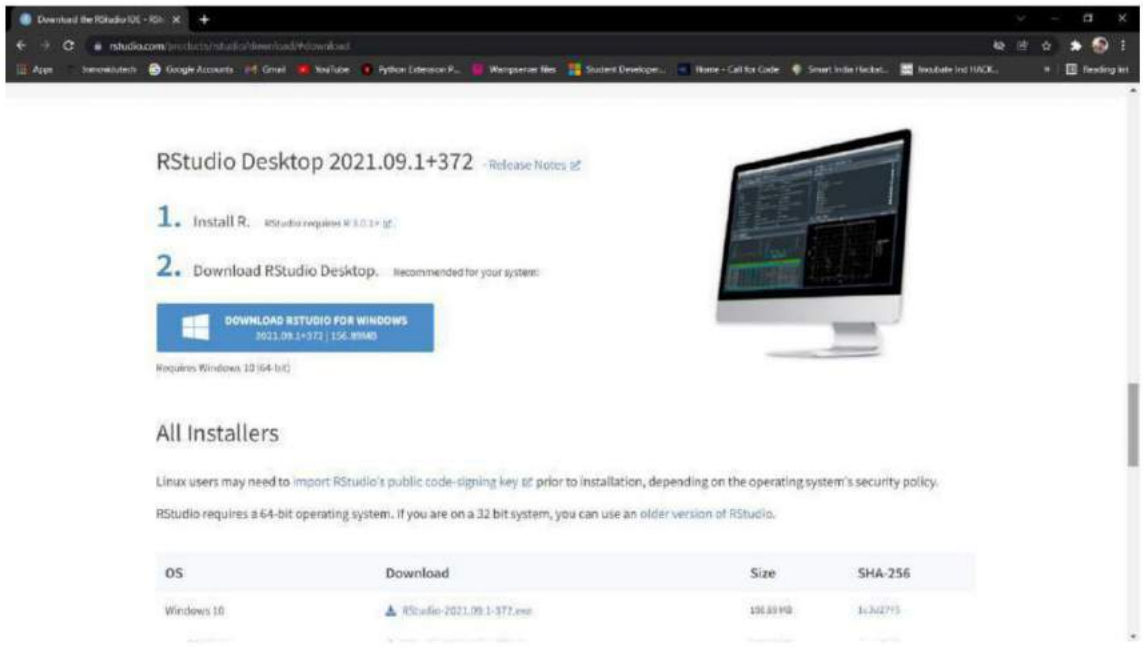
STEP 6: ONCE THE INSTALLATION IS COMPLETED, CLICK ON FINISH

INSTALLATION OF RSTUDIO:

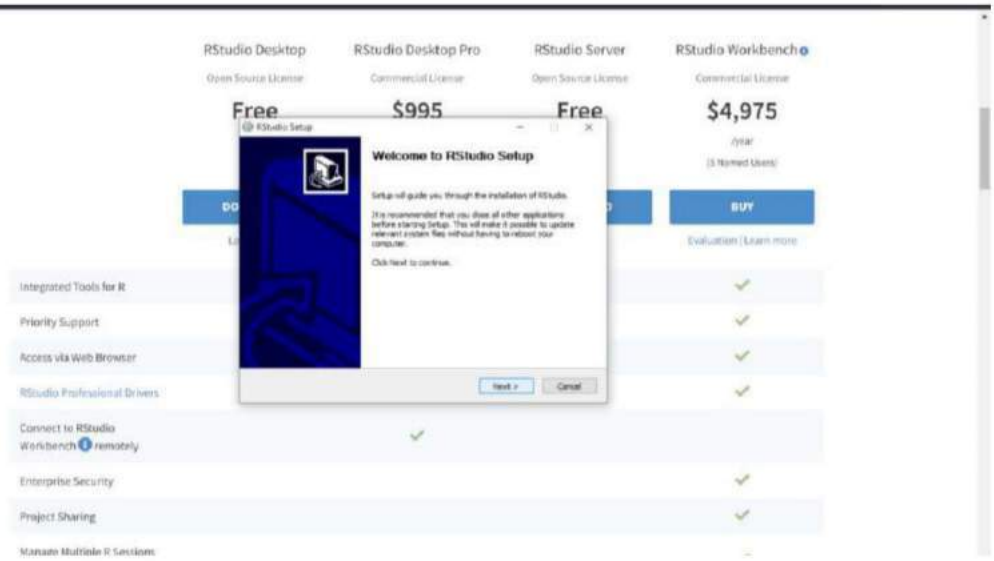
STEP 1: SEARCH FOR RSTUDIO IN GOOGLE / BROWSER



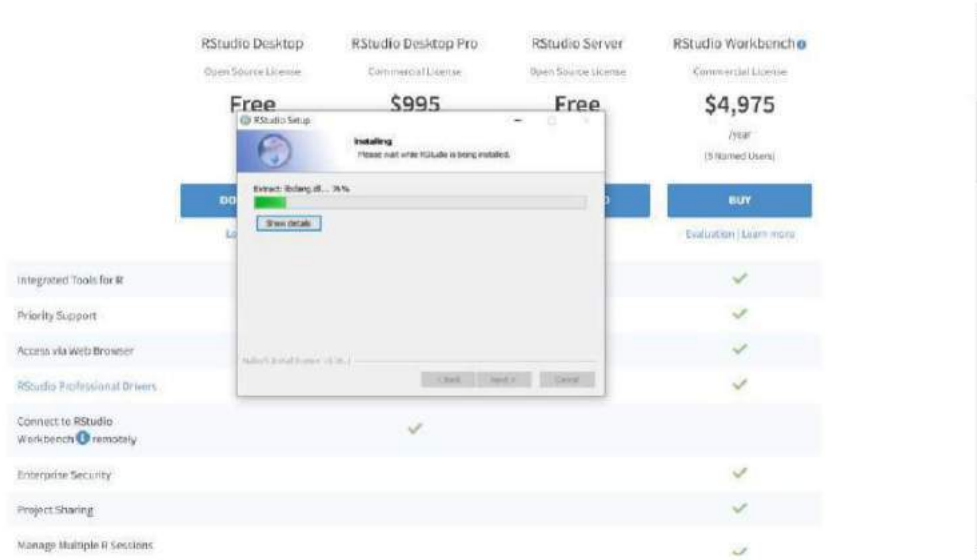
STEP 2: DOWNLOAD RSTUDIO FOR WINDOWS AND OPEN THE SET-UP DIALOGUE BOX



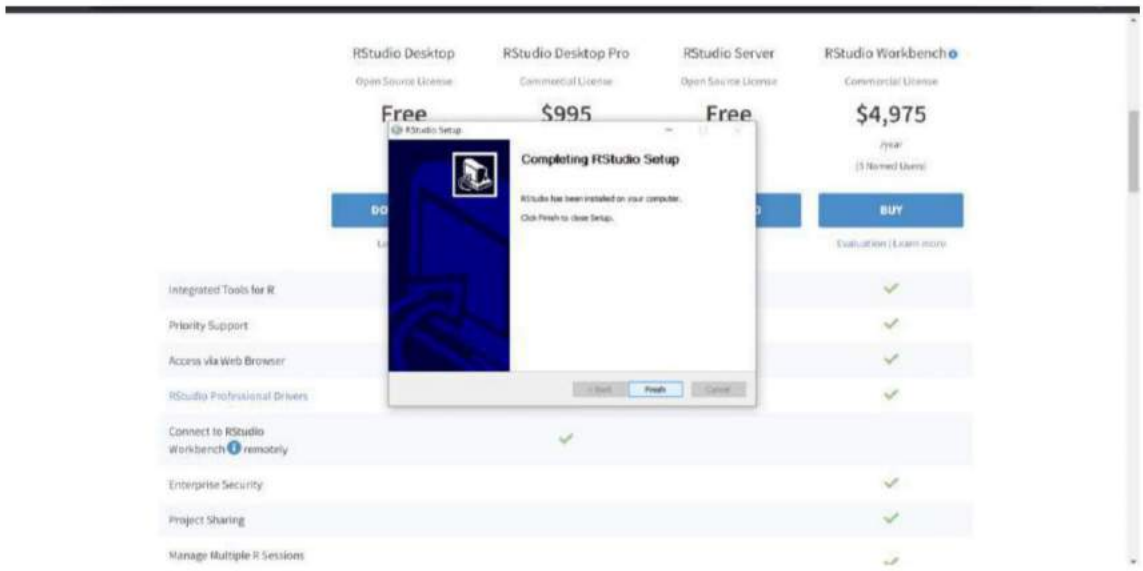
STEP 3: GO THROUGH THE SET-UP PROCESS



STEP 4: WAIT FOR THE INSTALLATION PROCESS

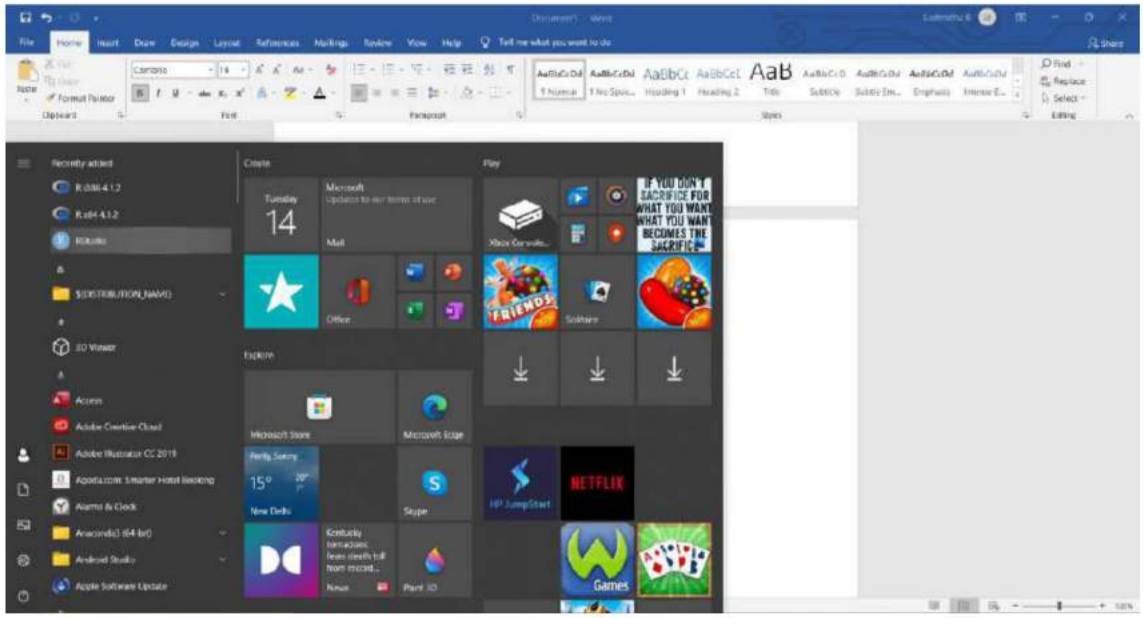


STEP 5: ONCE THE INSTALLATION IS COMPLETED, CLICK ON FINISH

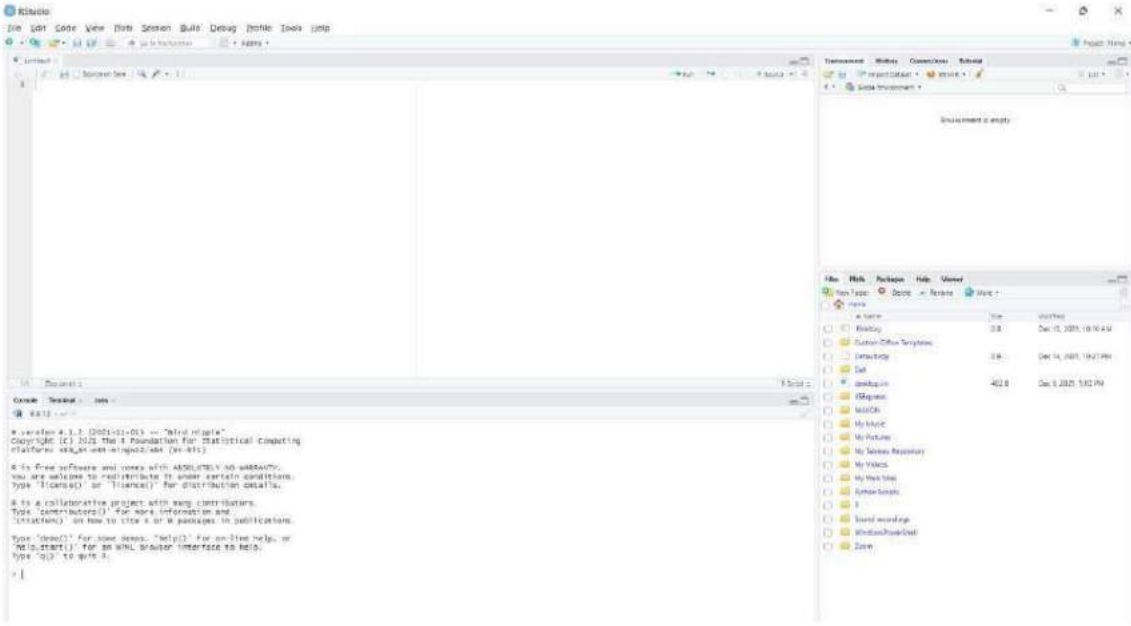


R BASICS IN R STUDIO:

OPEN RSTUDIO



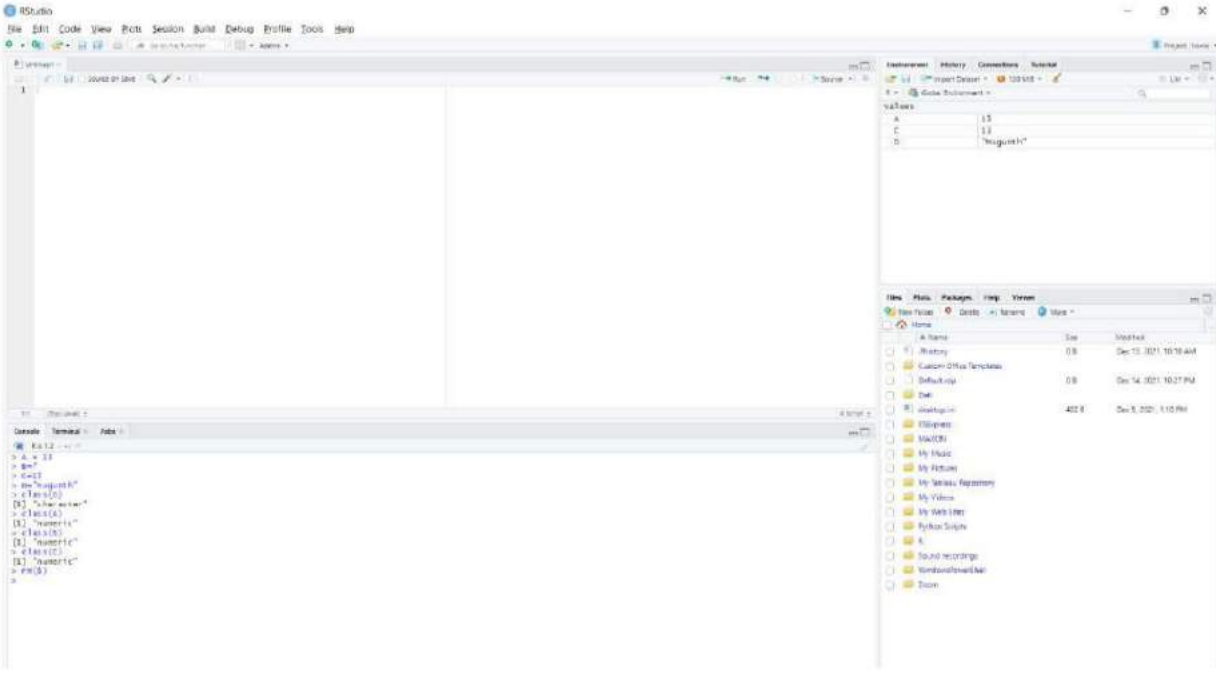
PERFORM YOUR OPERATIONS IN CONSOLE WINDOW



PERFORM OPERATIONS LIKE ASSIGNING A=13, B=7, A<-FALSE, C=13,

D= “Mugunth”, class(D), class(A), class(B), class(C), rm(B) IN CONSOLE WINDOW.

THE OUTPUT WILL BE DISPLAYED IN ENVIRONMENT WINDOW



RESULT:

THUS, WE HAVE DOWNLOADED R CONSOLE AND R STUDIO AND IMPLEMENTED THE BASICS OF R STUDIO SUCCESSFULLY.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE : 17-12-2021

EXPERIMENT NAME: R Program using Operators

Aim:

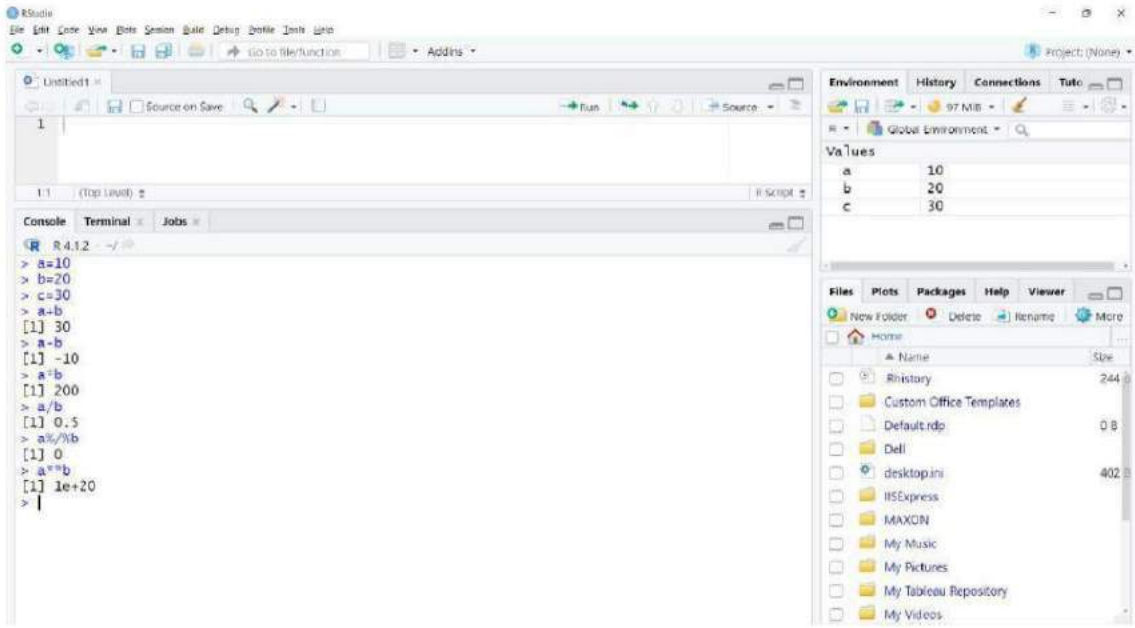
To perform various operations on variables in R language.

Procedure:

Operators are special symbols which represents computations, conditions matching etc. Operators are categorized as Arithmetic, Relational, Logical operators.

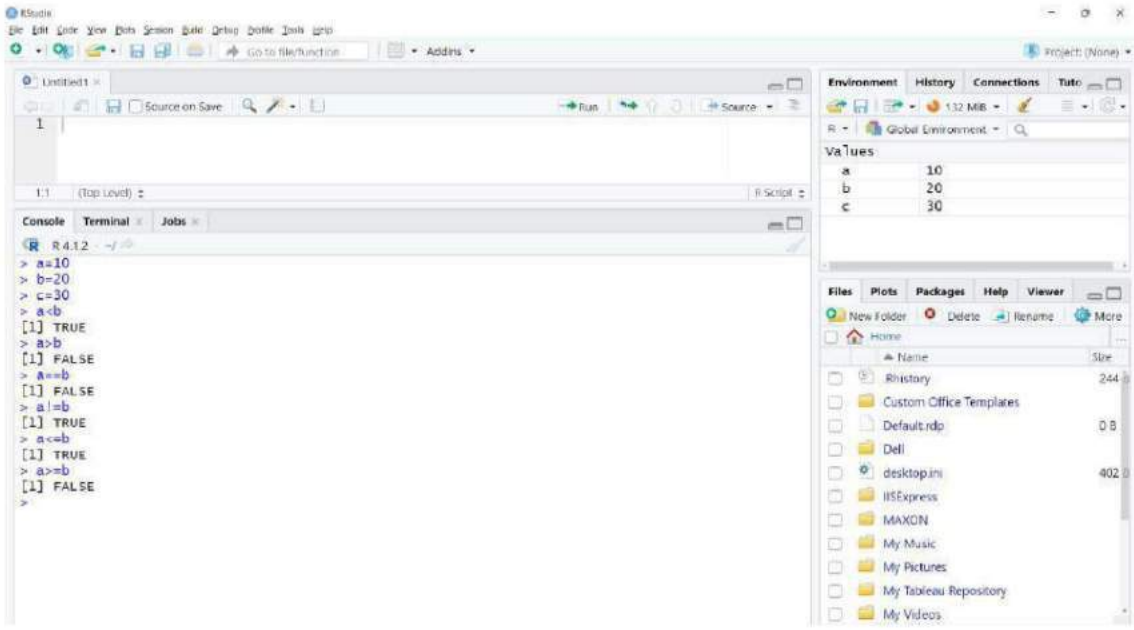
1. Arithmetic Operators:

These are mathematical operators that takes two operands and performs calculations. Symbols: +,-,*,/,%,.**



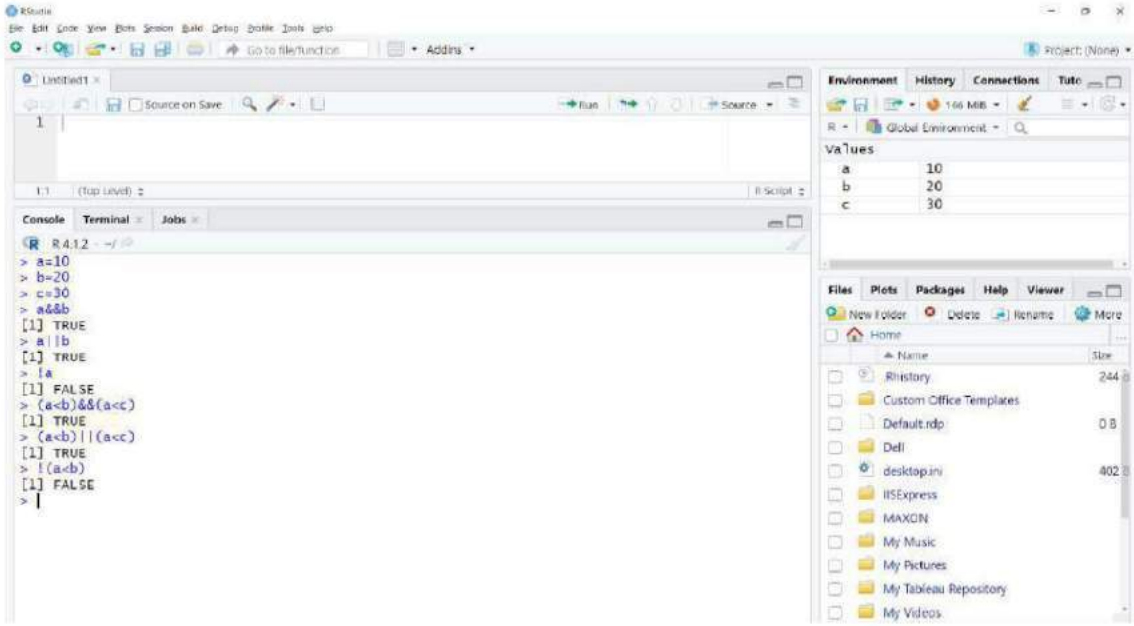
2. Relational Operators:

These are used to check relationship between two operands. If the relation is true it returns true, else returns false. Symbols: <,>,<=,>=,==,!=.



3. Logical Operators:

These operators performs operations on the given expressions. There are 3 logical operators: and, or, not.



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 21-12-2021

EXPERIMENT NAME: R Program for Vectors and Matrices Operations.

