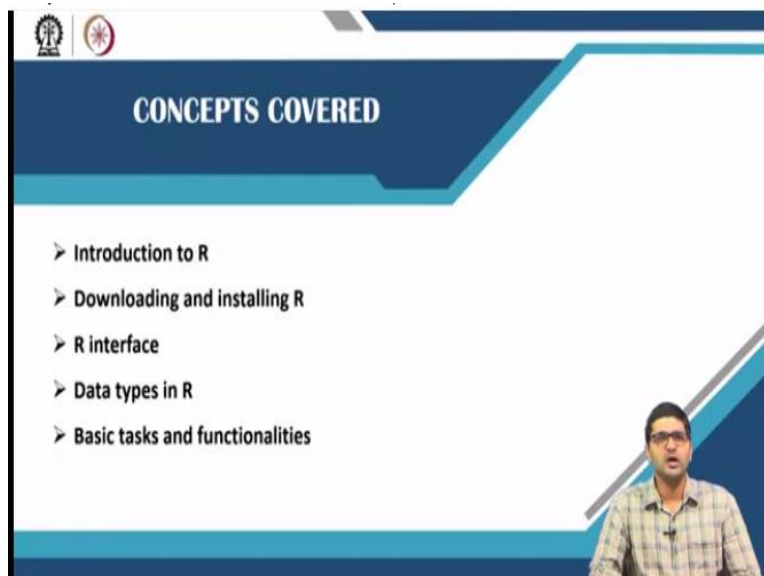


Geographic Information Systems
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Lecture – 55
Introduction to R

Welcome back to the course on geographic information system, so this is module 11, GIS as a software and in this hands on session, we are going to look at introduction to R software.

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The concept covered in this sessions are introduction to R and how to download and install R software and we will see the R interface and different data types in R and basic functionalities which can be performed using R software.

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Introduction to R

- R is a development environment rather than just a programming language
- It is a handy and popular tool for statistical calculations, analyzing data and creating graphs
- Popularity of R among data scientists and researchers is because of its ease of learning, availability of packages, and compatibility across various operating systems
- Also, it is a free software

The slide features a background with faint icons of gears, a tree, and a molecular structure. A small video inset in the bottom right corner shows a man with glasses speaking. At the bottom, there are logos for institutions and the text 'Dr. Prashant'.

So, when we see R, so R is software, it is a research or development environment rather than just a programming language, so it is a handy and popular tool for statistical computation and to analyse data and creating graphs and charts. The popularity of R among data scientists and researchers is because of its ease of learning, availability of different packages and compatibility across various platforms.

So, R can be used in window system or Mac system or Linux system as well and also it is an open source and free software, so that can be downloaded and installed without paying for it and it can be redistributed or it can use for commercial and research purposes without really paying for it.

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Installation of R

Download R software using this link

- <https://cran.r-project.org/bin/windows/base/>

Download R Studio software using this link

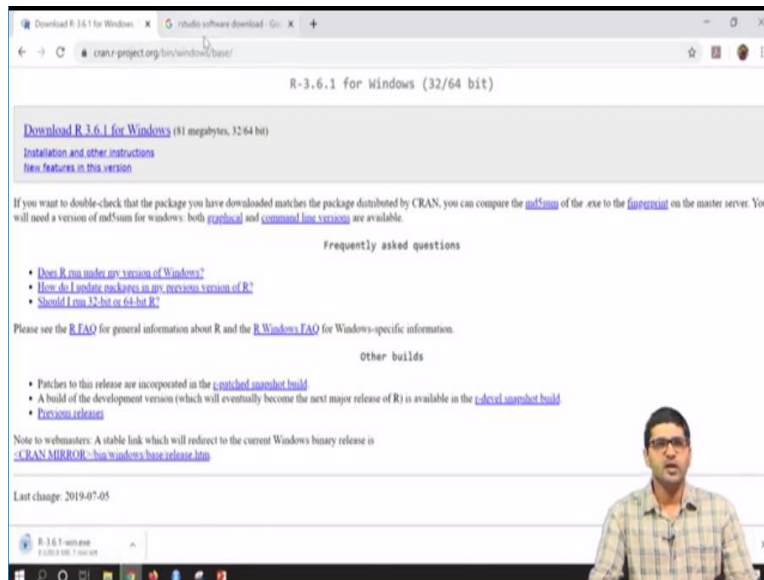
- <https://www.rstudio.com/products/rstudio/download/>

So, with this introduction we will directly jump to how to install R software, so let us go to the website from which we can download R software.