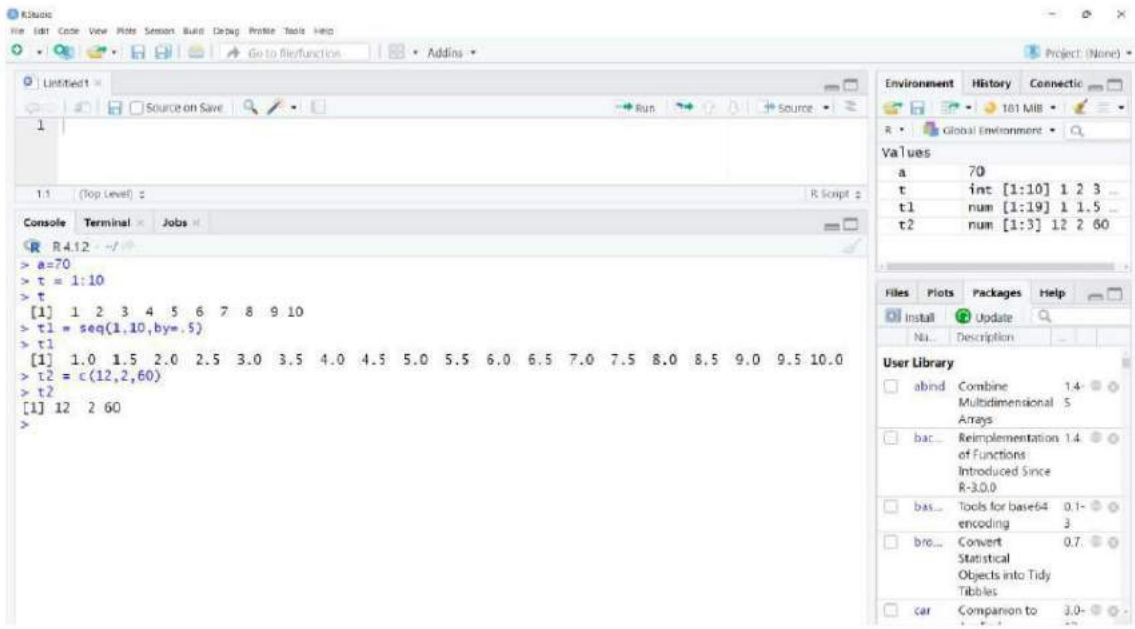
AIM: To perform Vectors and Matrices Operations in R programming.

Procedure:

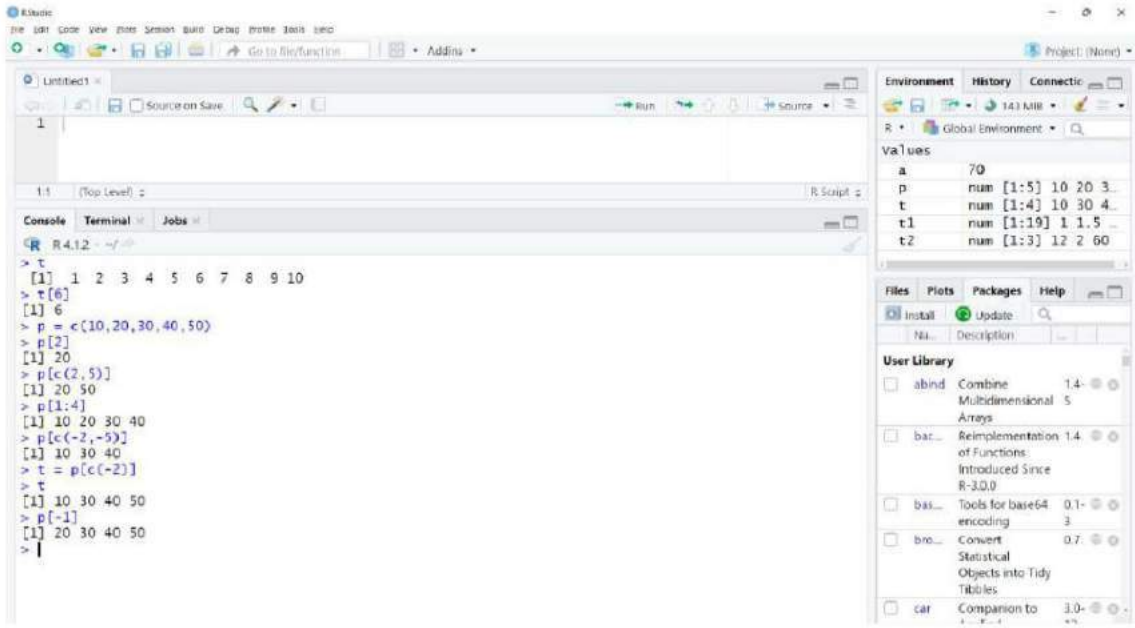
- To perform Vector Operations.
- To perform Matrices Operations.

Vectors:

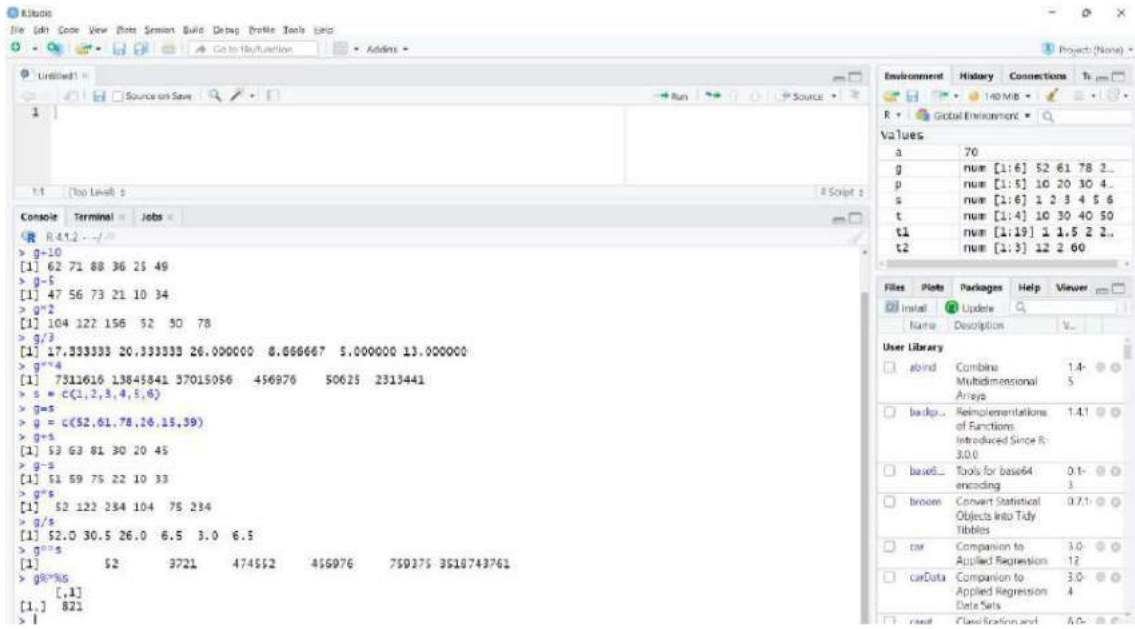
- Vectors can be created using operators such as :, seq(), c().



- **Accessing Elements from a vector: Elements of the vector can be accessed using their index values.**



- **Vectors Operations: We can perform arithmetic, relational, logical operations between vectors.**



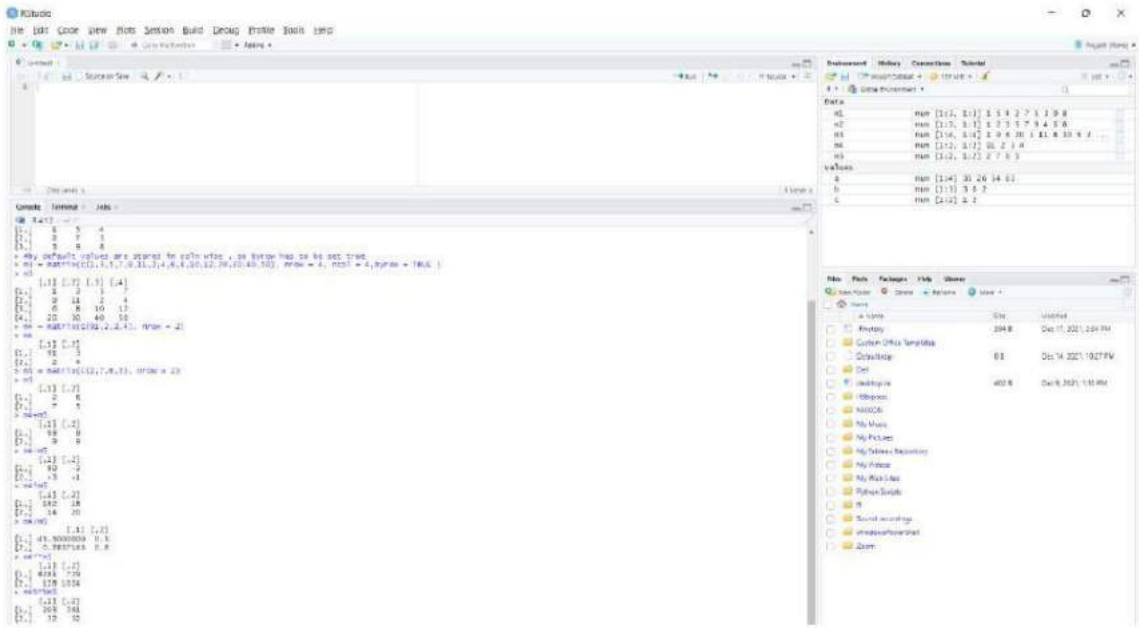
Matrix:

- ### Creating Matrix:

  Syntax: matrix(data, nrow, ncol, byrow, dimnames).

- ### Operations on matrix:

  Basic arithmetic operations such as addition, subtraction, multiplication, division can be performed between matrices. We can also perform transpose of a matrix and inverse of a matrix.



Result:

Thus, we have performed vector and matrix operations in R successfully.

NAME: Mugunth. D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 29-12-2021

EXPERIMENT NAME: R Program for List and String Operations.

Aim:

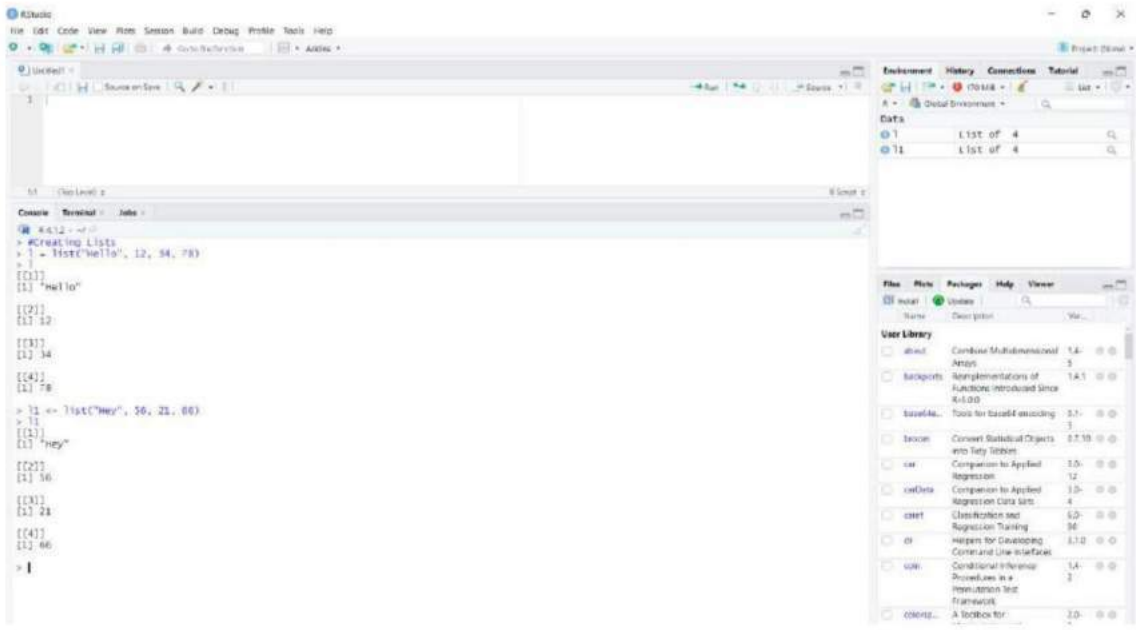
To perform various operations on List and String .

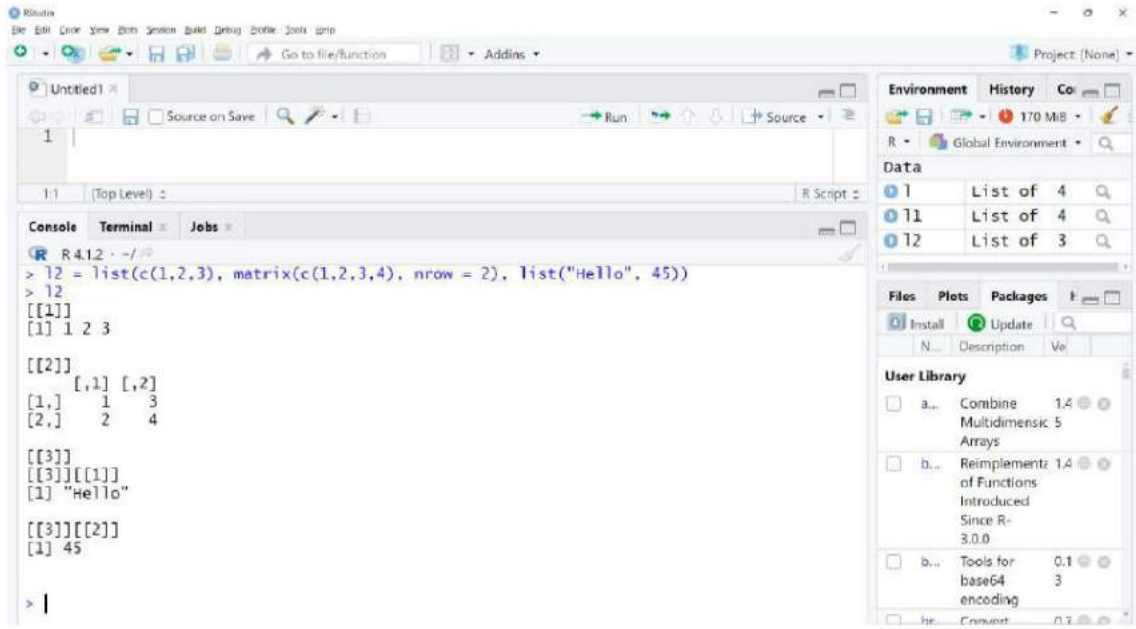
Procedure:

- To perform List Operations.
- To perform String Operations.

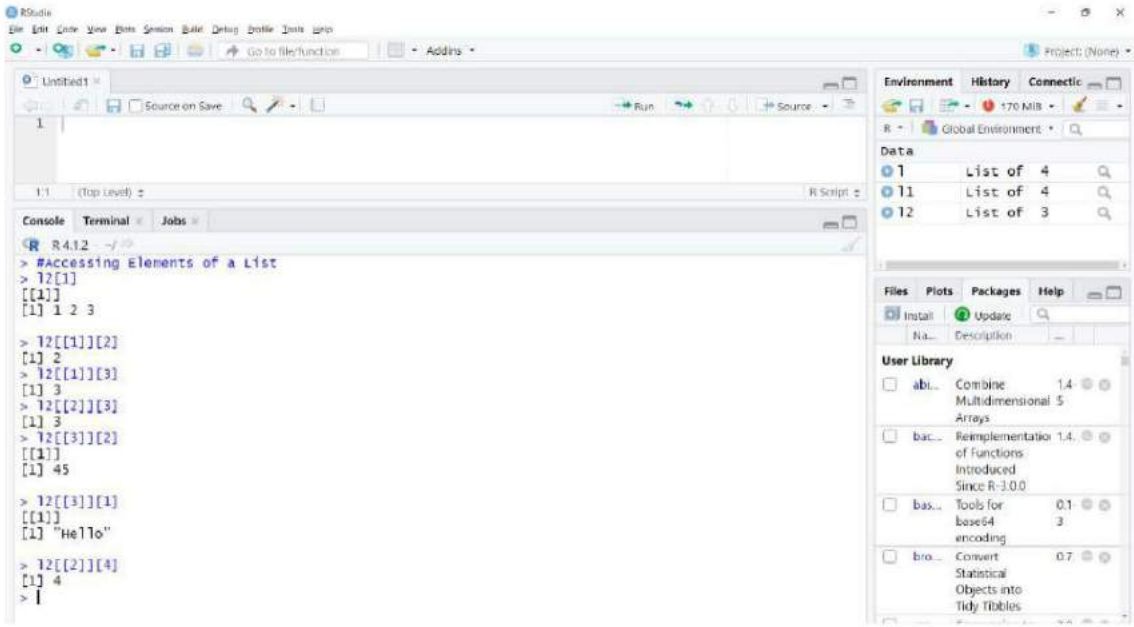
List Operations:

- Creating a List

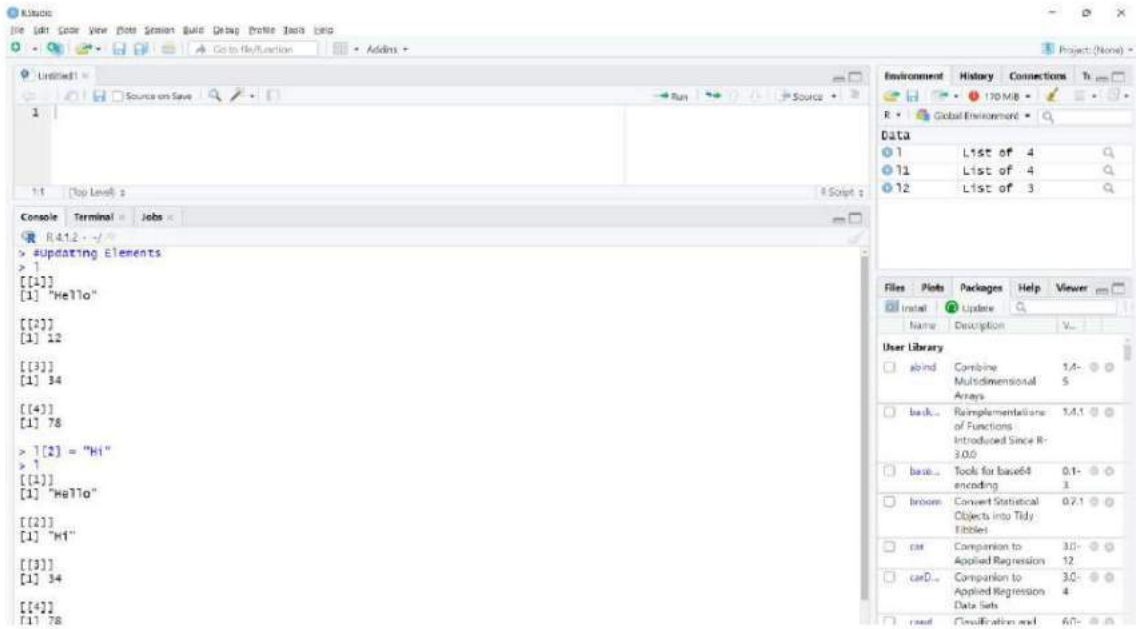


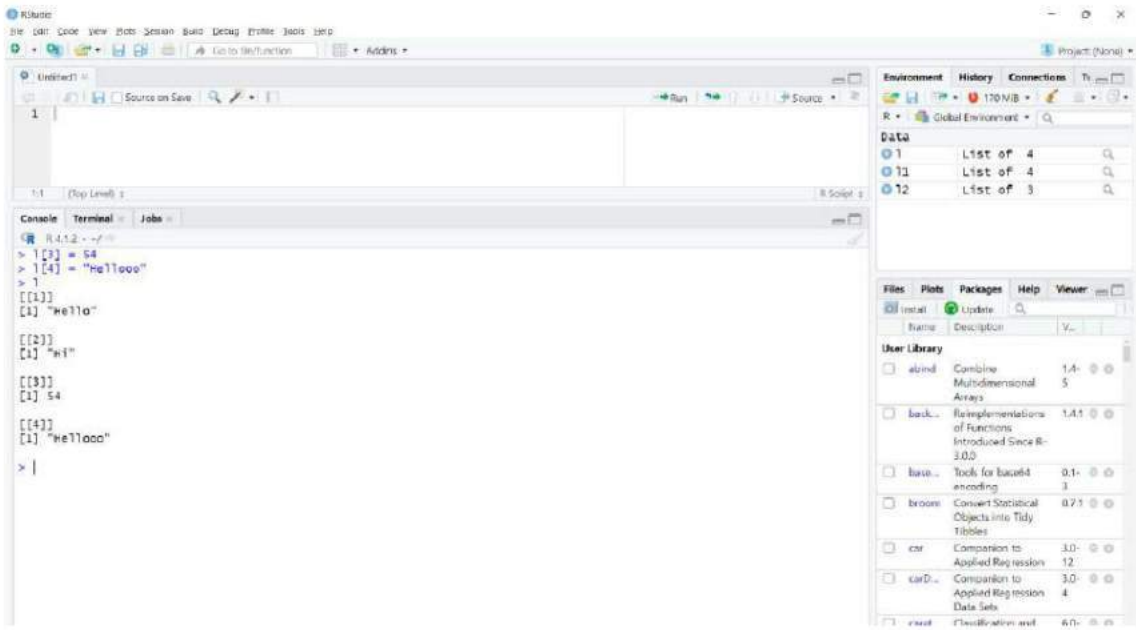


- **Accessing Elements of a List**

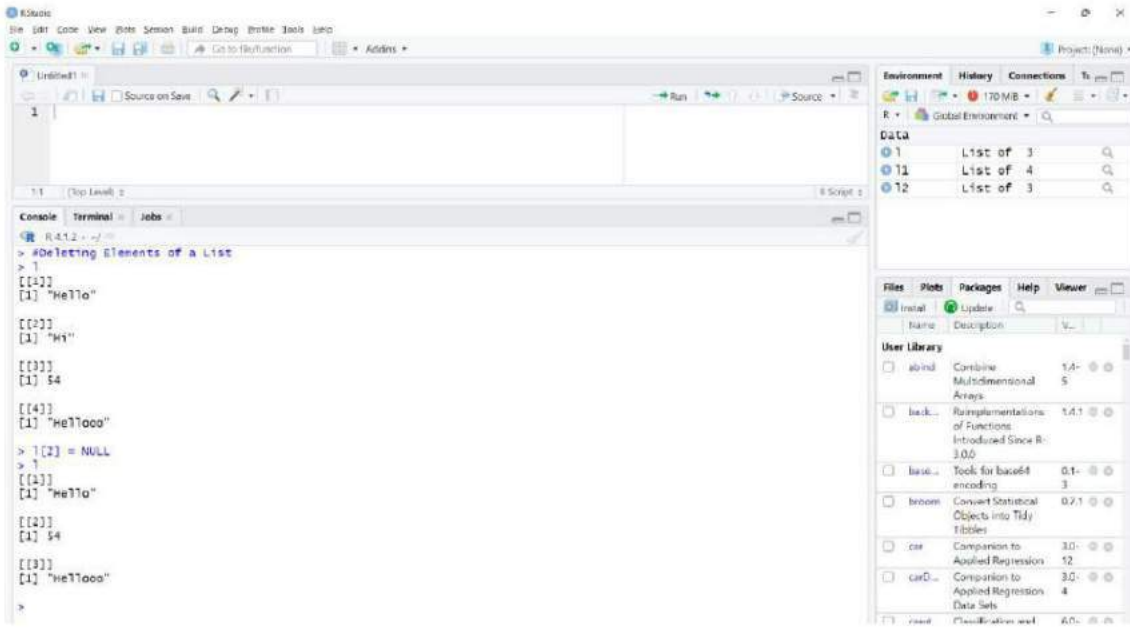


- **Updating Elements of a List**



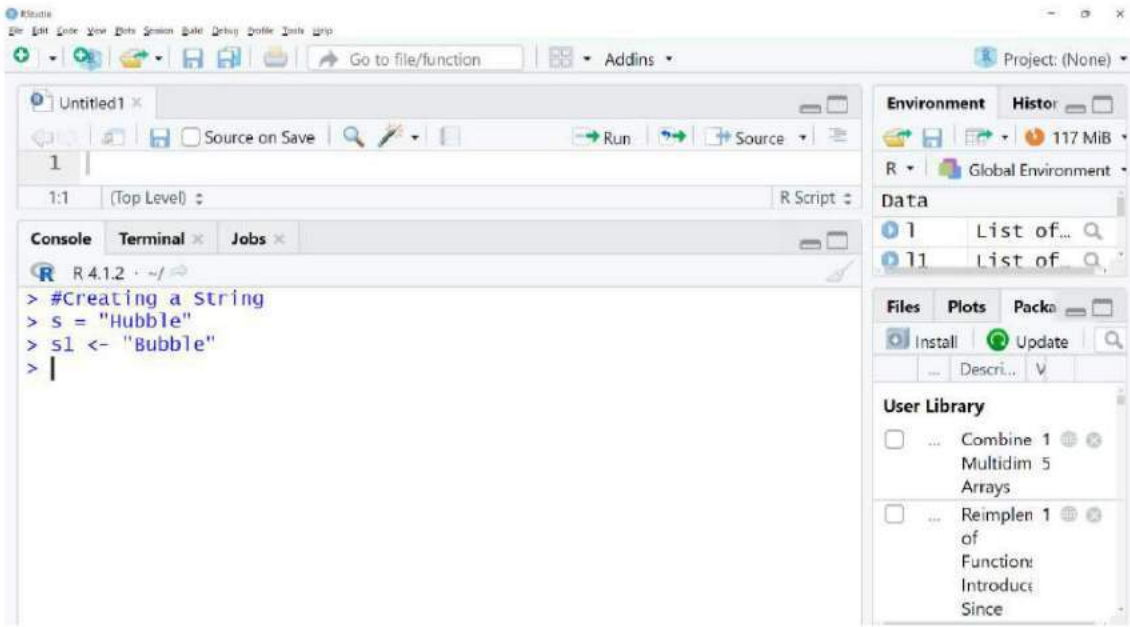


- **Deleting Elements of a List**

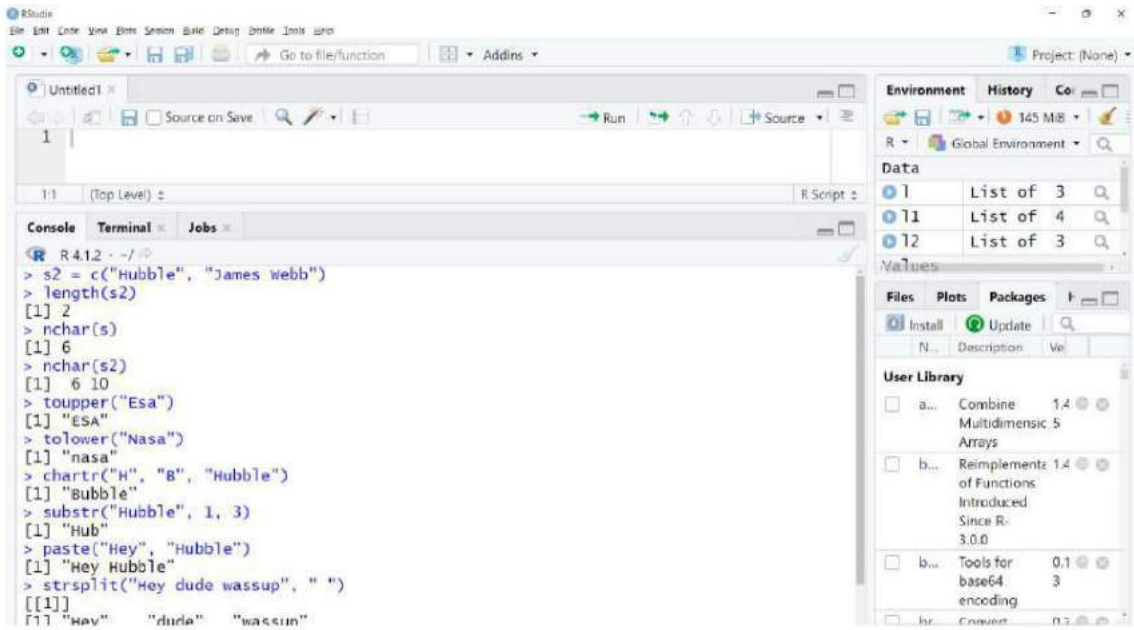


String Operations:

- **Creating a String**



- **Operations:**
  - **length(x):** Get or set the length of vectors (including lists) and factors, and of any other R object for which a method has been defined.
  - **nchar(x):** returns number of characters in a string.
  - **toupper(x):** translates all the characters of a string to upper case.
  - **tolower(x):** translates all the characters of a string to lower case.
  - **chartr(x):** translates each character in x that is specified in old to the corresponding character specified in new. Ranges are supported in the specifications.
  - **substr(x):** Extract or replace substrings in a character vector.
  - **Concatenating Strings:** two or more strings can be concatenated using paste(x) command.
  - **strsplit(x):** Split the elements of a character vector x into substrings according to the matches to substring split within them.



Result:

Thus we have performed operations on List and Strings successfully.

NAME: Mugunth. D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 29-12-2021

EXPERIMENT NAME: R Program for Data Frame Operations.

Aim:

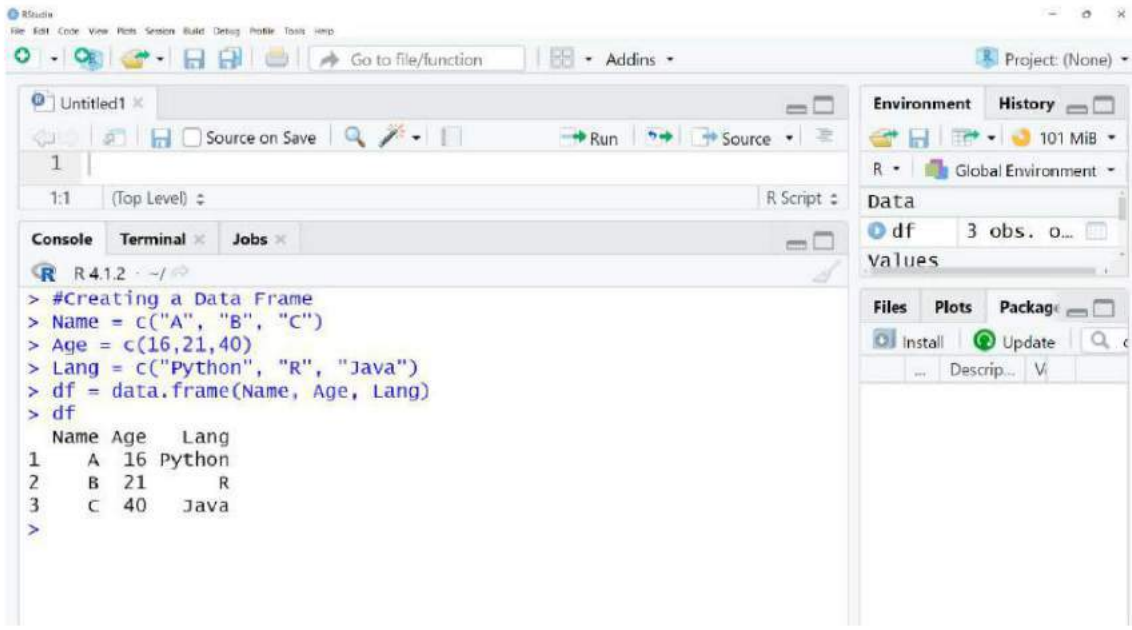
To perform various operations using Data Frames.

Procedure:

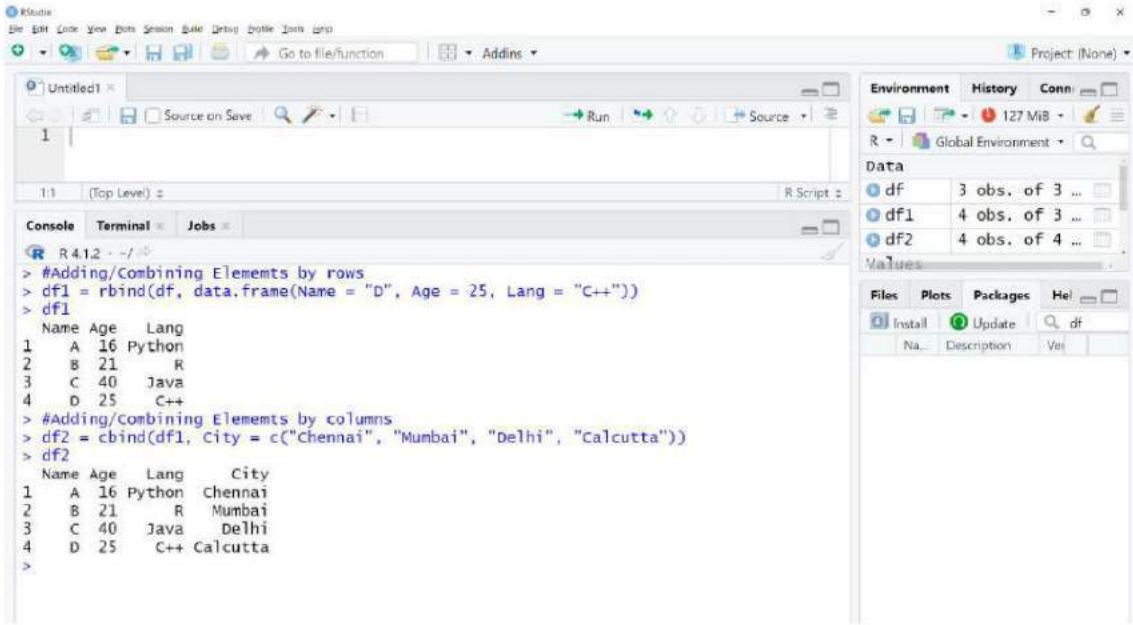
- The function data.frame() creates data frames, tightly coupled collections of variables which share many of the properties of matrices and of lists, used as the fundamental data structure by most of R's modeling software.
- Syntax:

```
data.frames(..., row.names = NULL, check.rows = FALSE,
                check.names = TRUE, fix.empty.names = TRUE,
               stringsAsFactors = FALSE)
```

- Creating a Data Frame

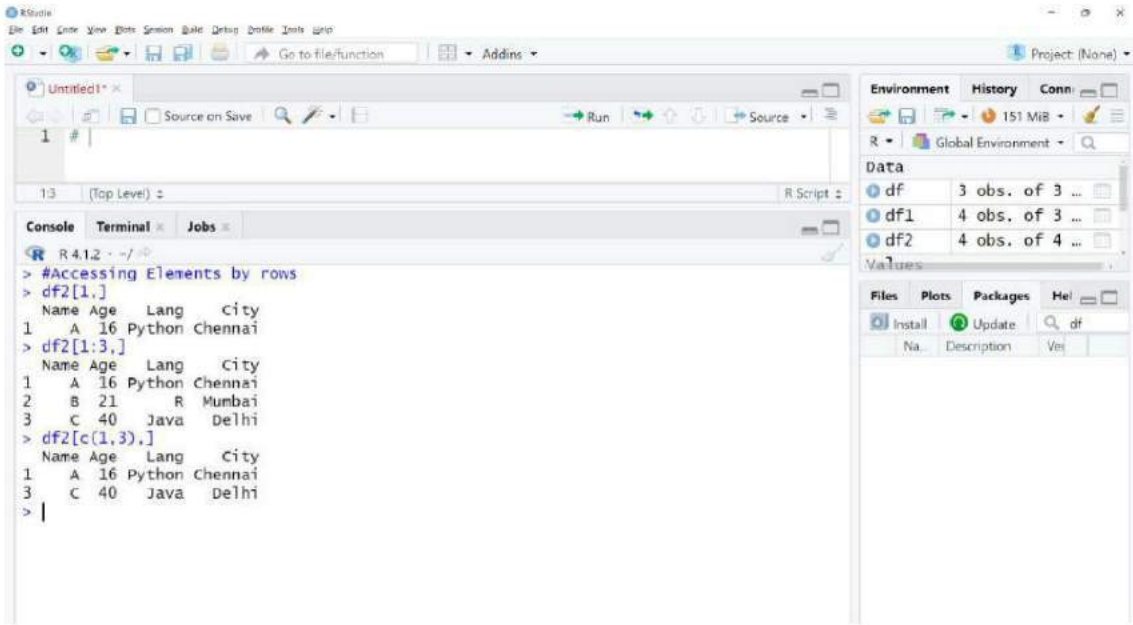


➢ Adding/Combining Elements by rows/columns



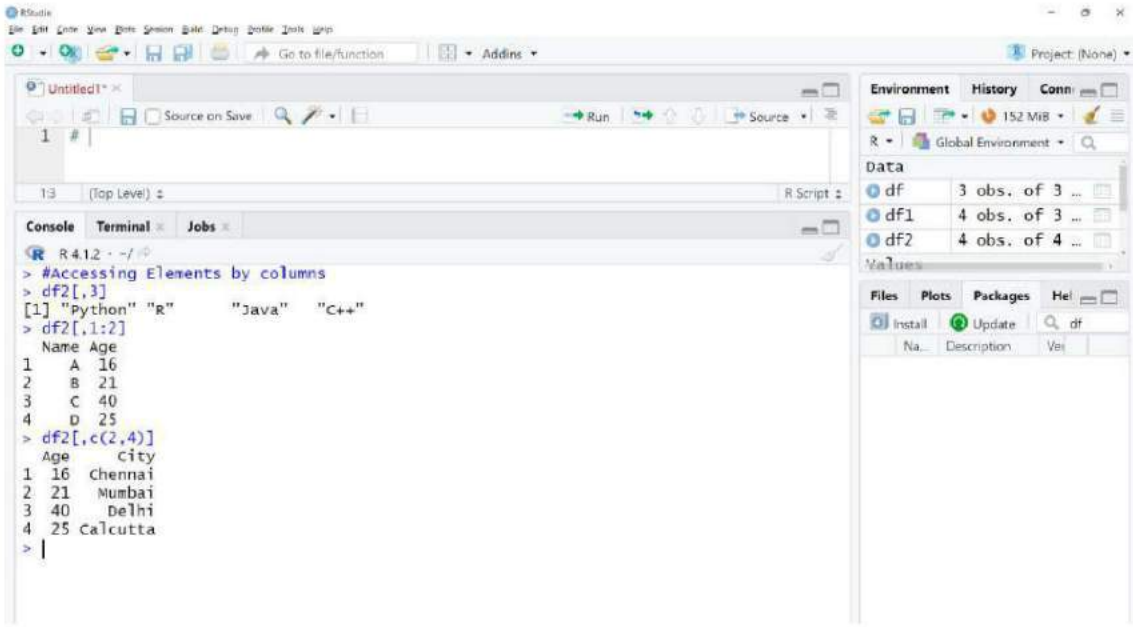
```
> #Adding/Combining Elememts by rows
> df1 = rbind(df, data.frame(Name = "D", Age = 25, Lang = "C++"))
> df1
  Name Age   Lang
1    A  16 Python
2    B  21      R
3    C  40   Java
4    D  25    C++
> #Adding/Combining Elememts by columns
> df2 = cbind(df1, City = c("Chennai", "Mumbai", "Delhi", "Calcutta"))
> df2
  Name Age   Lang     City
1    A  16 Python  Chennai
2    B  21      R   Mumbai
3    C  40   Java    Delhi
4    D  25    C++ Calcutta
>
```

➢ Accessing Elements by rows



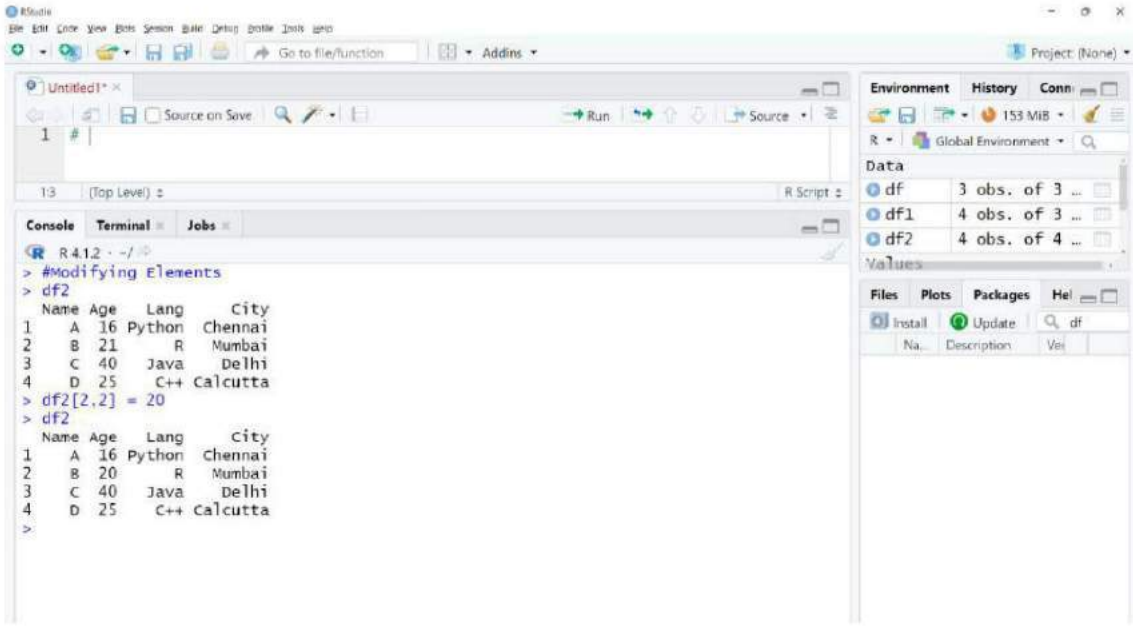
```
> #Accessing Elements by rows
> df2[1,]
  Name Age   Lang    City
1    A  16 Python Chennai
> df2[1:3,]
  Name Age   Lang    City
1    A  16 Python Chennai
2    B  21      R  Mumbai
3    C  40   Java   Delhi
> df2[c(1,3),]
  Name Age   Lang    City
1    A  16 Python Chennai
3    C  40   Java   Delhi
>
```

➢ Accessing Elements by columns



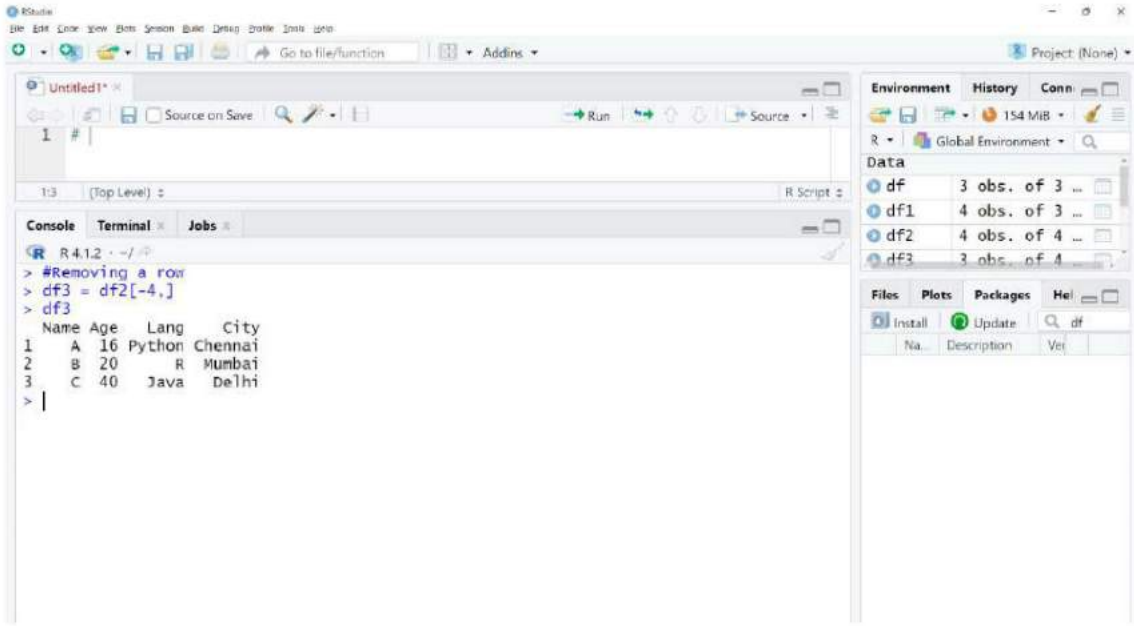
```
> #Accessing Elements by columns
> df2[,3]
[1] "Python" "R"      "Java"   "C++"
> df2[,1:2]
  Name Age
1    A  16
2    B  21
3    C  40
4    D  25
> df2[,c(2,4)]
  Age     City
1  16  Chennai
2  21   Mumbai
3  40    Delhi
4  25 Calcutta
>
```

➢ Modifying Elements of a Data Frames

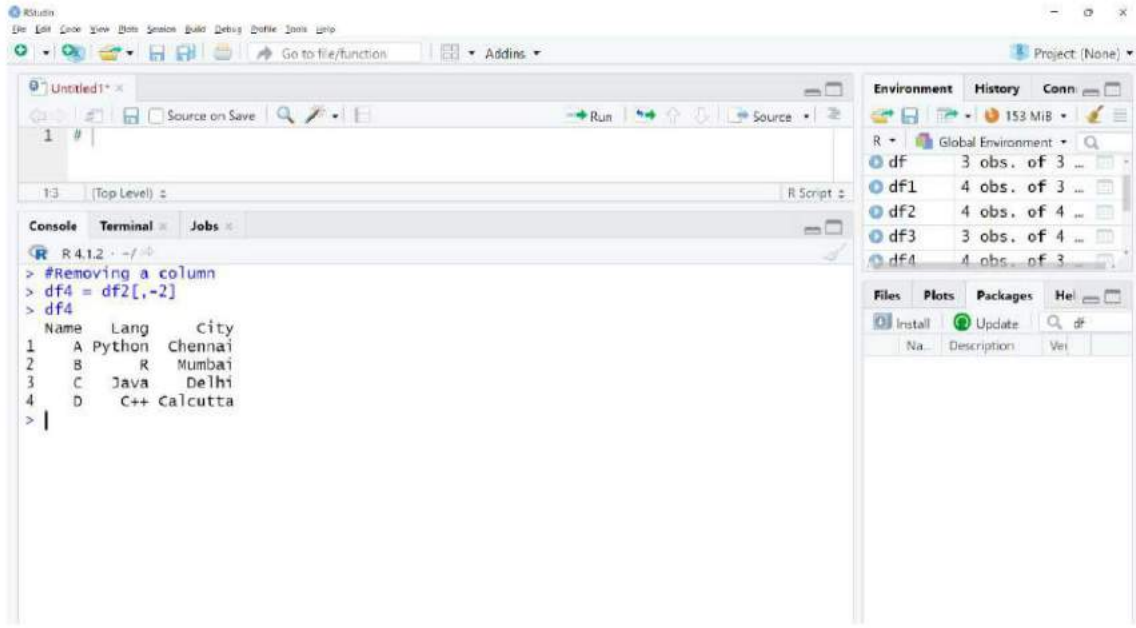


```
> #Modifying Elements
> df2
  Name Age   Lang     City
1    A  16 Python  Chennai
2    B  21      R   Mumbai
3    C  40   Java    Delhi
4    D  25    C++ Calcutta
> df2[2,2] = 20
> df2
  Name Age   Lang     City
1    A  16 Python  Chennai
2    B  20      R   Mumbai
3    C  40   Java    Delhi
4    D  25    C++ Calcutta
>
```

- **Removing a row**



- **Removing a column**



Result:

Thus we have performed operations on Data Frames successfully.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE: 04-01-2021

EXPERIMENT NAME: R Program for Built-in functions and User defined functions.