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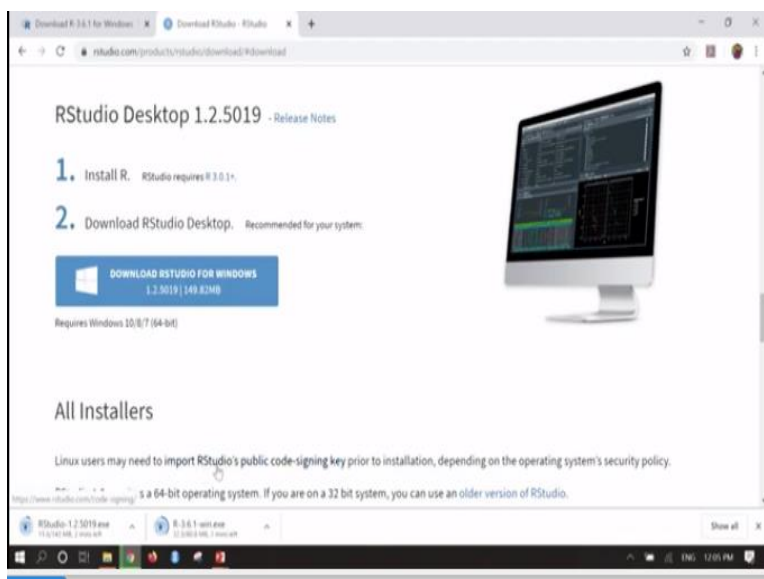
So, this is a website with which we can download R and R studio, so please make a note that we need to download 2 softwares; one is R and one more is R studio. R studio is an extension to R, which provides more sophisticated functionalities similar to R, so if you type R software download as a Google search, so the first link; cran dot R project dot org.

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If you go to this particular website, so the first option which gives R, download R 3.6.1 the latest version for windows, so we will see how to install and use R for windows version, so which is similar; the functionality is similar to any other operating system also. So, if you click this particular link, R our software will get download, so it is just.exe file, it is having somewhere around 80 MB, so it will get downloaded to your system.

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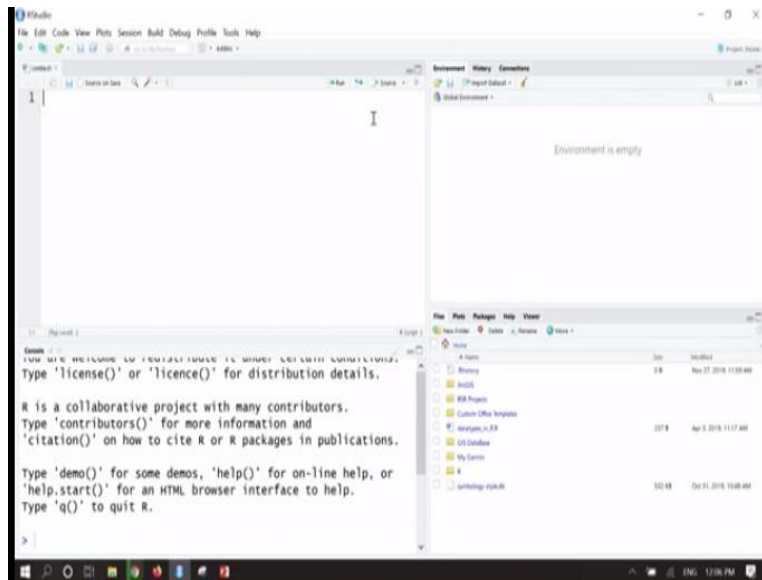


Similarly, you what you need to use in this particular session is also an software called R studio, so if you search R studio software as downloading Google search, R studio website will get open, here you need to come down and there is a free version available for R studio desktop, so

if you click on download and download R studio for windows, so it will get; so R studio will also have an dot exe file, so this is around 140 MB.

These 2 files you need to download and keep it and finally, needs to be installed to start using R software for this particular session. So, what currently I have done; I have download all these things and already installed in my system, so I will stop this processes and directly jump to R software, so these 2 are the links with which we can download R software.