Aim:

To

a) Write the R Script for built in functions (Any 10)

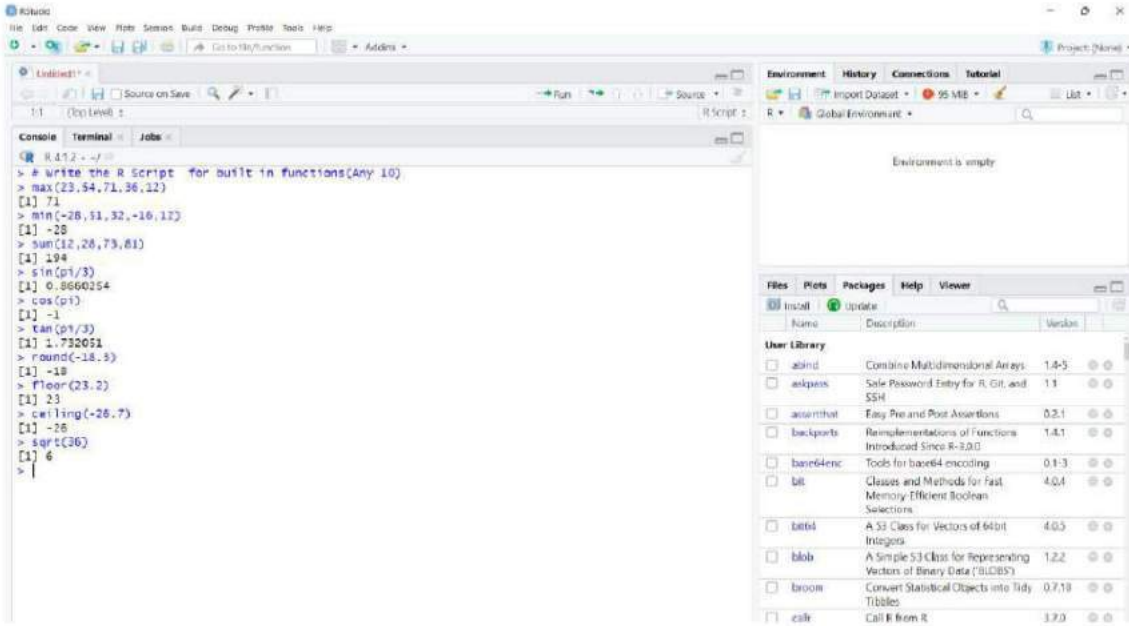
b) Write a R program to check odd or even number using custom Function (User Defined Function)

Procedure:

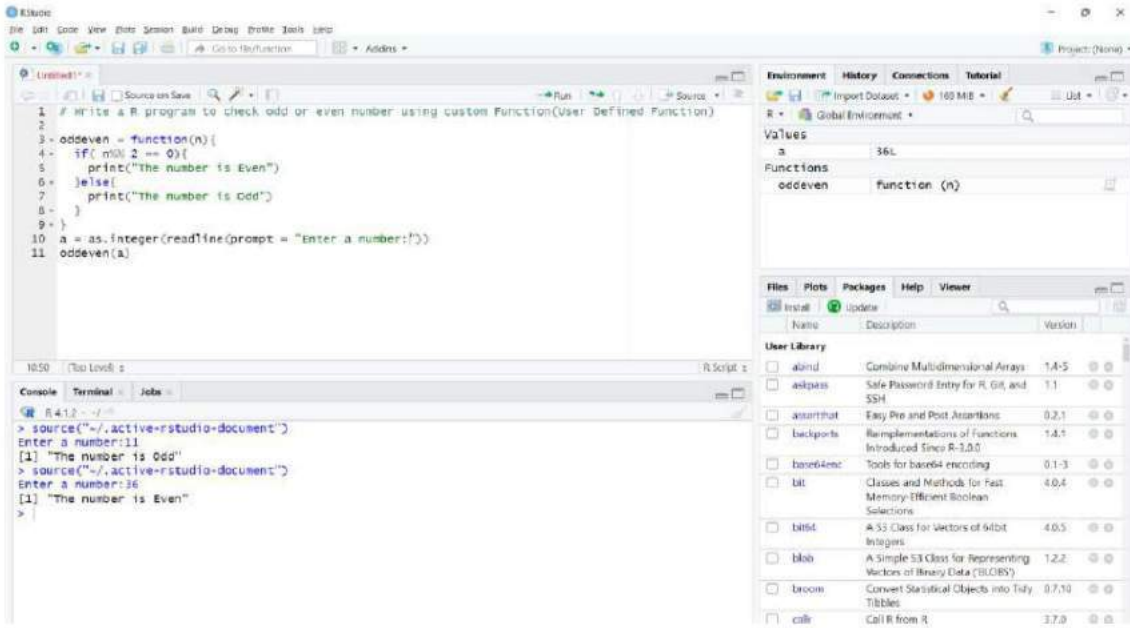
a) Built-in Functions:

There are various built-in functions available in R. Here is a few popular built-in functions used in R:

- max(x) – returns the maximum of the input values.
- min(x) – returns the minimum of the input values.
- sum(x) – returns the sum of the input values.
- sin(x) – returns the sin of input values.
- cos(x) – returns the cosine of input values.
- tan(x) – returns the tangent of input values
- floor(x) – returns the largest integer less than or equal to input values.
- ceiling(x) – returns the smallest number greater than or equal to input values.
- round(x) - rounds the values in its first argument to the specified number of decimal places.
- sqrt(x) – returns the square root of input values which is greater than zero (0).



b) Write a R program to check odd or even number using custom Function (User Defined Function)



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 04-01-2021

EXPERIMENT NAME: R Program for Control Structures.

Aim:

To

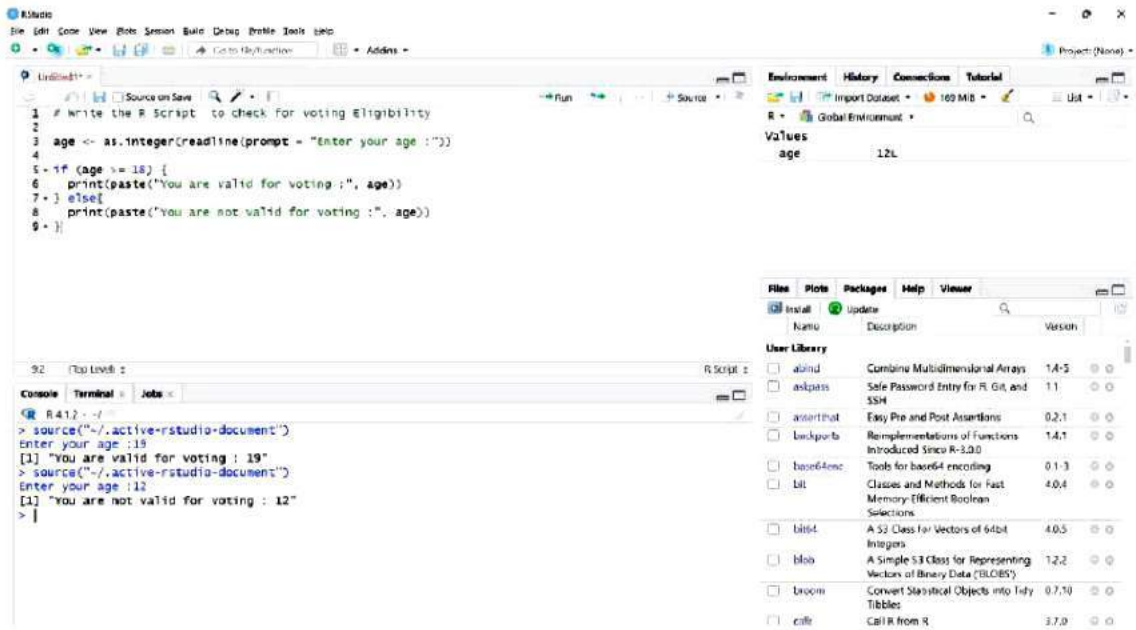
a) Write the R Script to check for voting Eligibility.

b) Write the R Script to find Youngest among given three children.

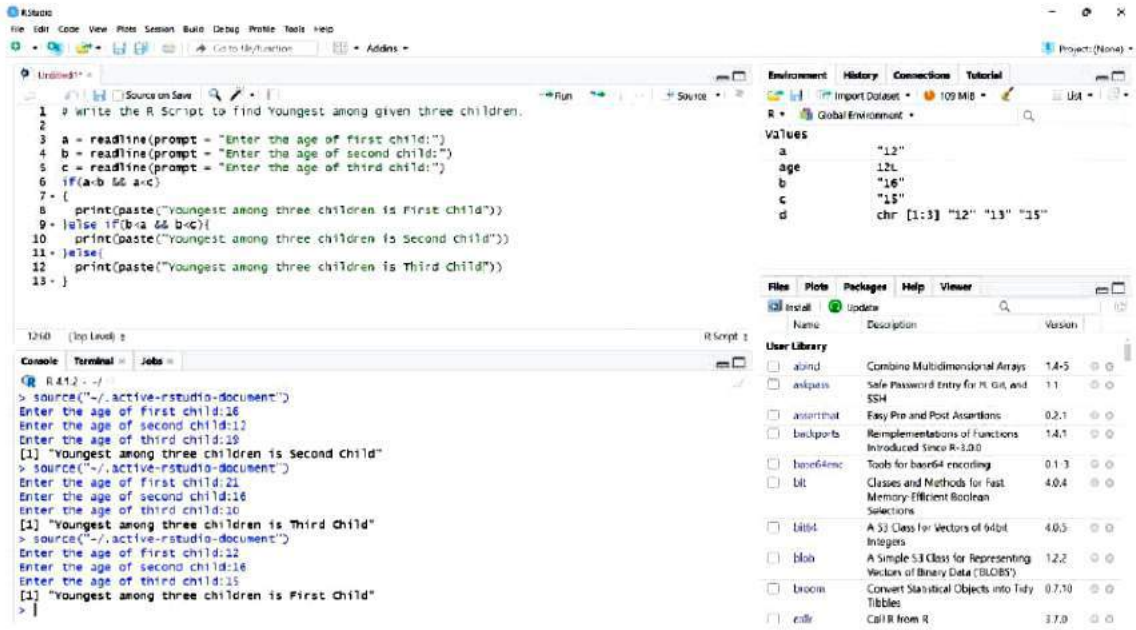
c) Write the R script to sort values of given vector. (Without using built in function)

Procedure:

a) R Script to check for voting Eligibility



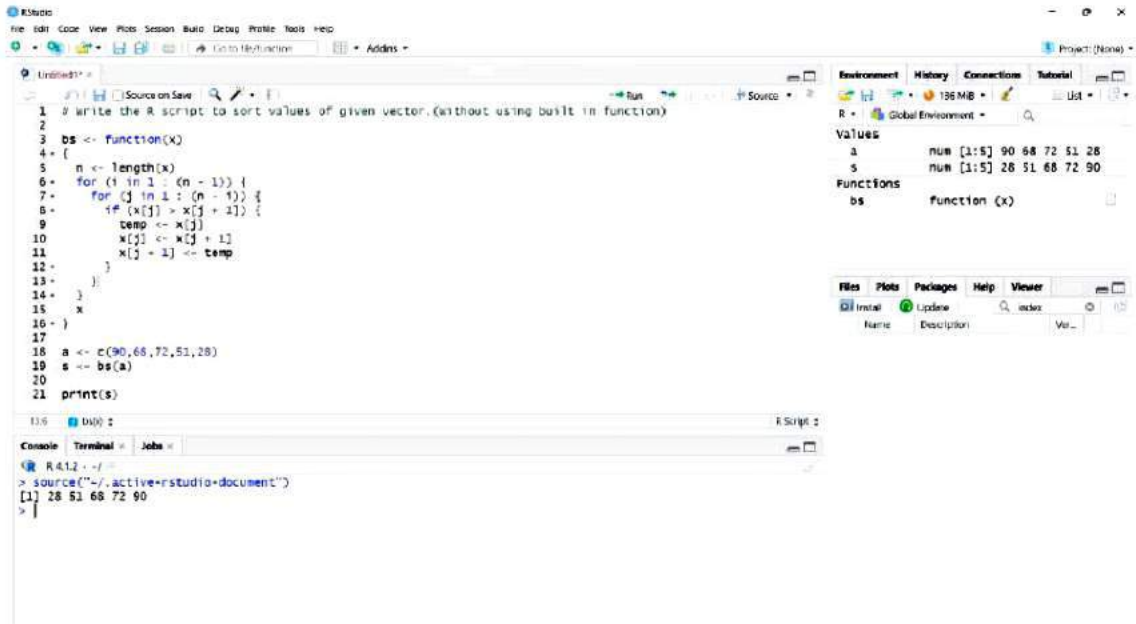
b) R Script to find Youngest among given three children



```
# Write the R Script to find Youngest among given three children.

a = readline(prompt = "Enter the age of first child:")
b = readline(prompt = "Enter the age of second child:")
c = readline(prompt = "Enter the age of third child:")
if(a<b && a<c)
{
  print(paste("Youngest among three children is First Child"))
}else if(b<a && b<c){
  print(paste("Youngest among three children is Second Child"))
}else{
  print(paste("Youngest among three children is Third Child"))
}
```

```
> source("~/.active-rstudio-document")
Enter the age of first child:16
Enter the age of second child:12
Enter the age of third child:19
[1] "Youngest among three children is Second Child"
> source("~/.active-rstudio-document")
Enter the age of first child:21
Enter the age of second child:16
Enter the age of third child:10
[1] "Youngest among three children is Third Child"
> source("~/.active-rstudio-document")
Enter the age of first child:12
Enter the age of second child:16
Enter the age of third child:15
[1] "Youngest among three children is First Child"
>
```

c) R script to sort values of given vector (Without using built in function)



```
# Write the R script to sort values of given vector.(without using built in function)

bs <- function(x)
{
  n <- length(x)
  for (i in 1 : (n - 1)) {
    for (j in 1 : (n - 1)) {
      if (x[j] > x[j + 1]) {
        temp <- x[j]
        x[j] <- x[j + 1]
        x[j + 1] <- temp
      }
    }
  }
  x
}

a <- c(90,68,72,51,28)
s <- bs(a)

print(s)
```

```
> source("~/.active-rstudio-document")
[1] 28 51 68 72 90
>
```

Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE: 08-01-2022

EXPERIMENT NAME: R Program for Control Structures Part-II

Aim:

To

a) Write the R Script to search an element using Linear Search (Use for, if and break)

b) Write the R Script to search an element using Binary Search (use while, if and break)

Algorithm:

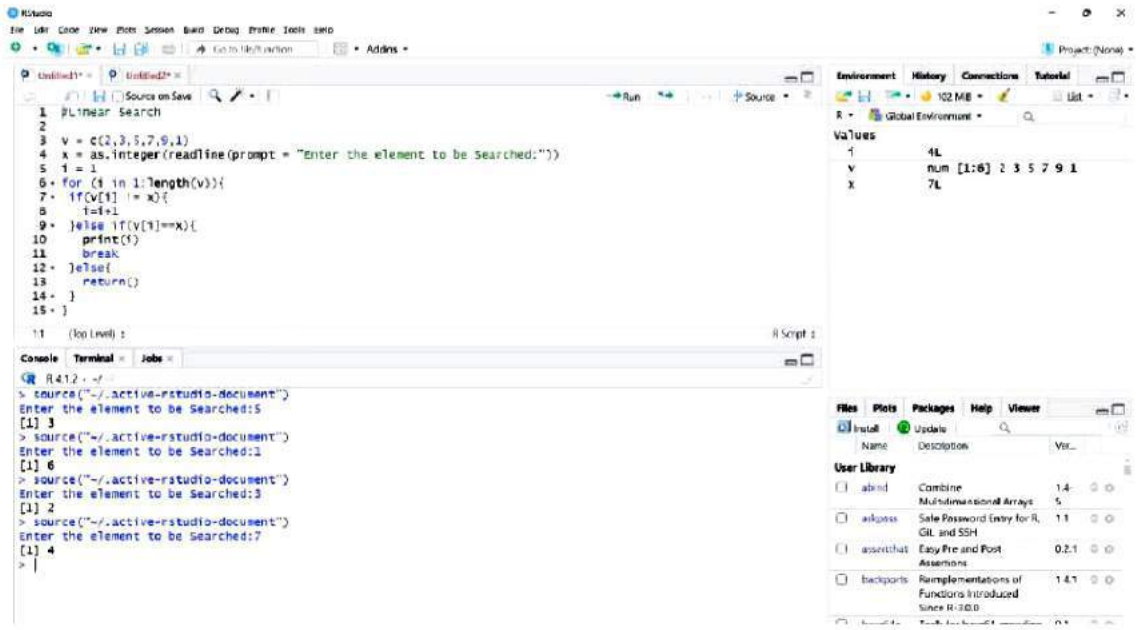
a) Linear Search:
   Step 1: Set i to 1
   Step 2: if i > n then go to step 7
   Step 3: if A[i] = x then go to step 6
   Step 4: Set i to i + 1
   Step 5: Go to Step 2
   Step 6: Print Element x Found at index i and go to step 8
   Step 7: Print element not found
   Step 8: Exit.

b) Binary Search:
   Step 1: Create a Function rs with arguments lst, value
   Step 2: Set low=1
   Step 3: Set high=length(lst)
   Step 4: Set mid=length(lst)%/%2
   Step 5: if (lst[low]==value) then return low
   Step 6: if (lst[high]==value) then return high
   Step 7: else while (lst[mid] != value) and
   Step 7.1: if (value > lst[mid]) return low = mid+1
   Step 7.2: if (value < lst[mid]) return high = mid - 1
   Step 7.3: if(high<low) return mid=-1;break
   Step 7.4: mid=(low+high)%/%2

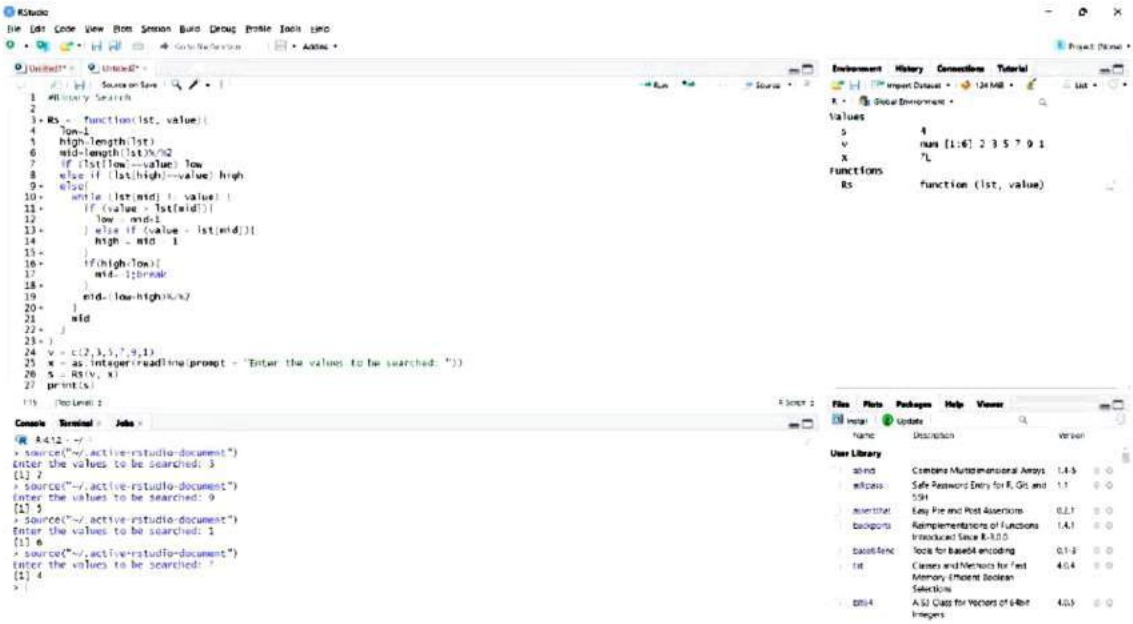
Step 7: Return mid.

Procedure:

a) R Script to search an element using Linear Search



b) R Script to search an element using Binary Search



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE: 11-01-2022

EXPERIMENT NAME: R Script for Data Visualization

Aim:

To

a) Write the R Script to generate pie chart to represent revenue generated by 4 branches of same company. Provide appropriate legend also.

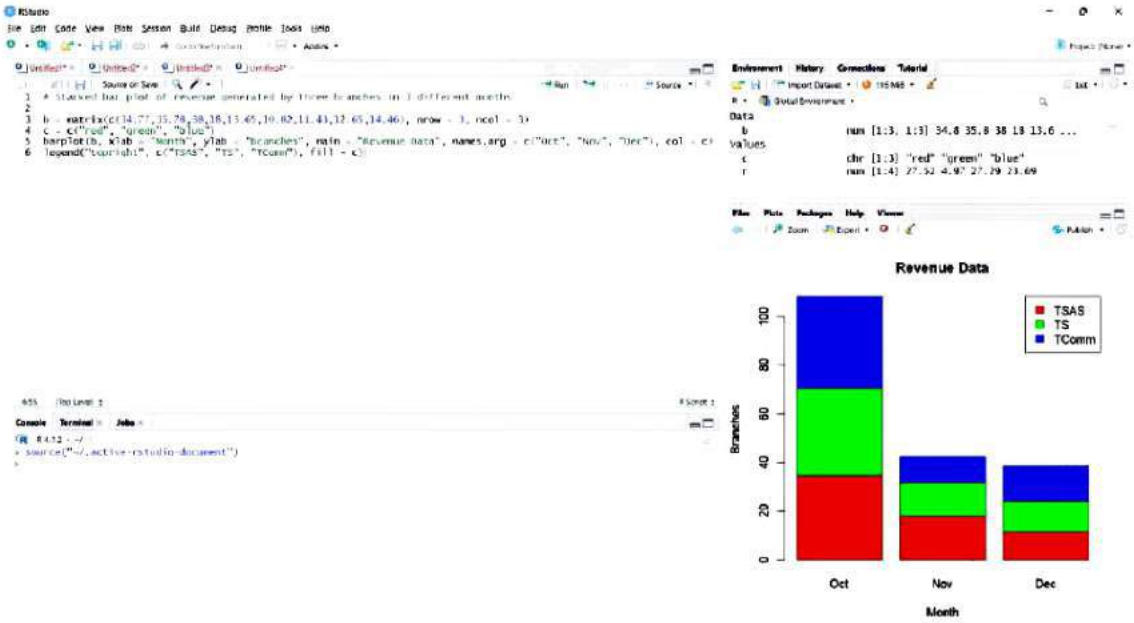
b) Write the R Script to generate Stacked bar plot to represent revenue generated by three branches in 3 different months.

c) Write the R script to show mark distribution of students in 3 different sections using line graph.

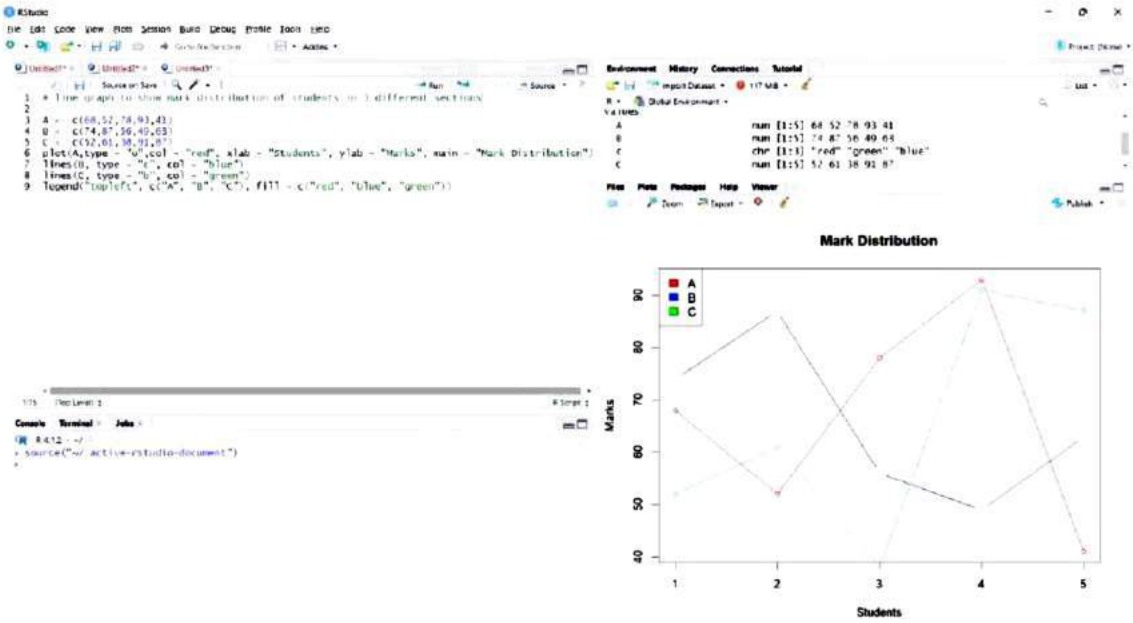
Procedure:

a) R Script to generate pie chart of revenue generated by 4 branches of same company

b) R Script to generate Stacked bar plot of revenue generated by three branches in 3 different months



c) R script to show mark distribution of students in 3 different sections using line graph



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 21-01-2021

EXPERIMENT NAME: R Script for Data Visualization-Par-II

Aim:

To

a) Write the R Script to generate Scatter Plot to show relationship between Age and Height.

b) Write the R Script to generate Scatter plot matrix to show relationship between 5 variables which are present in your dataset.

c) Write the R script to show mark distribution of students in 3 different sections using Box Plot.