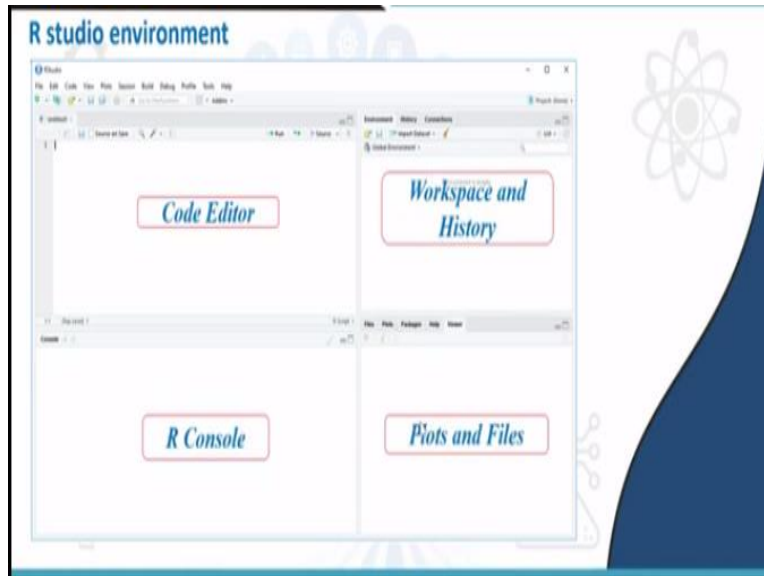
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So, how to go to R software? If you go to windows and search as R studio, so R studio link will appear, so if you just click on that, R studio will get open, so this is the basic interface of R, so if you go to file and new file and you can say as R script, so R script will page get open, so this is the page in which we can write; start writing the R codes and right side you can see, there is an environment history and connections.

Here, all the data set which we loaded to R environment will get displayed, at the right bottom this is the area where we can search for particular tool to get help or we can see different packages installed in R or if you can see different plots and charts which are which can be generated from the R can be seen here and also we can establish a connection to the R software using here.

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So, this is the basic console, we will go back to slides and try to understand the processes, so this is the code editor as I was shown to you in R software and at the right top, as the left top and right top is the workspace and the history, left side we can see R console and right bottom we can see plots and files.

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Data types

Object classes

- Character `c = "RCGSIDM"; c = "52.5"`
- Numeric `x = 52.5`
- Integer `y = 50`
- Complex `m = 1+2i`
- Logical (true or false) `g = x>y`

So, now we will try to understand different data types and objects which are present in the R, first one is object classes. So, R has 5 object classes; one is character, numeric, integer and complex and logical, so we will try to see one by one.

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Data types

Vectors

- `x = c("Cheers", "to", "the", "session")`
- `class(x)`
- `[1] "character"`
- `y = c(1,2,3,4,5)`
- `class(y)`
- `[1] "numeric"`

Lists

```
x = list("Session", 2019, TRUE)
class(x[[1]])
[1] "character"
class(x[[2]])
[1] "numeric"
class(x[[3]])
[1] "logical"
```



And next is vectors and lists.

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Data types

Data frames

Data frames are used to store data in table format.

It can contain data of different types on each column and logical constraint is that each column can only contain objects of same class. Data frame is created using a function `data.frame()`

```
x = c("Shiv", "Raj", "Krish")
y = c(35,25,15)
z = c(TRUE,TRUE,FALSE)
data_frame = data.frame(username=x, age=y, adult=z)
data_frame
  username age adult
1 Shiv 35 TRUE
2 Raj 25 TRUE
3 Krish 15 FALSE
```




And finally matrix and data frames.

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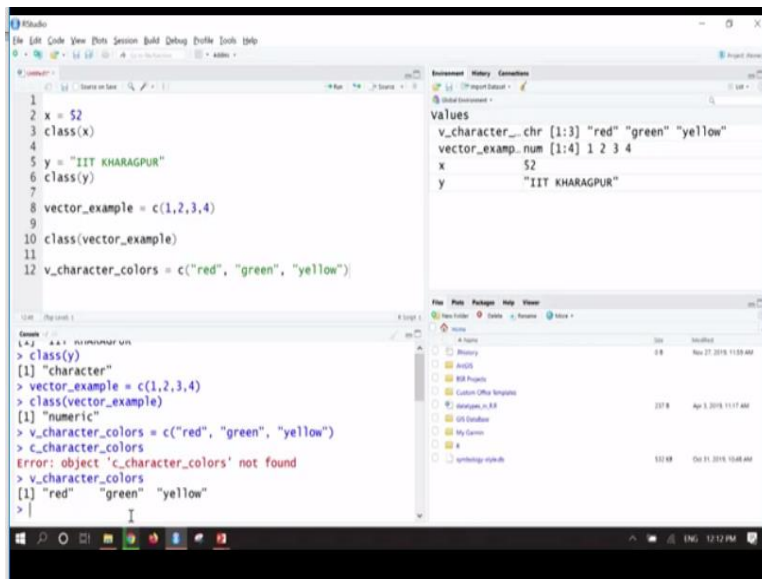
Importing CSV data to R

- `Employ_data = read.csv(file.choose())`
- `Employ_data = read.csv("Directory and file path")`

	rank	discipline	yrs.since.phd	yrs.service	sex	salary
1	Prof	0	19	18	Male	139750
2	Prof	0	20	16	Male	173200
3	AsstProf	0	4	3	Male	79750
4	Prof	0	45	39	Male	115000
5	Prof	0	40	41	Male	141500
6	AssocProf	0	6	6	Male	97000
7	Prof	0	30	23	Male	175000
8	Prof	0	45	45	Male	147765
9	Prof	0	21	20	Male	119250
10	Prof	0	18	18	Female	129000
11	AssocProf	0	12	8	Male	119800



So, how to create these things; we will go on see in R software, we will go to R studio now.
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```

1
2 x = 52
3 class(x)
4
5 y = "IIT KHARAGPUR"
6 class(y)
7
8 vector_example = c(1,2,3,4)
9
10 class(vector_example)
11
12 v_character_colors = c("red", "green", "yellow")

```

```

> class(y)
[1] "character"
> vector_example = c(1,2,3,4)
> class(vector_example)
[1] "numeric"
> v_character_colors = c("red", "green", "yellow")
> c_character_colors
Error: object 'c_character_colors' not found
> v_character_colors
[1] "red" "green" "yellow"
>

```

So, here let us try to create one object class for example, X is equal to 52 is a number and we will; so, how to run this, so once you type any code in R, you just need to click on run, to run R software, so now the value of X; 52 is assigned to X now, so a variable called X is assigned by a number 52, let us try to see its class; if you type class and X and run it, so it says it is a numeric, so 52 is the number, so R has a data type as a numeric.

So, similarly we will see Y is equal to IIT Kharagpur and run it, so how do we run? So, we can run using the run button or we can use keyboard shortcut; control and enter, so make sure that

your cursor is in that particular line for example, if I am running `Y = "IIT Kharagpur"`, so that cursor need to be in that particular line to run and then use control enter, so once you do control enter, that particular code will get run and that is visible in the console.

So, if the console shows the next arrow button that means the previous command has run properly, so at the right top you can see `Y = "IIT Kharagpur"` value is assigned to `Y`, so if you want to check that, in console you can, go to console and press `Y` and run it, so `"IIT Kharagpur"`, a string value is assigned to `Y`, so let us try to see what is its class; `class(Y)` and control enter that is a shortcut to run this particular line.

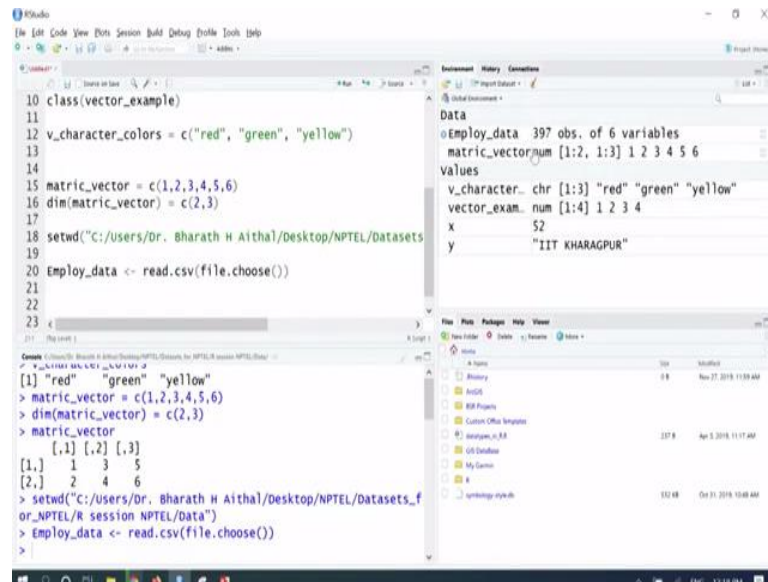
When you run this, it says is a character, so previously `X` was a numeric and now `Y` is a character similarly, we can do different data types such as complex number or integer, floating point number etc., this is how we can create a class in R. so, next we will try to create vector in R, so how to do that; a vector is equal to; this is a I will just name as vector example is equal to; you note that we can use either this symbol or we can use equal, both of these symbol are one and the same.