Procedure:

- **Scatter Plot: It is used to represent the relationship between two variables in a data-set. Generally the independent variable is plotted on the X-axis, while the dependent variable is plotted on the Y-axis. The simple scatterplot is created using the plot() function.**

  Syntax: plot(x, y, main, xlab, ylab, xlim, ylim, axes)

  Where

  - **x - the data set whose values are the horizontal coordinates.**
  - **y - the data set whose values are the vertical coordinates.**
  - **main - the tile of the graph.**
  - **xlab - the label in the horizontal axis.**
  - **ylab - the label in the vertical axis.**
  - **xlim - the limits of the values of x used for plotting.**
  - **ylim - the limits of the values of y used for plotting.**
  - **axes - indicates whether both axes should be drawn on the plot.**

- **Scatter Plot Matrix: When we have more than two variables and we want to find the correlation between one variable versus the remaining ones we use scatterplot matrix. pairs() function to create matrices of scatterplots.**

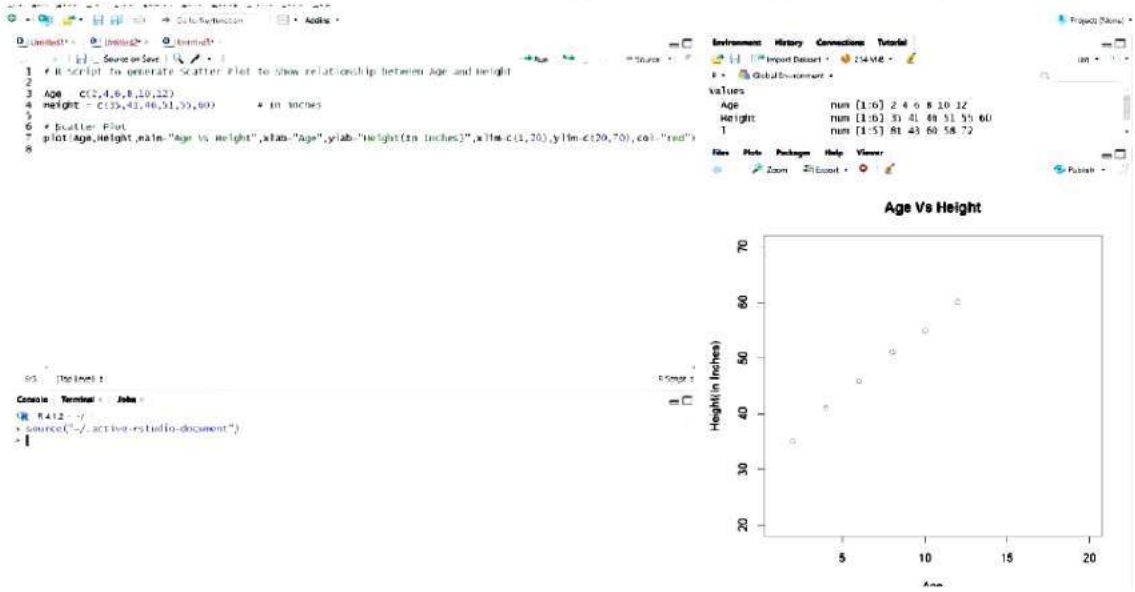
  Syntax: pairs(formula, data)

  Where
  - **formula - the series of variables used in pairs.**
  - **data - the data set from which the variables will be taken.**
- **Box Plot: used to display information in the form of distribution by drawing boxplots for each of them. This distribution of data based on five sets (minimum, first quartile, median, third quartile, maximum).**

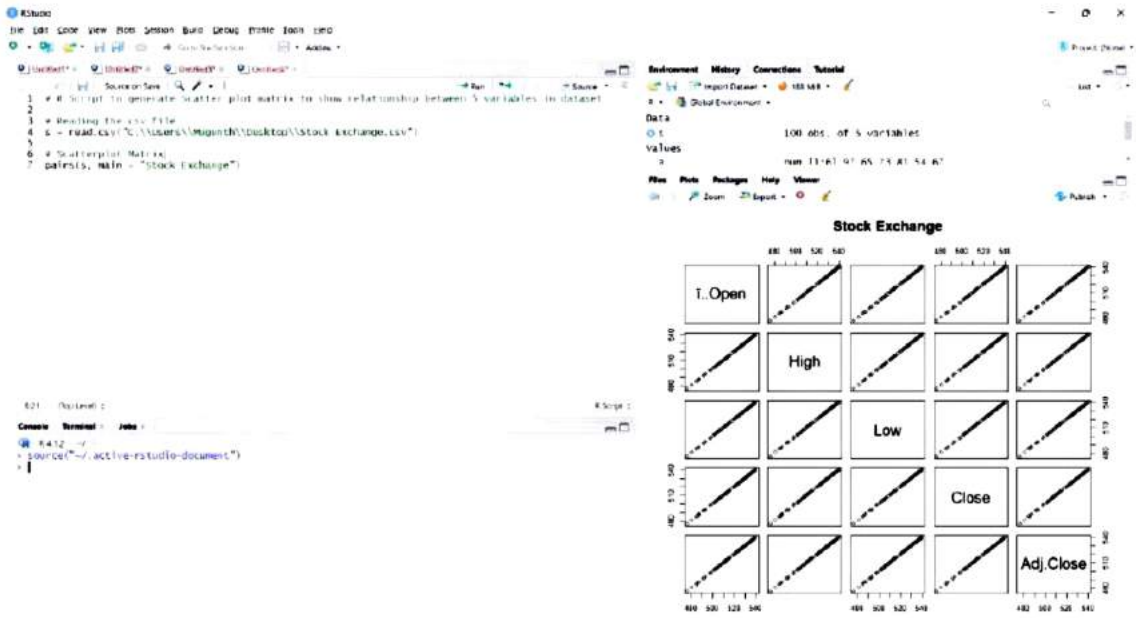
  Syntax: boxplot(x, data, notch, varwidth, names,main,xlab,ylab)

  Where
  - **x - vector or a formula.**
  - **data - data frame.**
  - **notch - a logical value. Set as TRUE to draw a notch.**
  - **varwidth - a logical value. Set as TRUE to draw width of the box proportionate to the sample size.**
  - **names - the group labels which will be printed under each boxplot.**
  - **main - used to give a title to the graph.**
  - **xlab - the label in the horizontal axis.**
  - **ylab - the label in the vertical axis.**

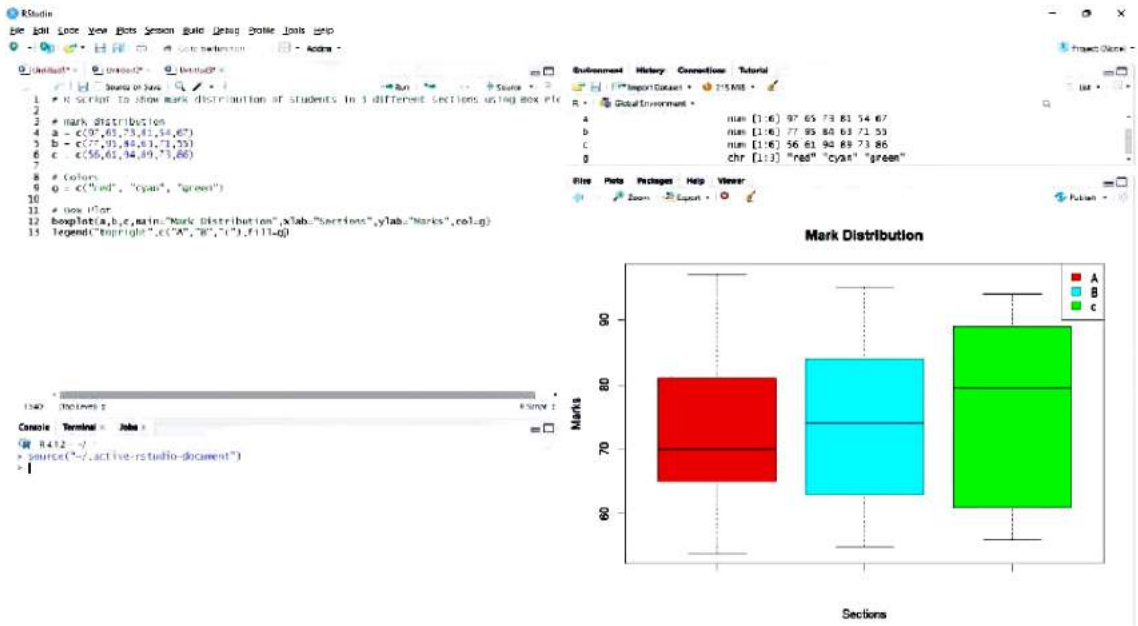
a) Scatter Plot to show relationship between Age and Height.



b) Scatter Plot matrix to show relationship between 5 variables.



c)Box Plot to show mark distribution of students in 3 different sections.



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 21-01-2021

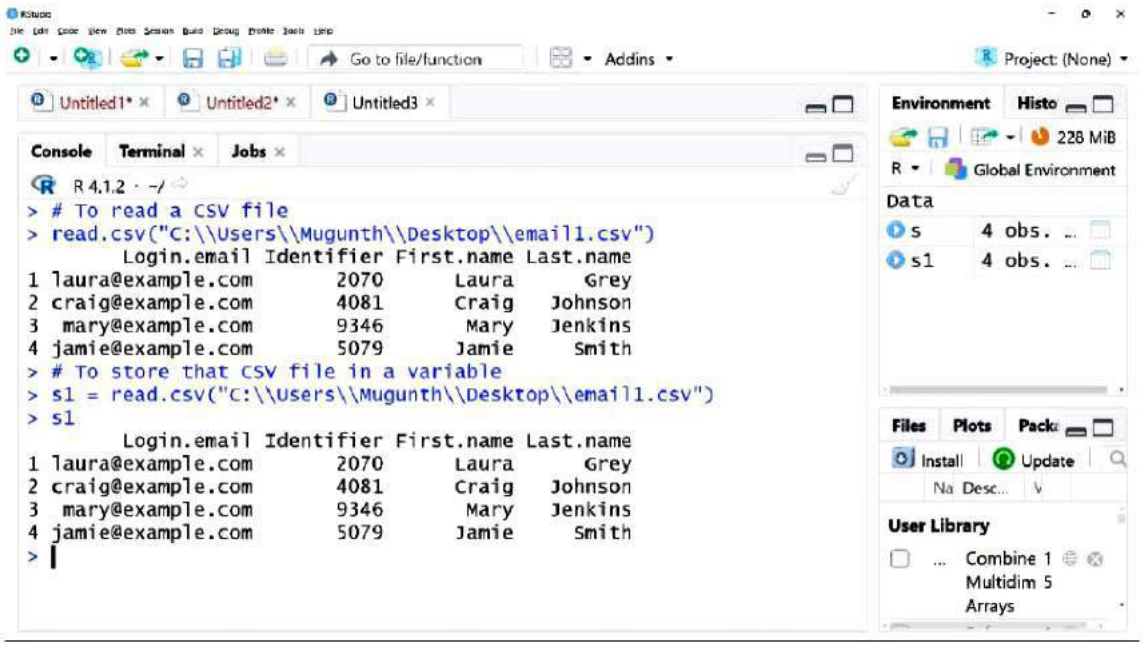
EXPERIMENT NAME: R Script for Reading and writing CSV

Aim:

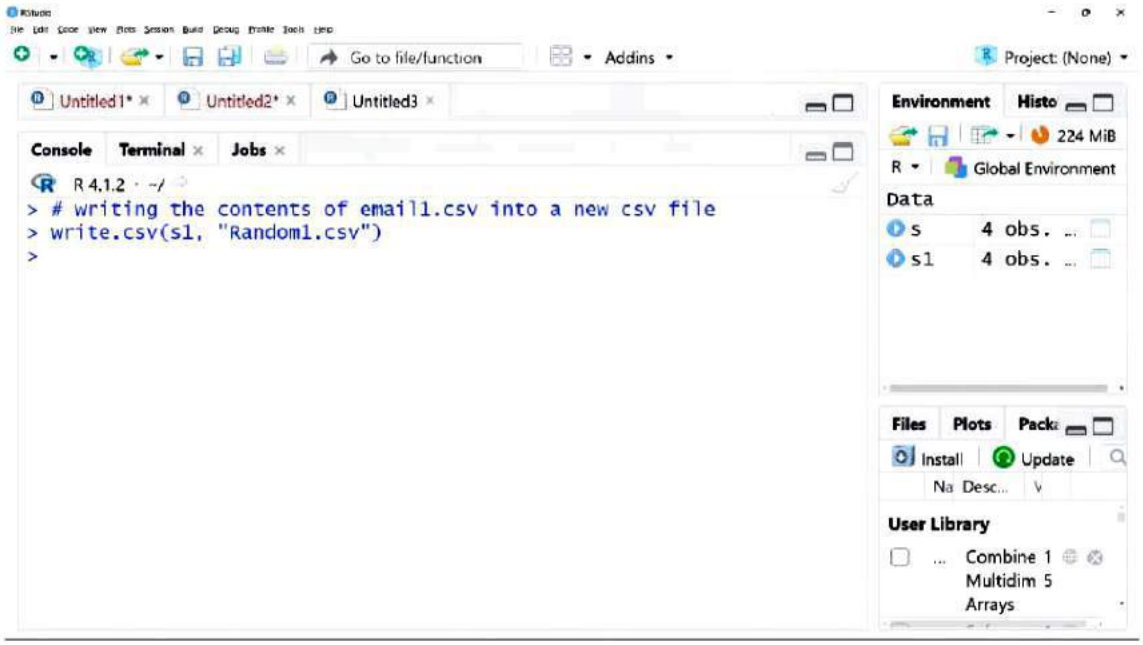
To read the csv file and write the contents of same into another file and check the same in R.

Procedure:

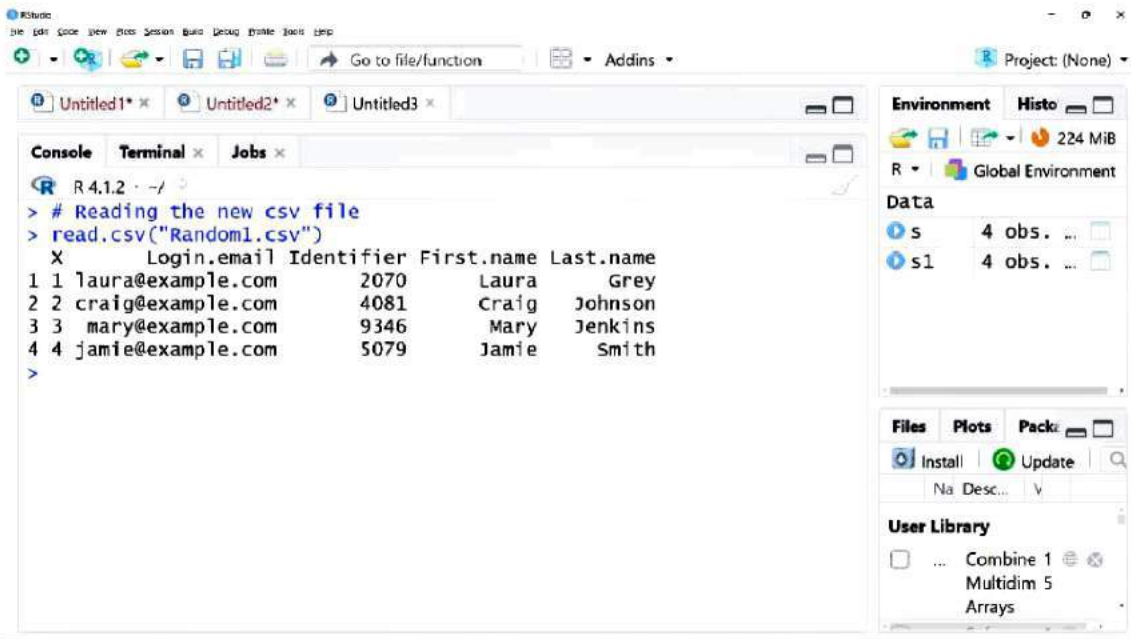
- **Reading the csv file and assigning it to a variable**



- **Writing the contents of csv file into a new csv file**



- **Reading the new csv file**



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 25-01-2022

EXPERIMENT NAME: R Script for Reading XML Contents

Aim:

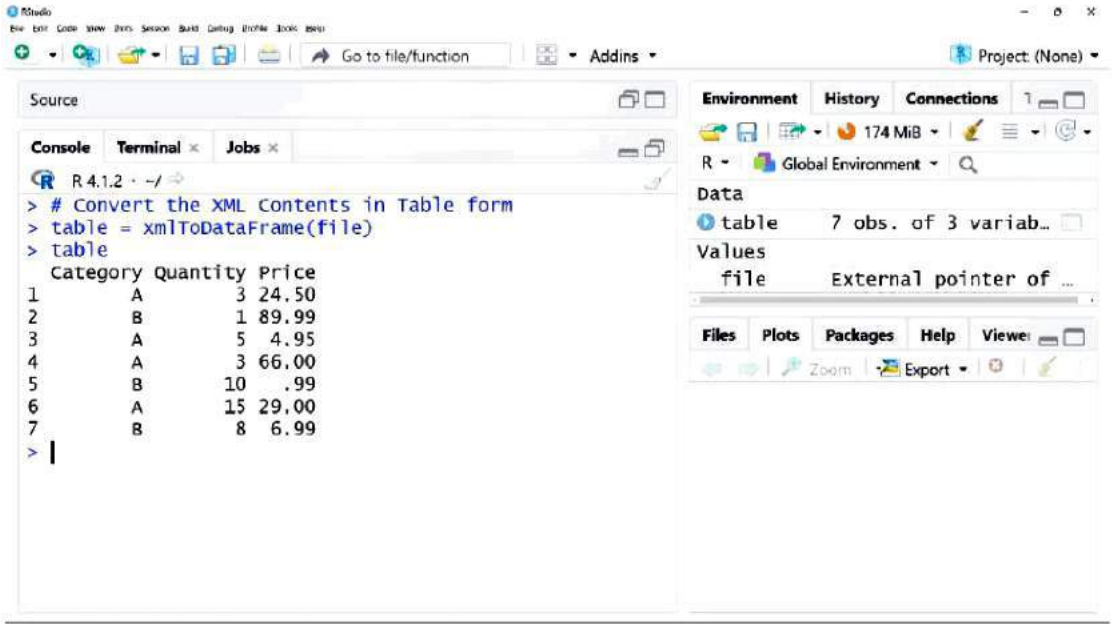
To

a) Write the R Script to read the attached XML file
b) Convert the XML Contents in Table form.
c) Extract and display Category A product details.
d) Find the total Quantity.
e) Display Price Column Alone.
f) Extract 4th,5th and 6th rows alone.

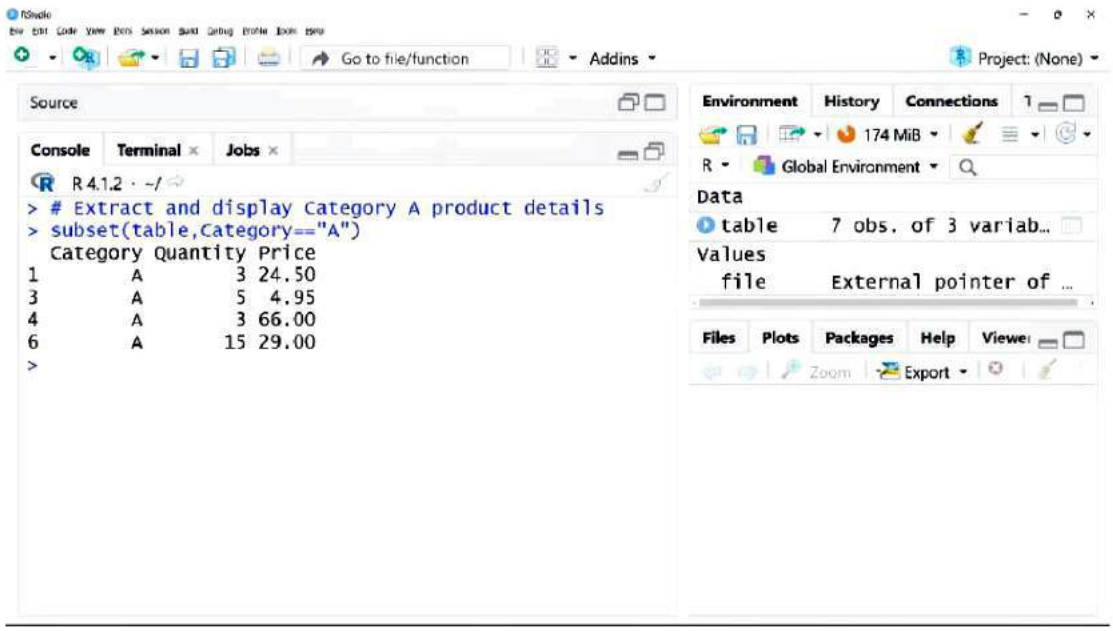
Procedure:

a) R Script to read the attached XML file

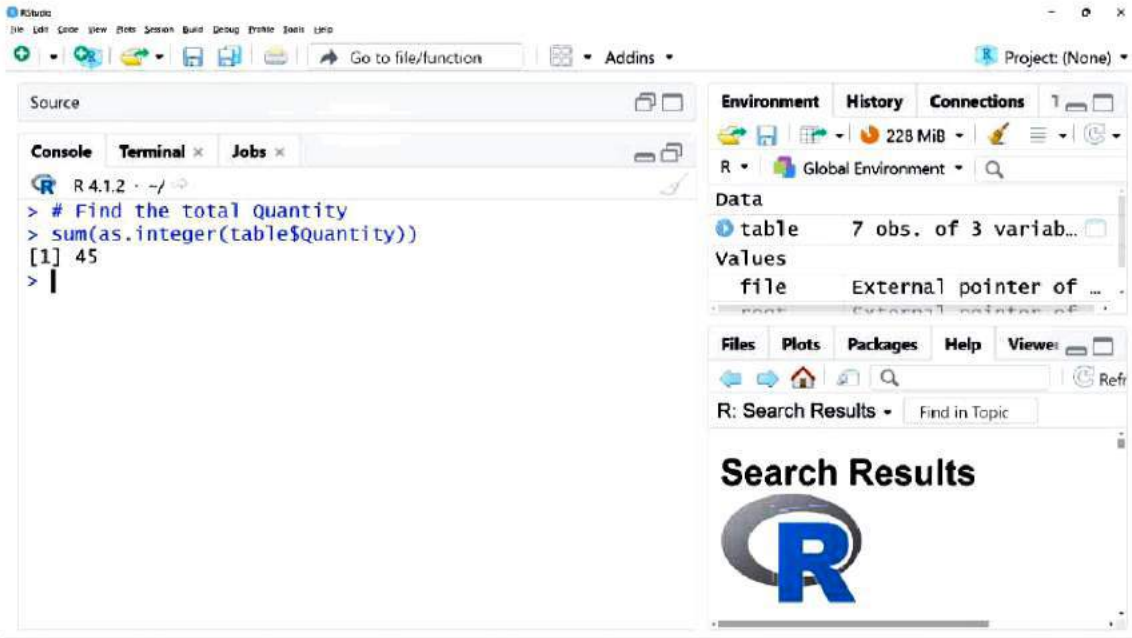
b) Convert the XML Contents in Table form



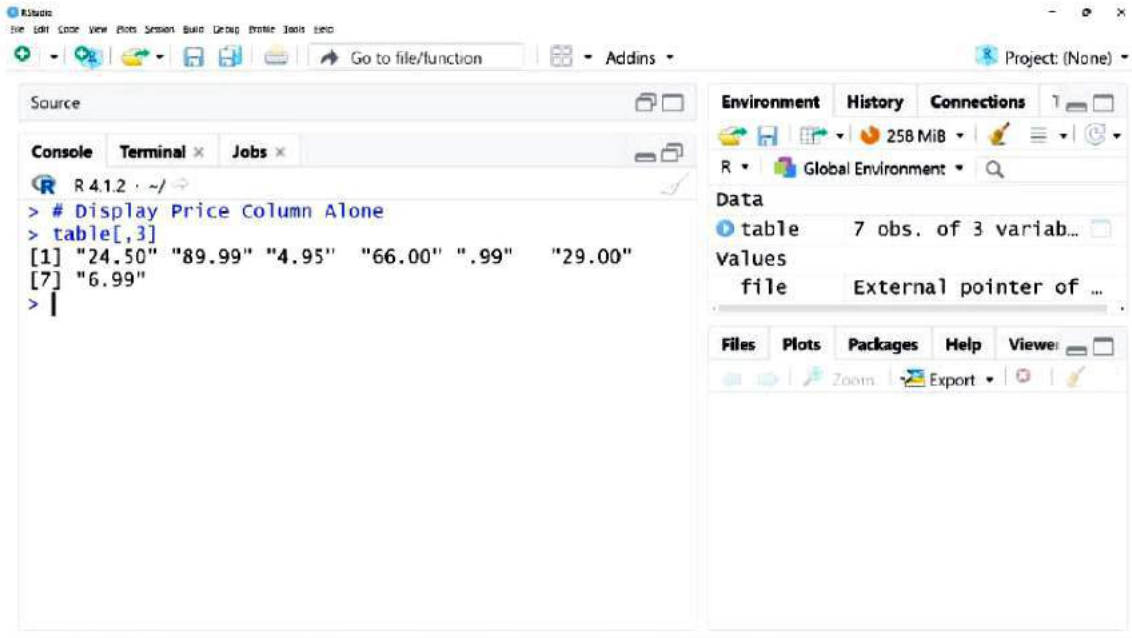
c) Extract and display Category A product details



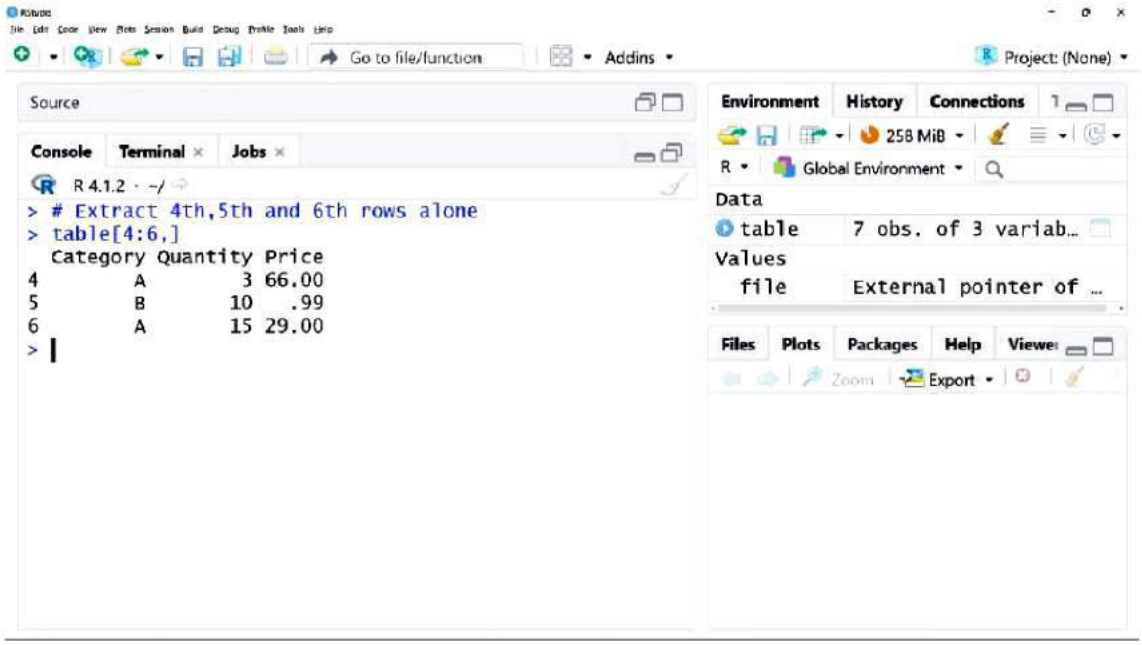
d) Find the total Quantity



e) Display Price Column Alone



f) Extract 4th,5th and 6th rows alone



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

SUBJECT: R PROGRAMMING

REG NO: 40733020

DATE: 28-01-2022

EXPERIMENT NAME: R Script for Handling Missing Values (Data Preprocessing)

Aim:

To

a) Download the data set with missing values.

b) Check the presence of missing values.