Both of them mean is equal to or vector is equal to; we need to use a command `C` to create a vector, so I will create a numeric vector now; `C(1, 2, 3, 4)`, so this is how we can create a numeric vector and control run. So, now a vector has been created, so we can see its class; type `class(C(1, 2, 3, 4))` vector example, here we can see the command has been shown, so if you run this and control enter, it says is a numeric vector.

Similarly, we can do a vector with the character vector; `C("red", "green", "yellow")`; using `C` command, we can create vector, I can create different colours may be red, green, yellow, these 3 colours I will put it into a variable called character colours and control enter if I do, variable called `V` character colour is created here, so that can be visualised in console as well, so if you go to console, `V` enter character underscore colours, if you type this and enter it, all the values will be visible.

Sorry, this would be V, so we can see all the values are visible, so this is how we can create a character vector or a numeric vector, next we will try to see how to create a matrix, so let us go back to the slides and explore. So, if you want to create a matrix, there are multiple options are available to create matrix. First one is to create a vector and then using dimension function you can create a matrix.

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Let us try to create using this, let us go back to R console, let us create a vector now, matrix vector is equal to; a vector can be created using C function, I will create a numeric vector of 1, 2, 3, 4, 5 and 6 and then run, then we can use the dimension of matrix vector should be, I can assign the dimension, so dimension should also be a vector and we have 3 and 3, 6 elements, let us have 2 cross 3 matrix, we can mention the dimension of a matrix.

Now, a matrix is created, we can go and inspect the matrix vector here, just copy a matrix and put it into a console and then run it, so we can see a matrix having rows; number of rows 2's and number of column 3's, so this how we can create a matrix. Similarly, we can create one more data type called data frame, so basically matrix is an arrangement of numbers or characters in terms of rows and columns.

So, in data frame or in data frame, data type in R, so it contains number of rows and columns arranged in (()) (12:38) format, so having unique elements in different data types, so for example