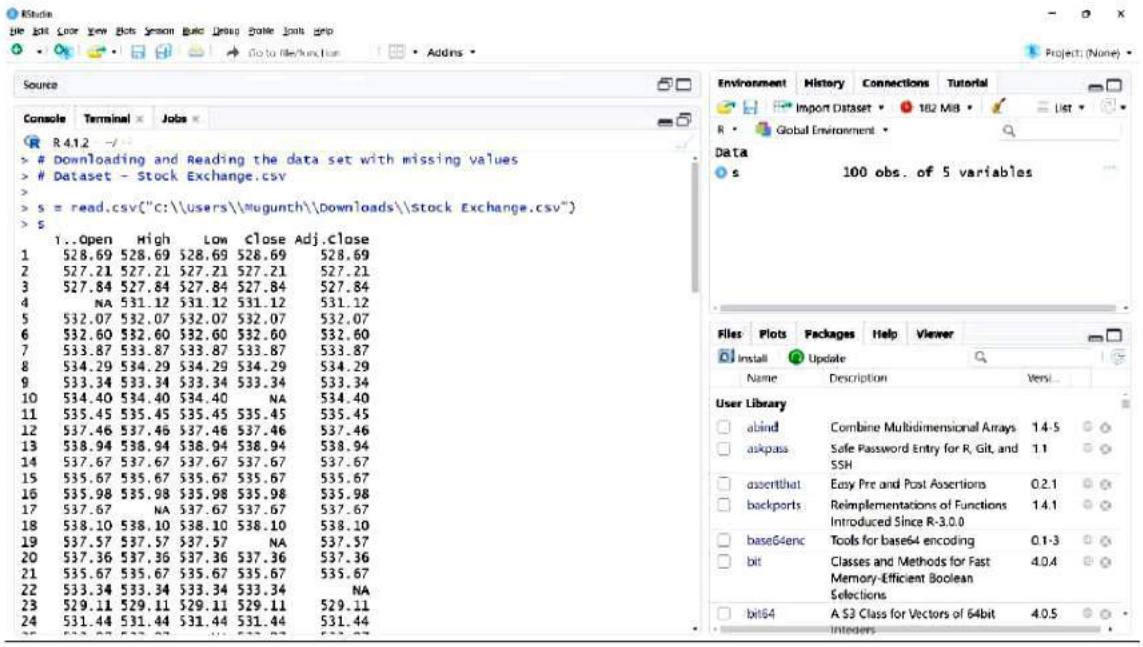
c) Calculate mean value with and without missing value.

d) Replace missing values with the mean value.

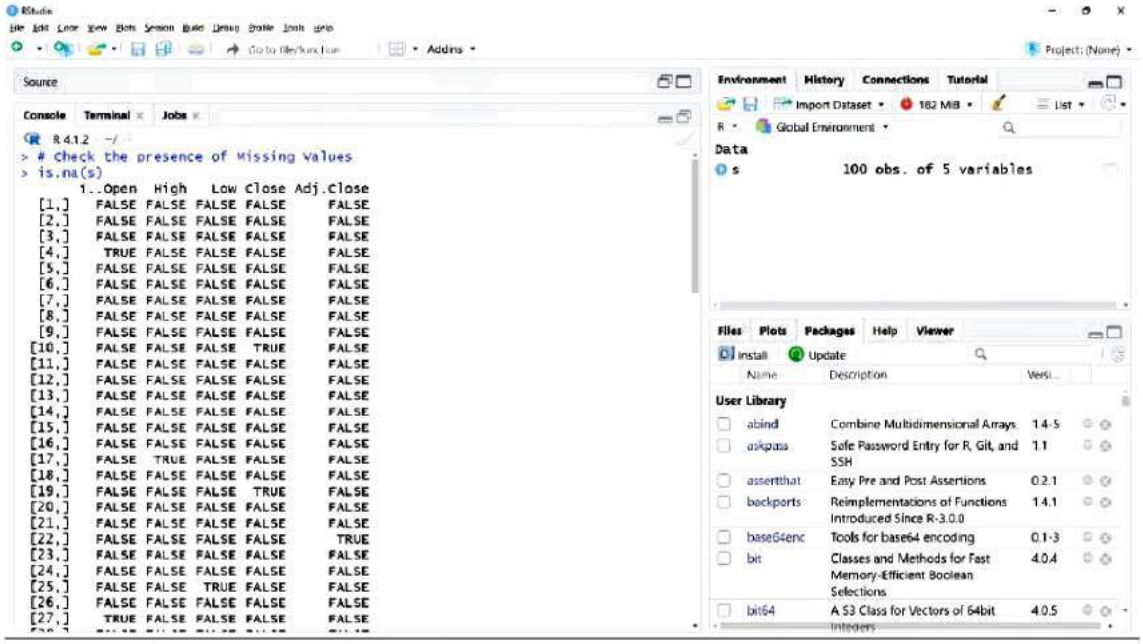
e) Display the updated data set.

Procedure:

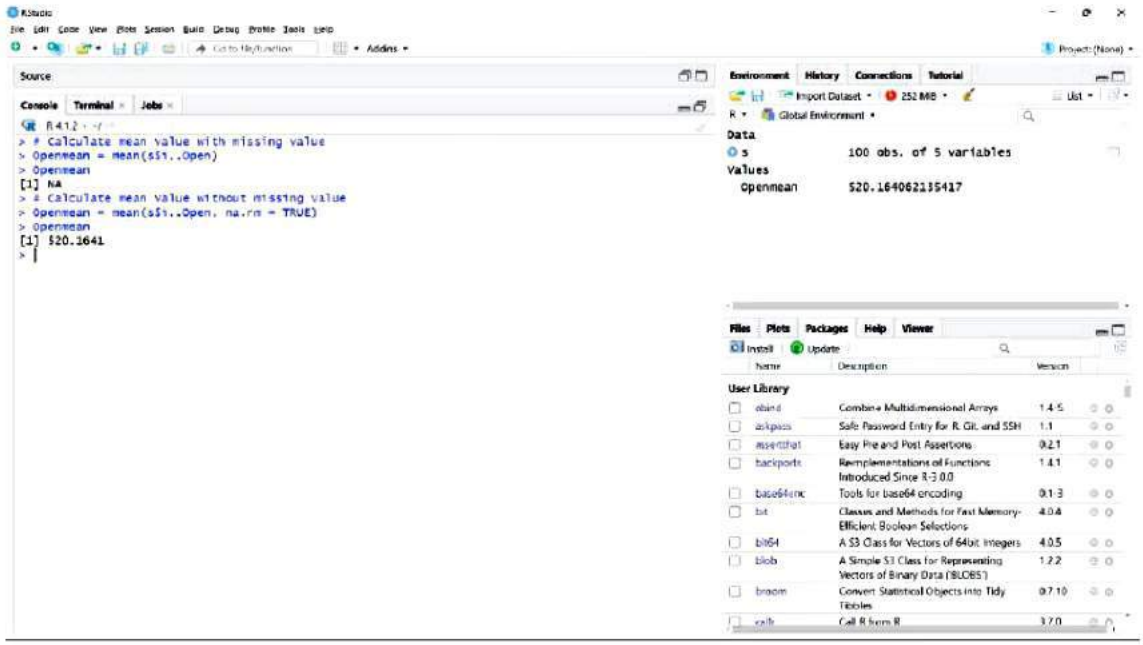
a) Download and Read the data set with missing values



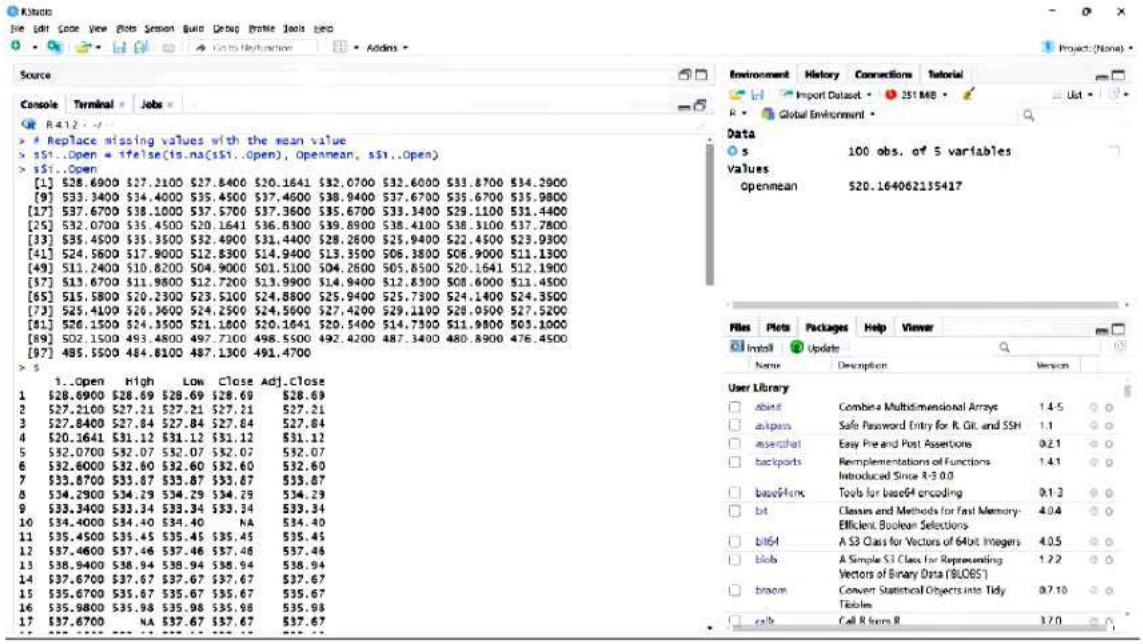
b) Check the presence of missing values



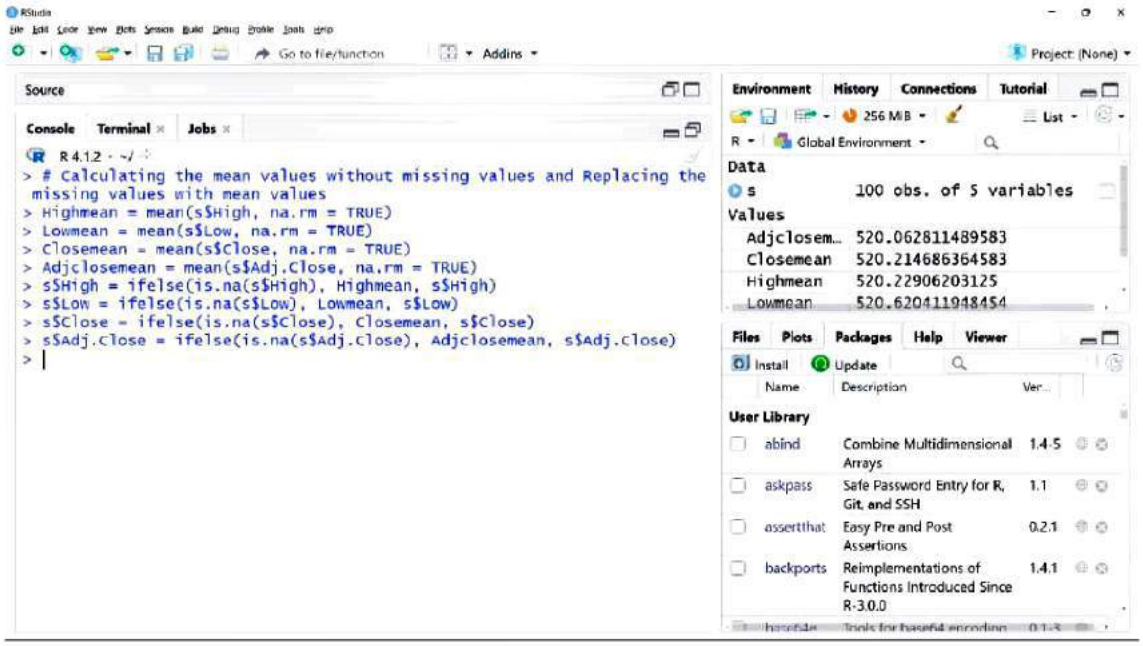
c) Calculate mean value with and without missing value



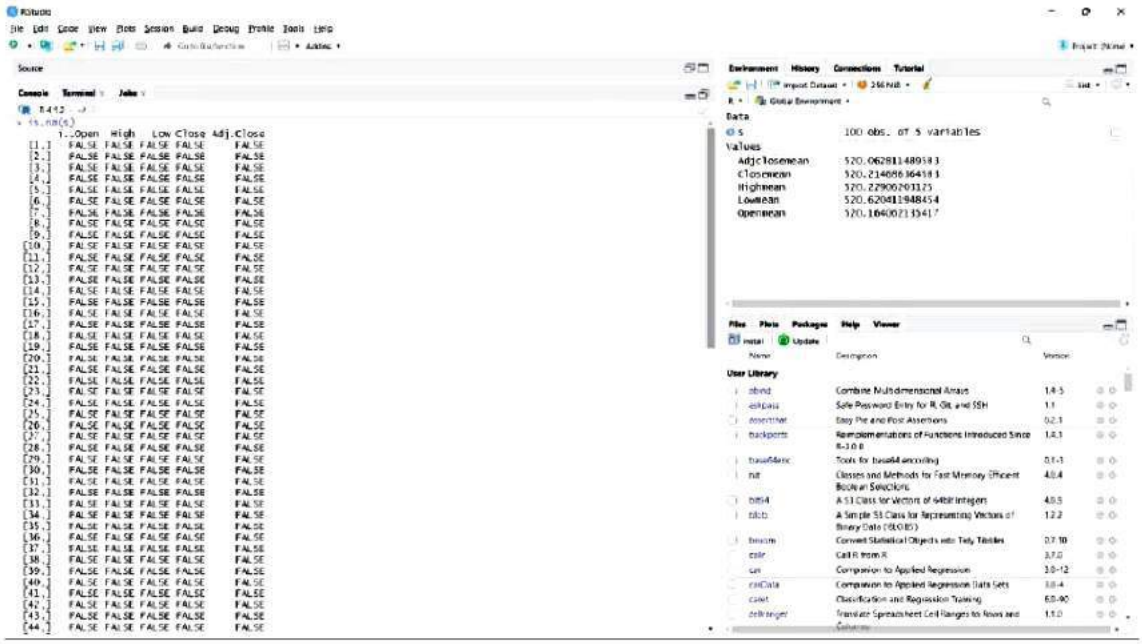
d) Replace missing values with the mean value



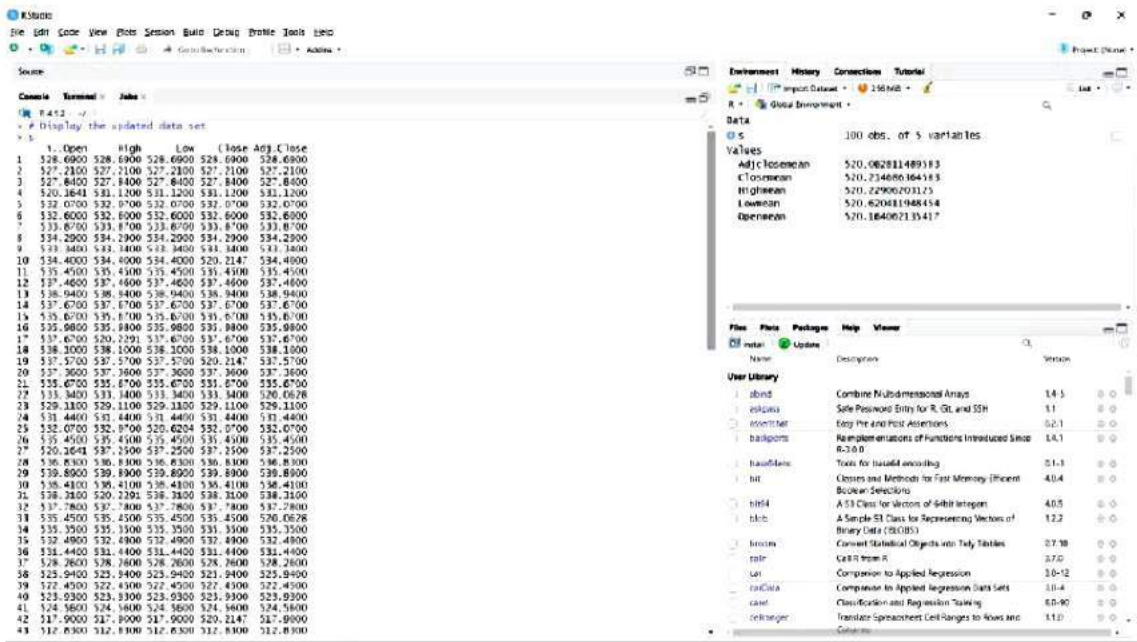
e) Calculating the mean values without missing values and replacing the missing values with mean values in other columns



f) Checking for any missing data after Data Preprocessing



g) Display the updated data set



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE: 08-02-2022

EXPERIMENT NAME: Statistics using R

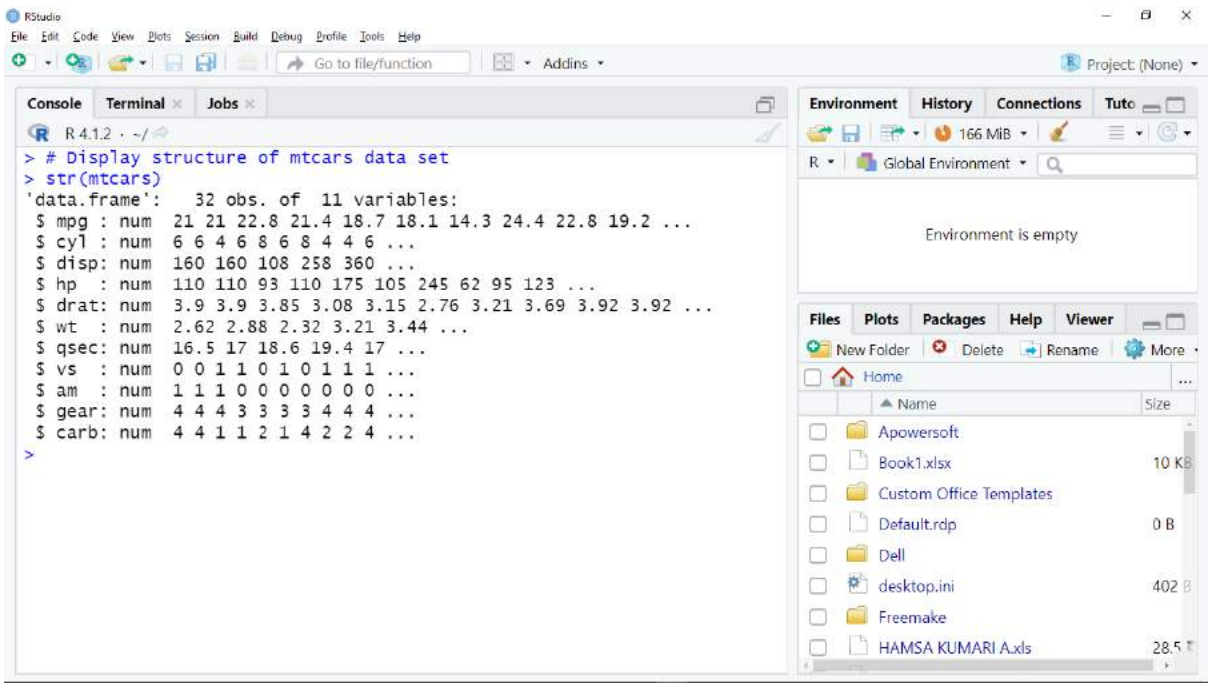
Aim:

To

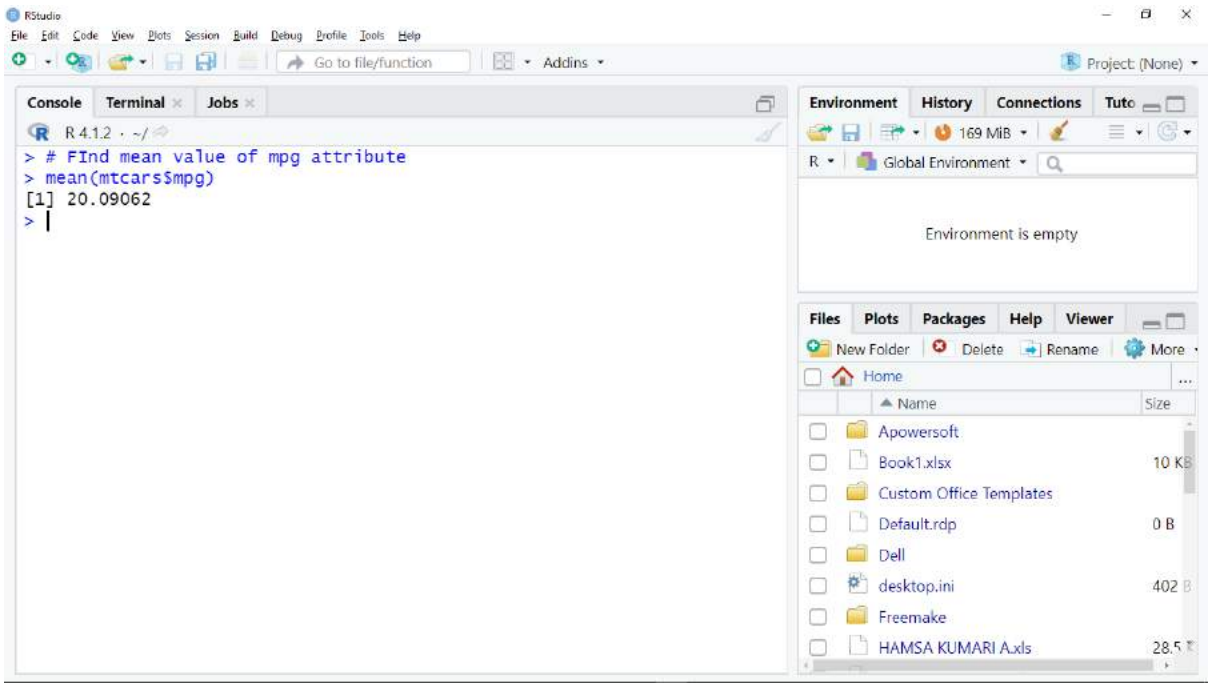
a) Display structure of mtcars data set(already available in R Studio).
b) Find mean value of mpg attribute.
c) Find the median value of Wt Attribute.
d) Find the mode value of cyl attribute.
e) Find the Quartiles of hp attribute.

Procedure:

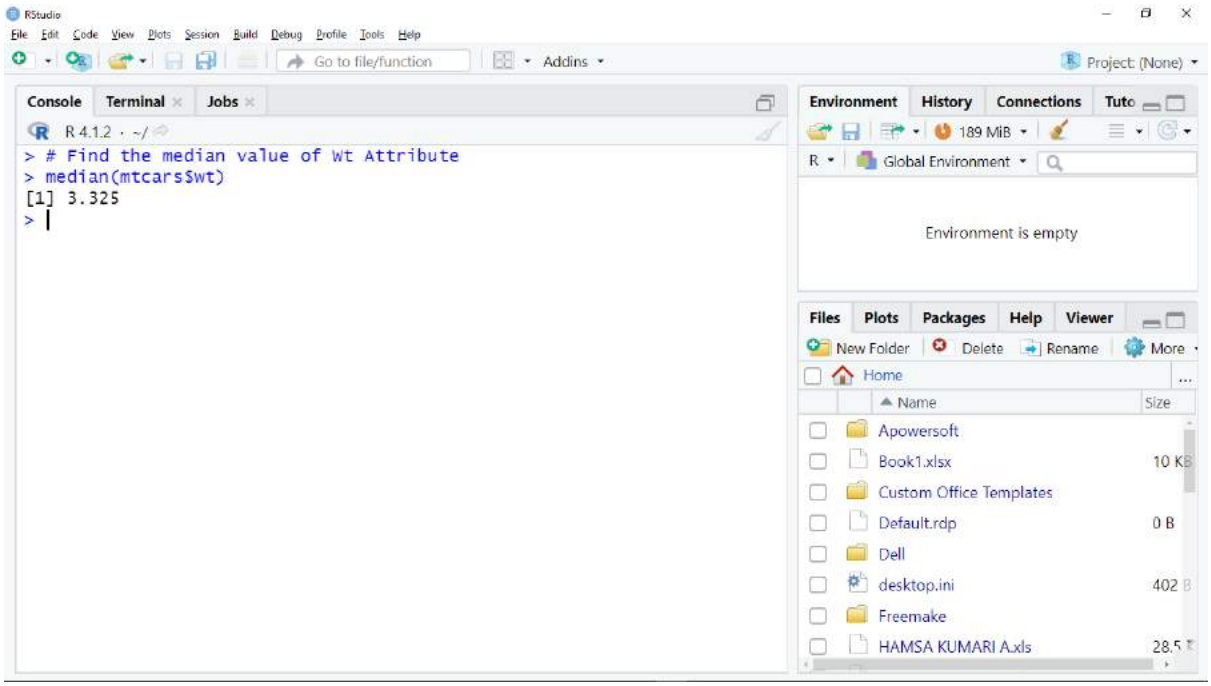
a) R Script to display structure of mtcars data set



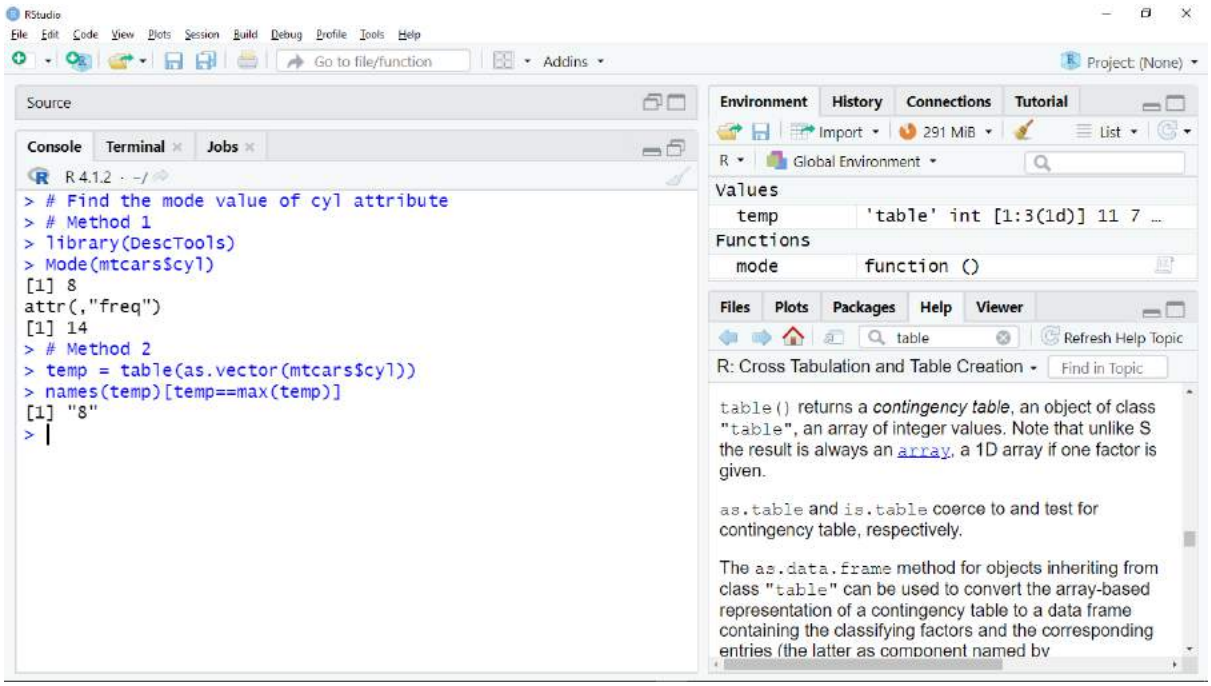
b) R Script to find mean value of mpg attribute

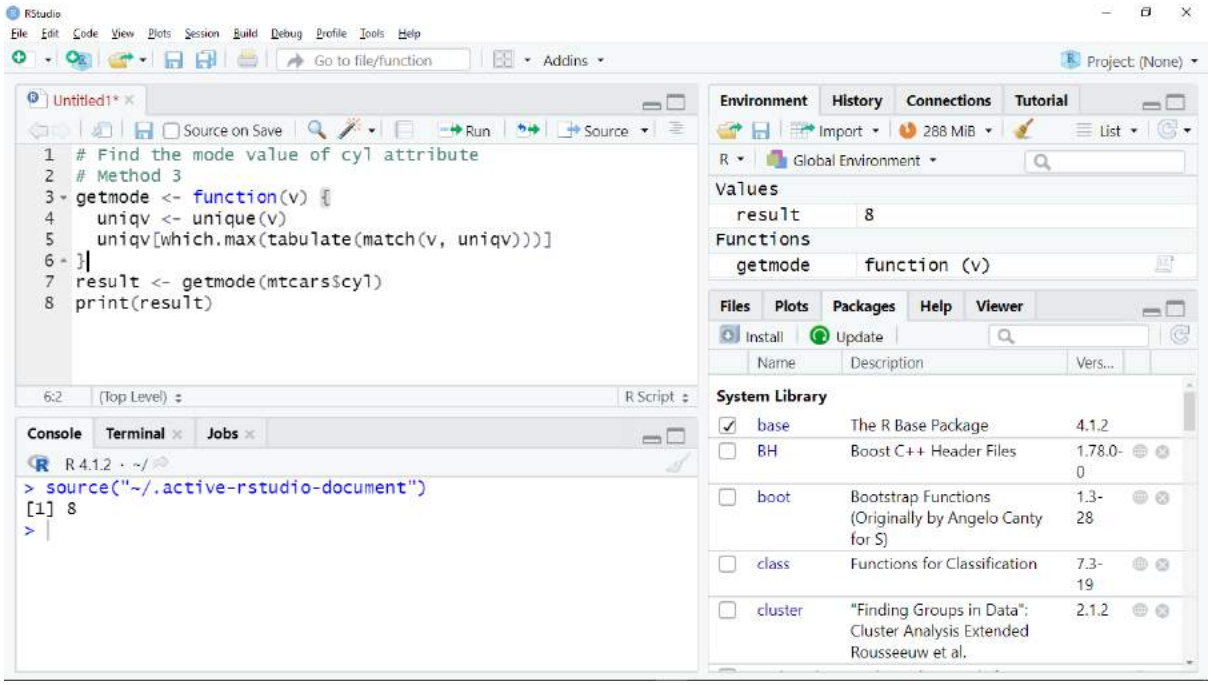


c) R script to find the median value of Wt Attribute

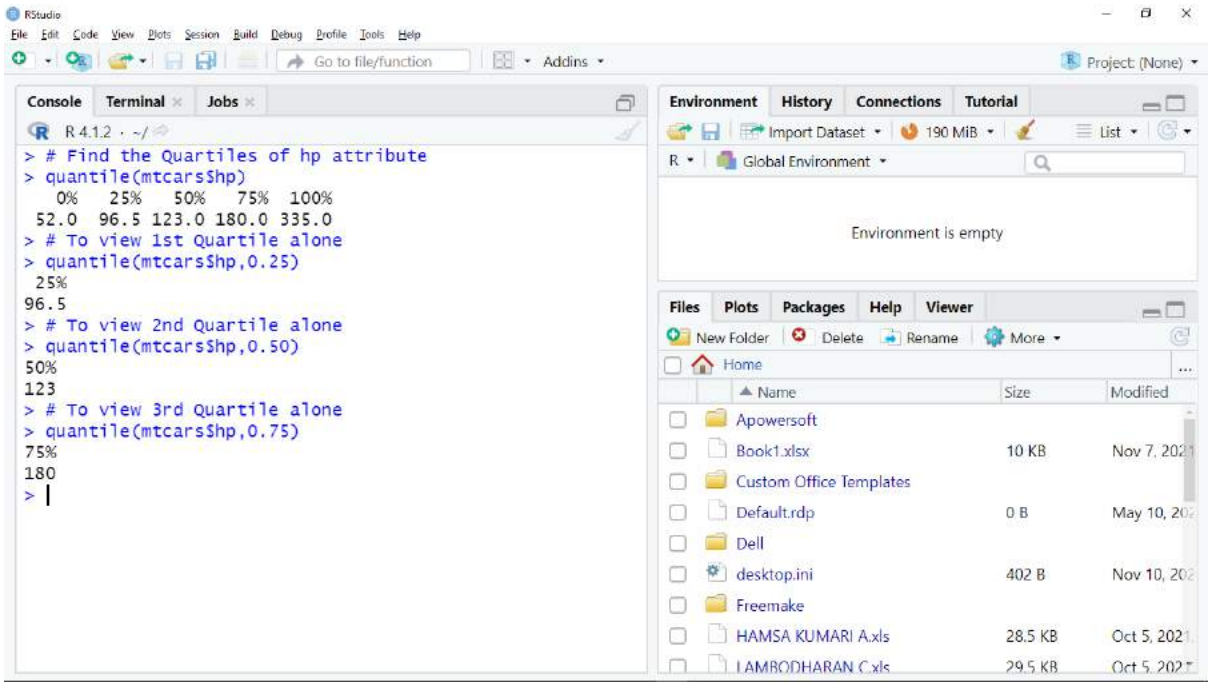


d) R script to find the mode value of cyl attribute





e) R script to find the Quartiles of hp attribute



Result:

Thus, the program has been executed and the output has been verified.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE: 01-03-2022

EXPERIMENT NAME: Machine Learning Algorithms in R

Aim:

To

1.Load the iris data set.

2.Identify the best model to predict Species of given flower based on width of Sepal and Petal and length of Sepal and Petal.

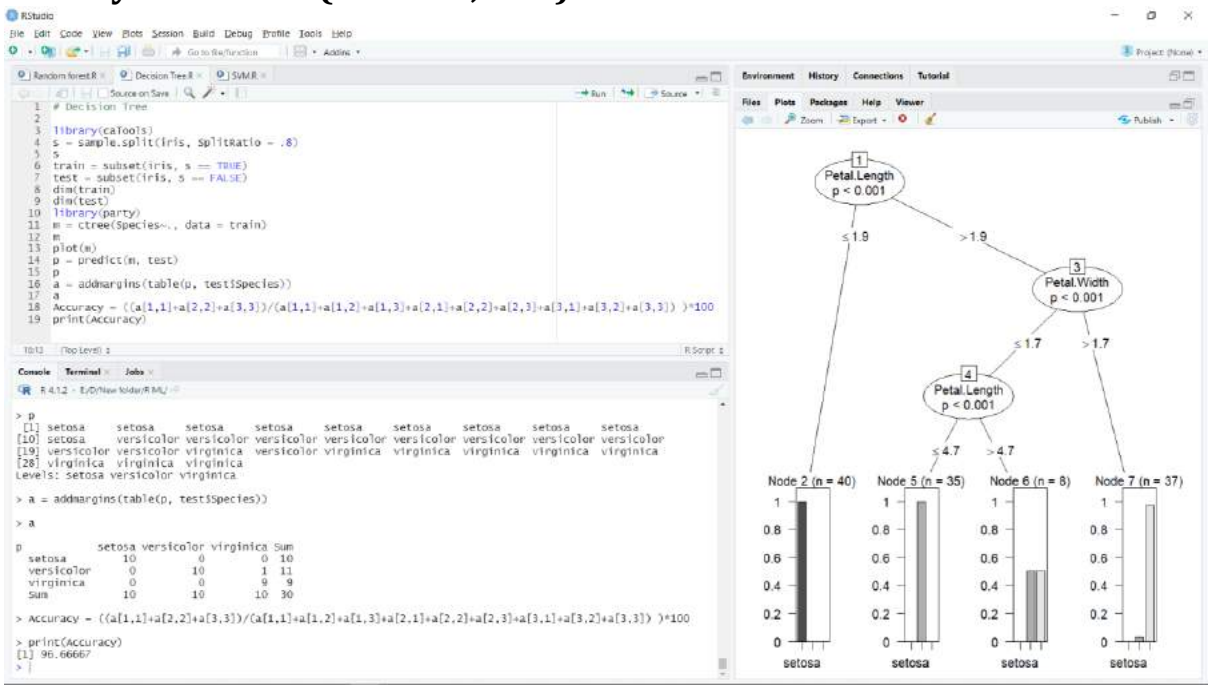
Procedure:

1. **Load the data set in RStudio.**
2. **for creating a model :**
   We create test and train data by dividing the data set into 2 parts 75% and 25%.
3. **we need to choose a model for predictions.**
4. **we use split() to split the dataset into train and test datasets.**
5. **We create a model.**
6. **Train the model using train dataset.**
7. **Predict values by entering the test dataset to the model.**
8. **Test the accuracy of the model(using confusion matrix).**

Syntax and code of:

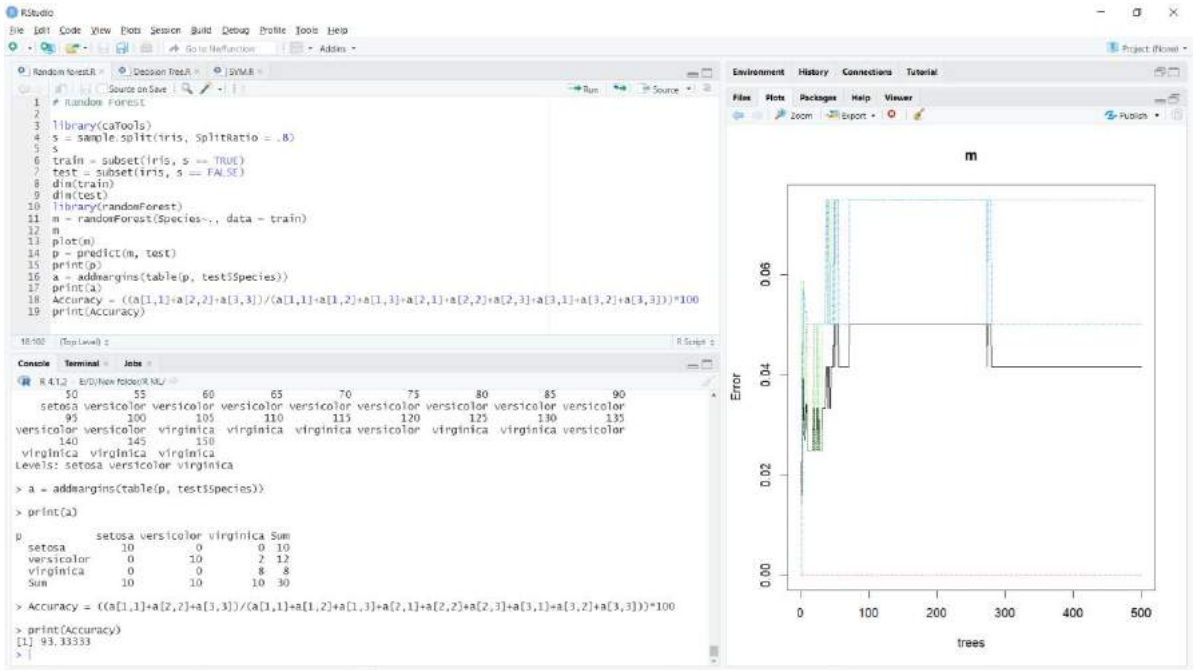
1. Decision tree:

We need to install.packages("party")
Library(party)
Syntax: Ctree(formula,data)



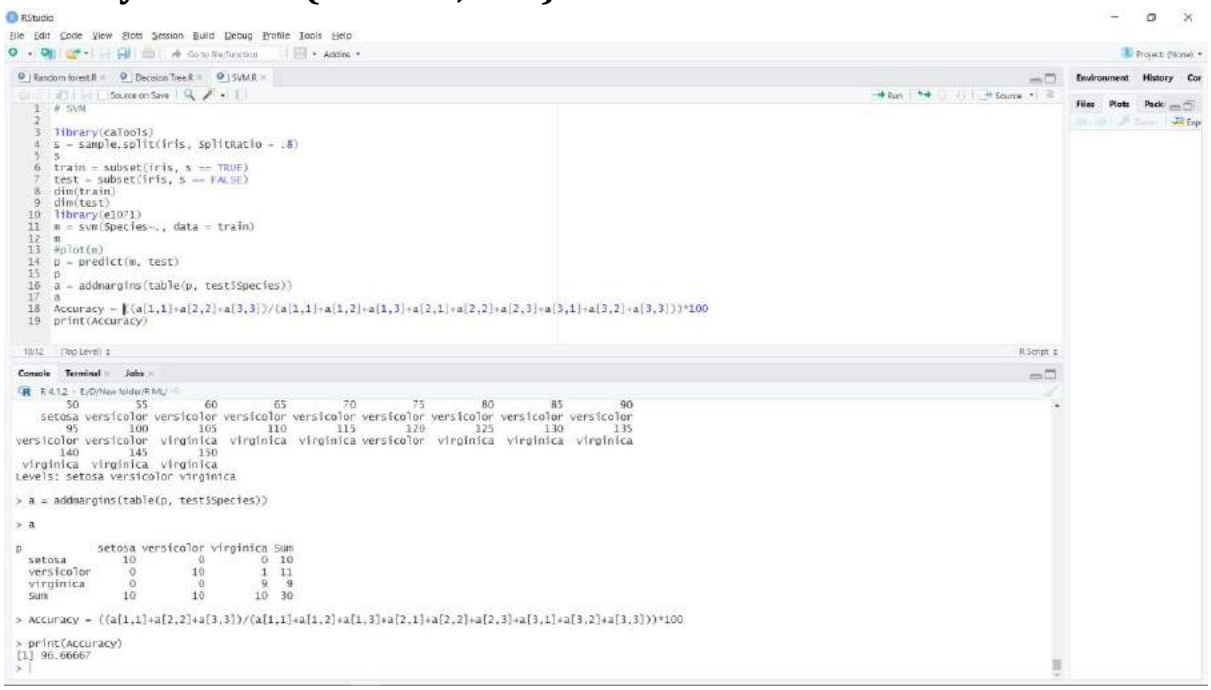
2. Random Forest:

We need to install.packages("RandomForest")
Library(RandomForest)
Syntax: randomForest(formula,data)



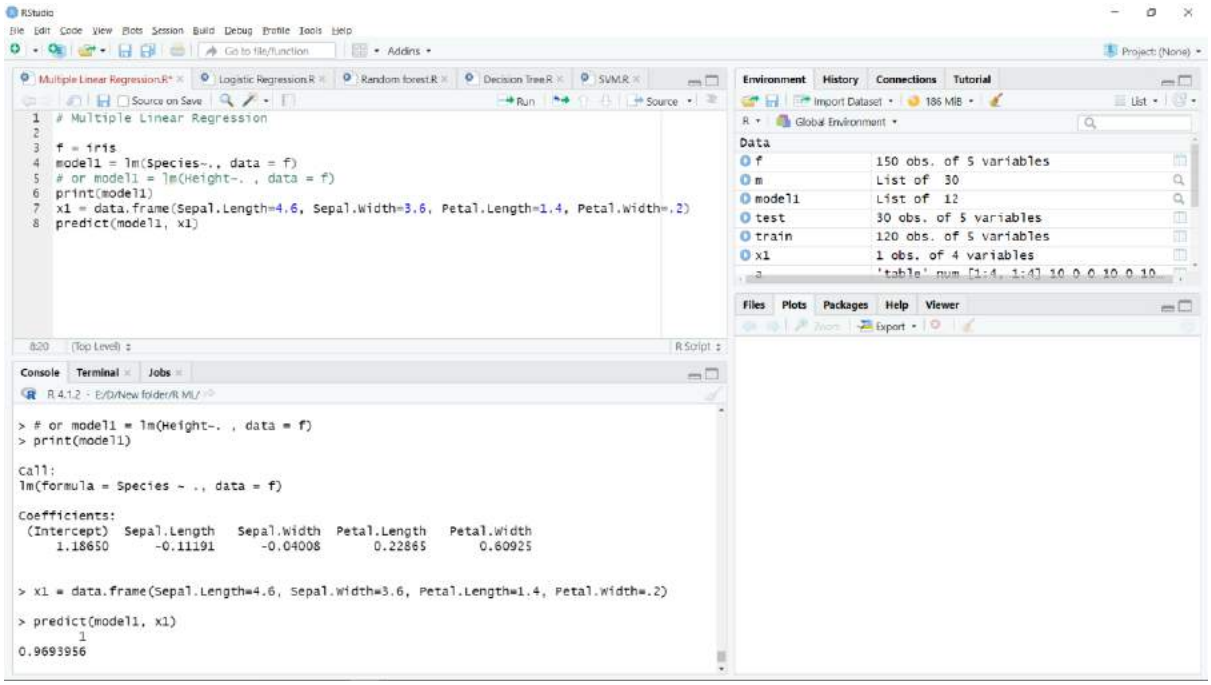
3. Support Vector Machine (SVM):

We need to install.packages("e1071")
Library(e1071)
Syntax: svm(formula,data)



4. Linear Regression:

Using function Lm()
Syntax : lm(formula,data)



Result:

Models	SVM	Decision Tree	Random Forest	Linear Regression
Accuracy	96.67	93.33	96.67	96.67

From these models we can say that SVM, Decision Tree, Linear Regression, Random Forest gave the good accuracy. Hence we can use either SVM or Decision Tree for predicting the species.

NAME: Mugunth.D

REG NO: 40733020

SUBJECT: R PROGRAMMING

DATE: 22-03-2022

EXPERIMENT NAME: Clustering Algorithms in R

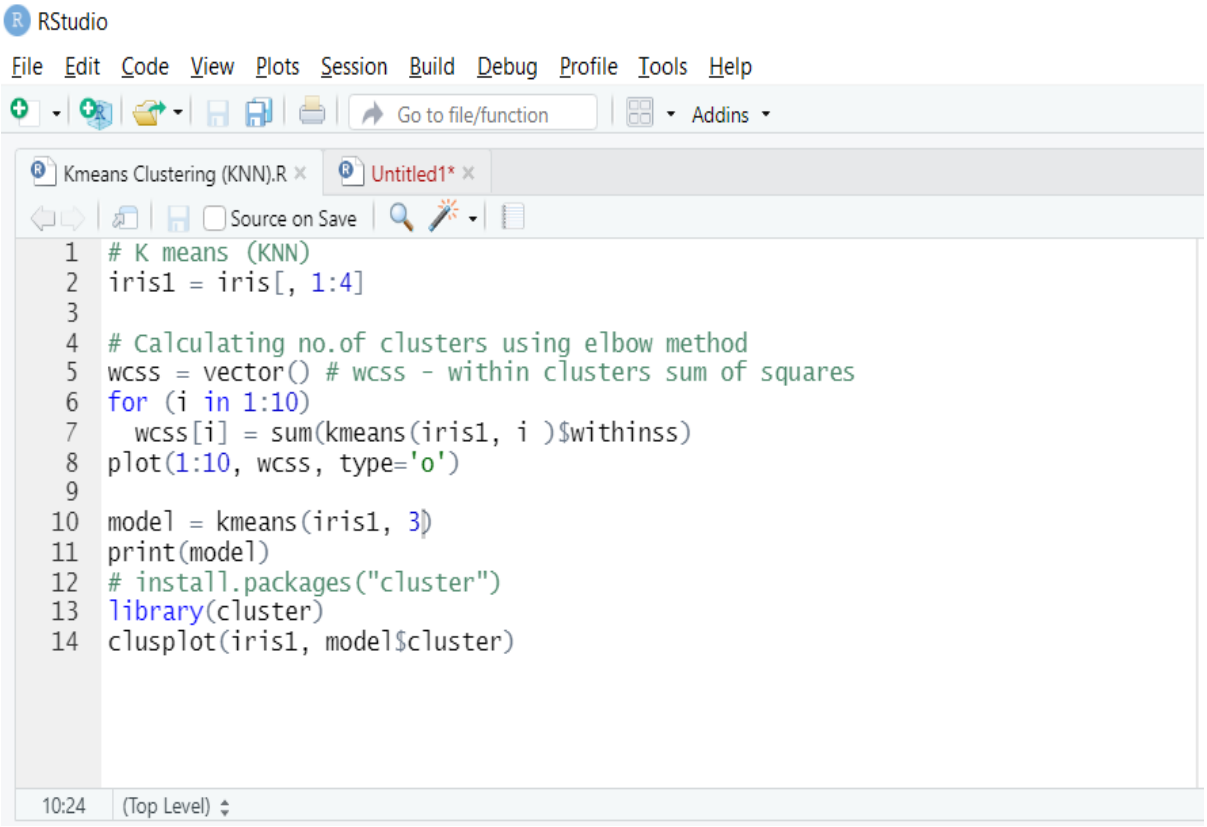
Aim:

To

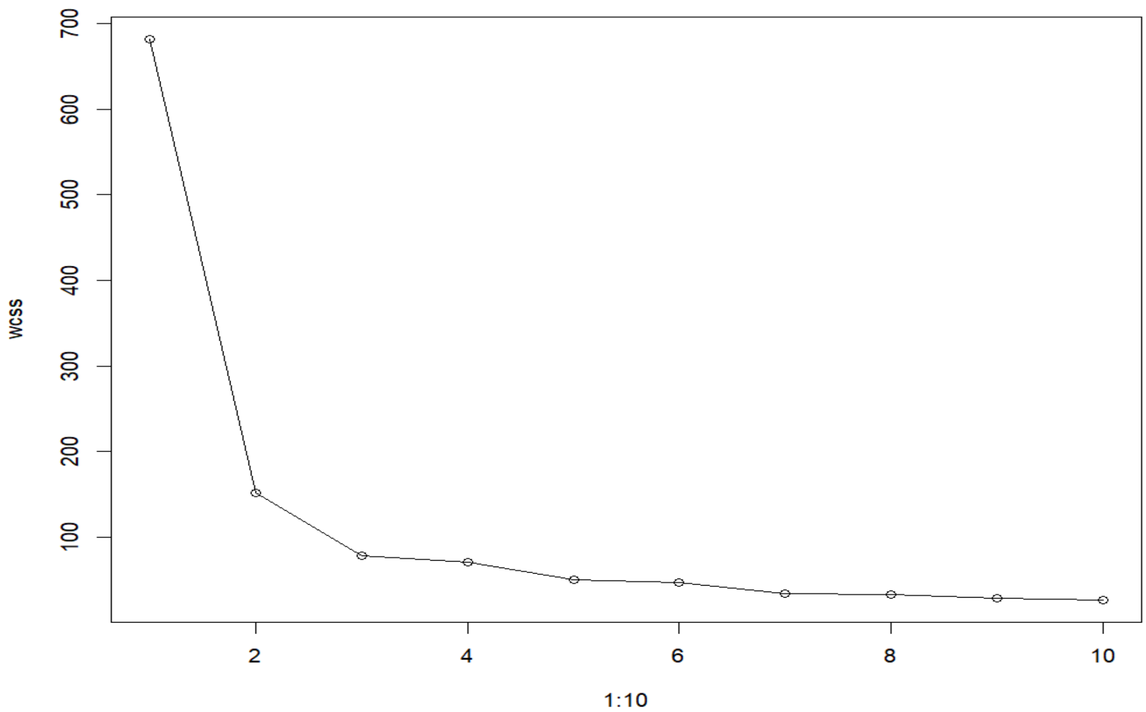
1. **Load the iris data set and USArrests data set.**
2. **Cluster the data sets using K means Clustering and also find optimal number of clusters using Elbow Method.**

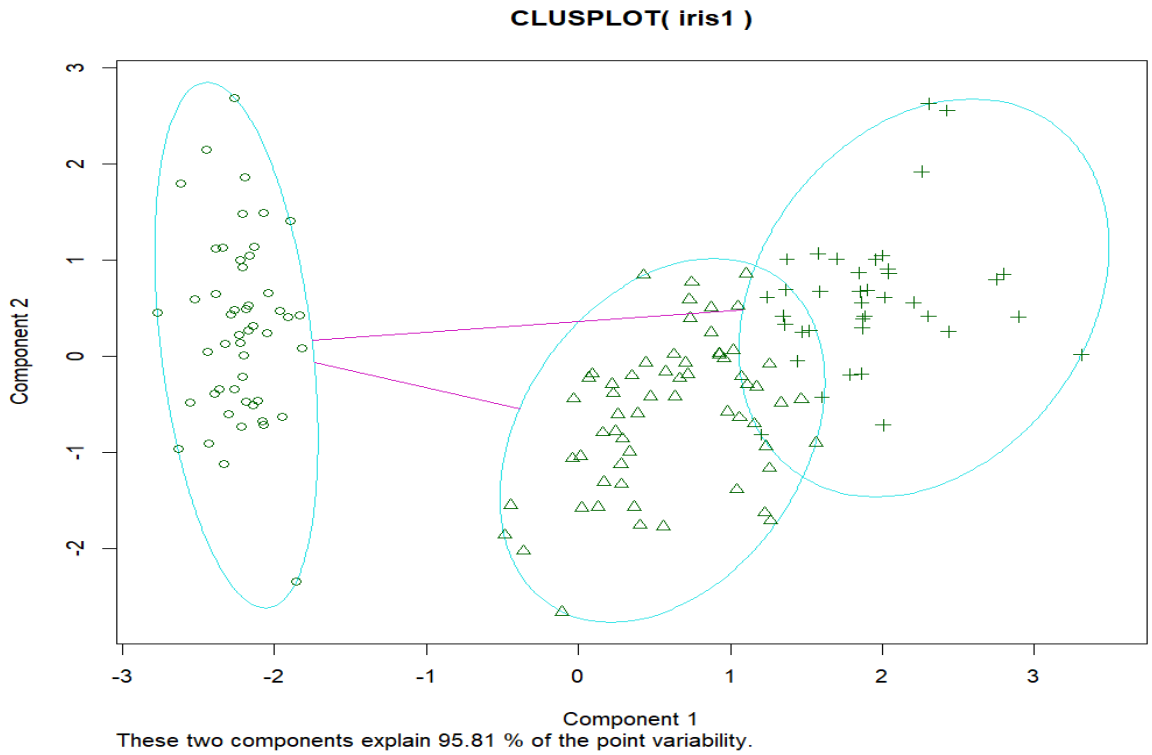
Procedure:

a) Loading iris data set and clustering the data sets using K means Clustering.



```
Console  Terminal  Jobs
R 4.1.2 · ~/
> source("E:/D/New folder/R ML/Kmeans Clustering (KNN).R")
K-means clustering with 3 clusters of sizes 62, 38, 50

Cluster means:
  Sepal.Length Sepal.Width Petal.Length Petal.Width
1     5.901613    2.748387     4.393548    1.433871
2     6.850000    3.073684     5.742105    2.071053
3     5.006000    3.428000     1.462000    0.246000

Clustering vector:
  [1] 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 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 [72] 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 2 2 1 2 2 2 2 2 2 1 1 2 2 2 2 1 2 1 2 1 2 2 1 1 2 2 2 2 2 1 2 2 2 2 1 2 2 2
[143] 1 2 2 2 1 2 2 1

Within cluster sum of squares by cluster:
[1] 39.82097 23.87947 15.15100
 (between_SS / total_SS =  88.4 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweenss"    "size"         "iter"         "ifault"
>
```





b) Loading iris data set and clustering the data sets using K means Clustering.

RStudio

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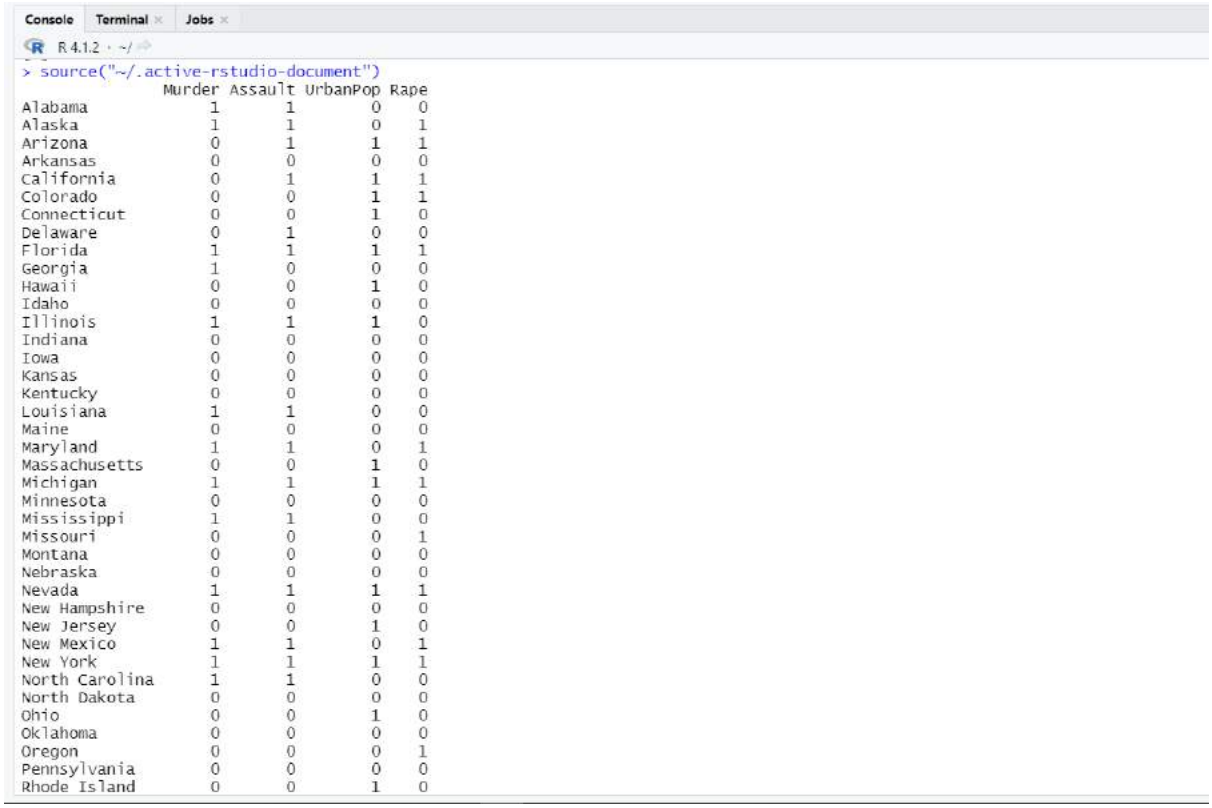
Go to file/function | Addins

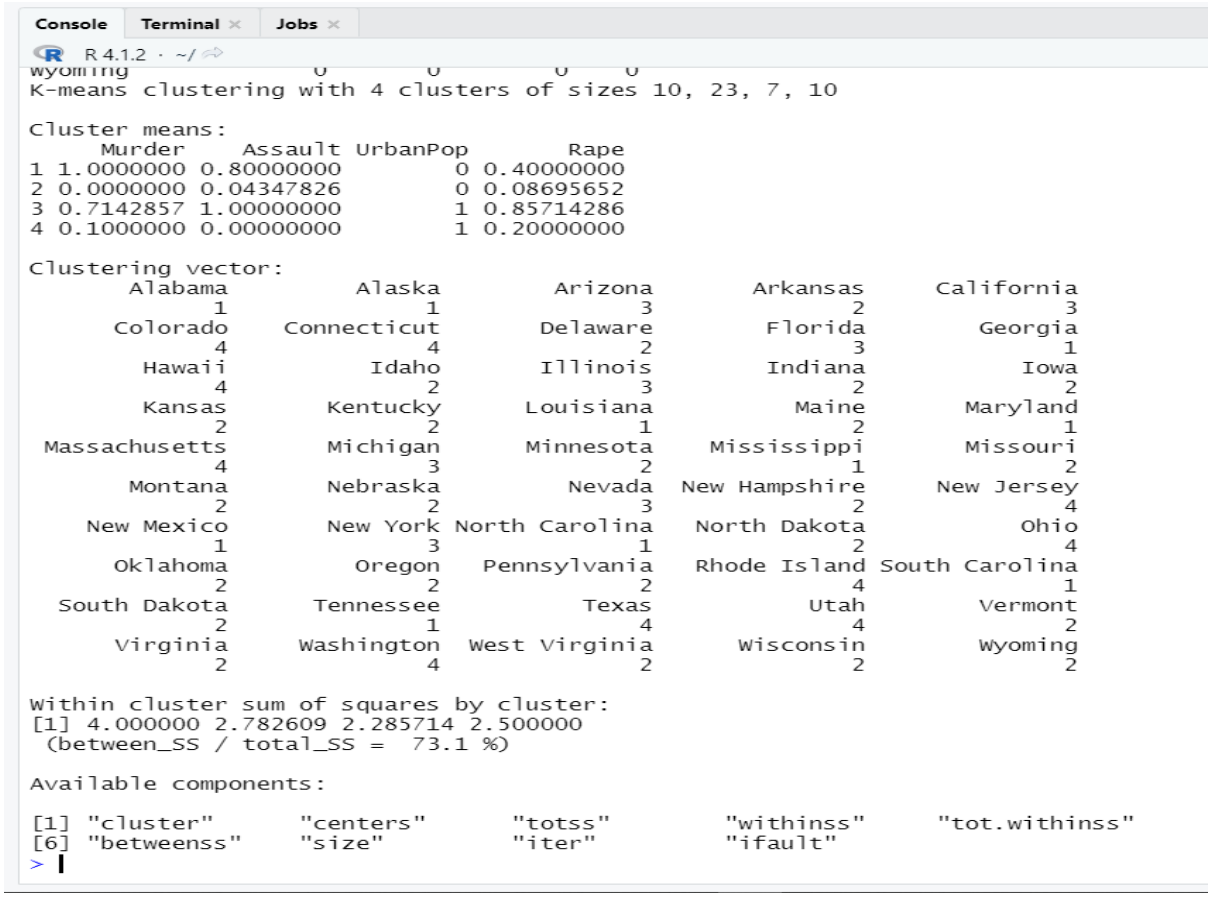
Kmeans Clustering (KNN).R | Untitled1*

Source on Save

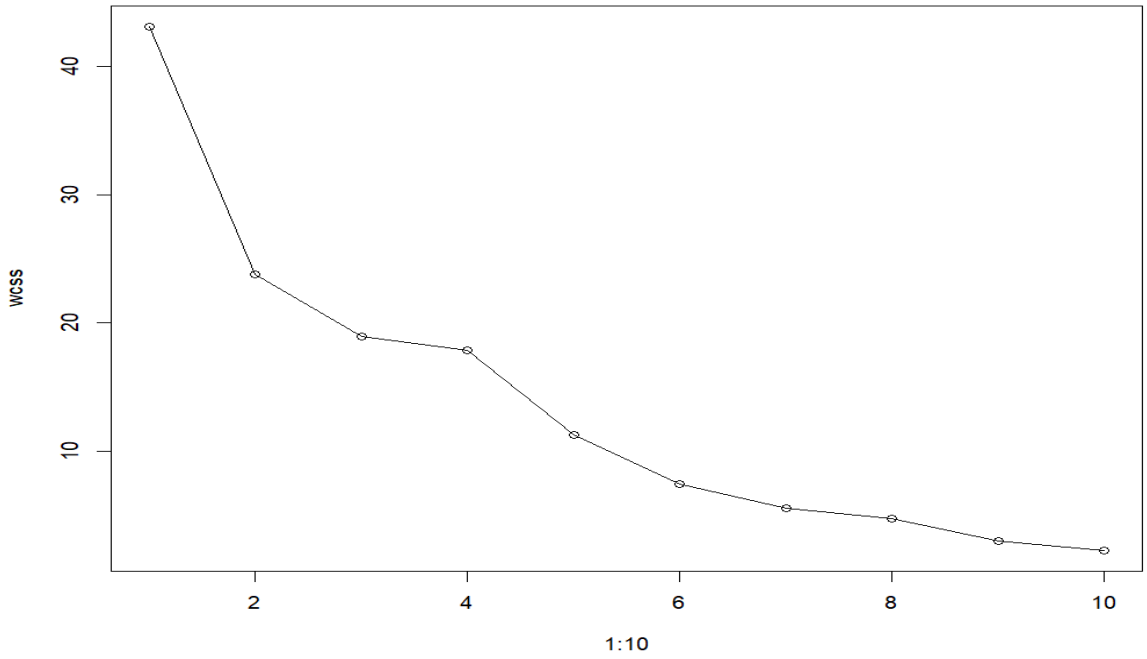
```
1  # K means (KNN)
2  d = USArrests[, 1:4]
3  sd = scale(d) # Scaling the data
4  sd_new = ifelse(sd>.5, 1, 0) # Standardizing the data
5  print(sd_new)
6
7  # Calculating no.of clusters using elbow method
8  wcss = vector() # wcss - within clusters sum of squares
9  for (i in 1:10)
10   wcss[i] = sum(kmeans(sd_new, i )$withinss)
11 plot(1:10, wcss, type='o')
12
13 model = kmeans(sd_new, 4)
14 print(model)
15 # install.packages("cluster")
16 library(cluster)
17 clusplot(sd_new, model$cluster)
```

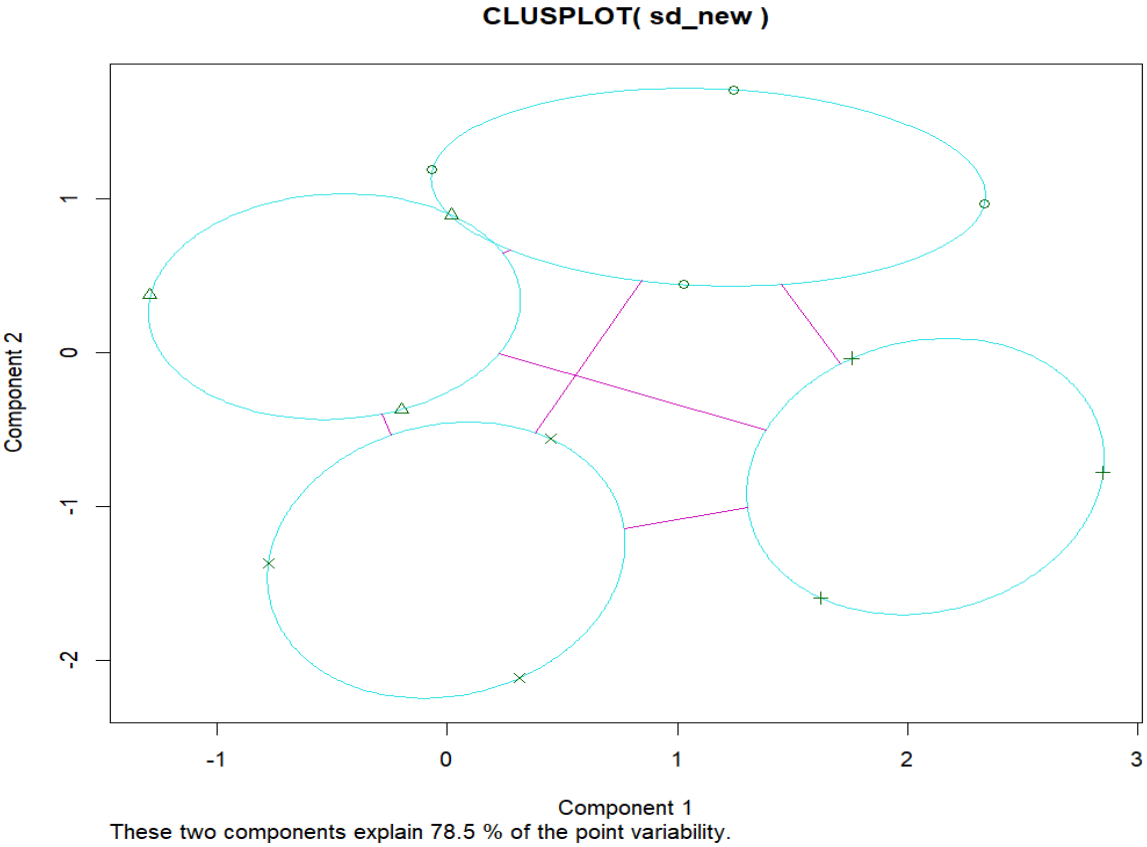


```
Console  Terminal  Jobs
R 4.1.2 · ~/
> source("~/.active-rstudio-document")
               Murder Assault UrbanPop Rape
Alabama             1       1        0    0
Alaska              1       1        0    1
Arizona             0       1        1    1
Arkansas            0       0        0    0
California          0       1        1    1
Colorado            0       0        1    1
Connecticut         0       0        1    0
Delaware            0       1        0    0
Florida             1       1        1    1
Georgia             1       0        0    0
Hawaii              0       0        1    0
Idaho               0       0        0    0
Illinois            1       1        1    0
Indiana             0       0        0    0
Iowa                0       0        0    0
Kansas              0       0        0    0
Kentucky            0       0        0    0
Louisiana           1       1        0    0
Maine               0       0        0    0
Maryland            1       1        0    1
Massachusetts       0       0        1    0
Michigan            1       1        1    1
Minnesota           0       0        0    0
Mississippi         1       1        0    0
Missouri            0       0        0    1
Montana             0       0        0    0
Nebraska            0       0        0    0
Nevada              1       1        1    1
New Hampshire       0       0        0    0
New Jersey          0       0        1    0
New Mexico          1       1        0    1
New York            1       1        1    1
North Carolina      1       1        0    0
North Dakota        0       0        0    0
Ohio                0       0        1    0
Oklahoma            0       0        0    0
Oregon              0       0        0    1
Pennsylvania        0       0        0    0
Rhode Island        0       0        1    0
```



```
Console  Terminal  Jobs
R 4.1.2 · ~/
Wyoming             0       0        0    0
K-means clustering with 4 clusters of sizes 10, 23, 7, 10

Cluster means:
     Murder    Assault UrbanPop       Rape
1 1.0000000 0.80000000        0 0.40000000
2 0.0000000 0.04347826        0 0.08695652
3 0.7142857 1.00000000        1 0.85714286
4 0.1000000 0.00000000        1 0.20000000

Clustering vector:
       Alabama         Alaska        Arizona       Arkansas     California
             1              1              3              2              3
      Colorado    Connecticut       Delaware        Florida        Georgia
             4              4              2              3              1
        Hawaii          Idaho       Illinois        Indiana           Iowa
             4              2              3              2              2
        Kansas       Kentucky      Louisiana          Maine       Maryland
             2              2              1              2              1
 Massachusetts       Michigan      Minnesota    Mississippi       Missouri
             4              3              2              1              2
       Montana       Nebraska         Nevada  New Hampshire     New Jersey
             2              2              3              2              4
    New Mexico       New York North Carolina   North Dakota           Ohio
             1              3              1              2              4
      Oklahoma         Oregon   Pennsylvania   Rhode Island South Carolina
             2              2              2              4              1
  South Dakota      Tennessee          Texas           Utah        Vermont
             2              1              4              4              2
      Virginia     Washington  West Virginia      Wisconsin        Wyoming
             2              4              2              2              2

Within cluster sum of squares by cluster:
[1] 4.000000 2.782609 2.285714 2.500000
 (between_SS / total_SS =  73.1 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
[6] "betweenss"    "size"         "iter"         "ifault"
>
```





Result:

Thus, the program has been executed and the output has been verified.