in matrix we can store only single type of data type, for example we can store only number or we can store only integers pictures but in data frame, we can store both together, so that is the advantage of data frame, in R we use data frame very much.

So, let us try to import an Excel file and then see how data frame can be useful, how we can convert an Excel file into a data frame. So, how do we bring the Excel file, let us go back to the slides and verify the steps, so we can use function called read dot csv to import an Excel file, so for this exercise we have given an Excel file in the data folder that you can see if you go to R session NPTEL folder.

There is a folder; there is a file called employ R data, so this one we will try to import into R and then inspect how it can be used. So, before bringing in the Excel file into database, we will try to see how we can set the directory. So, setting directory is important because once we try to open any file, the window will directly go to that particular folder, so that can be done using a command called setwd; setwd is a command to set the directory.

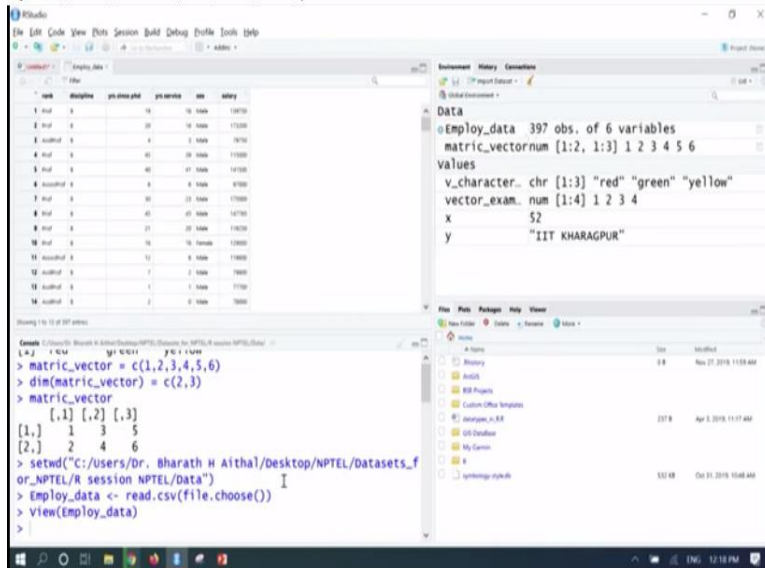
So, using setwd and double quotation, so here inside the double quotation, we need to mention the path, go back to the path and copy the path where the file is mentioned, file is kept and just copy the path to the R console, so here make sure that in Windows system, if you use forward slash instead of backward slash, all these slashes need to be; forward slash need to be; backward slash need to be change it to forward slash to file setting the directories.

So, once we have the location in you set properly, then we need to run setwd command, so when we run this, the particular folder is set as a set directory in R, so now we can directly start importing excel file into the R environment, let us name the Excel file as employ dot data; employ underscore data is equal to read dot csv, so when you type read, so it gives a solution, so this one can be used; read dot csv.

And we can; so here we can use file dot choose command to import the file and then run it, a window will open, so asking to open the file, so since now we have set the directory to this path,

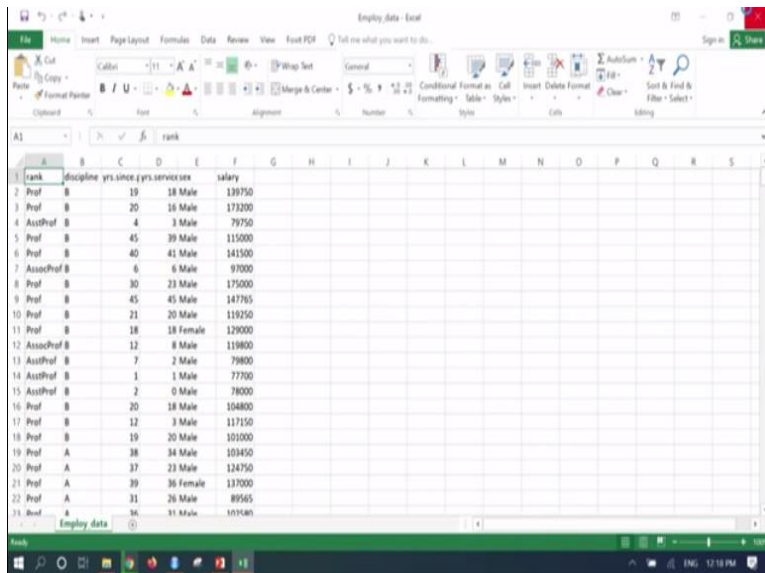
so it is directly opening this particular path, so if you double click on employ dot data, the employ data is imported into R environment now.

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So, here if you go and see, the employed data is imported into R environment, so let us inspect the same data in Excel as well.

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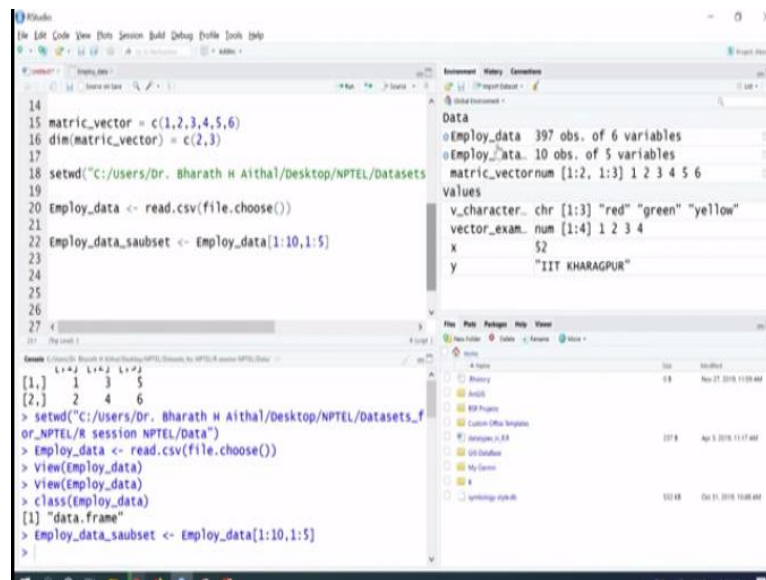


In a spread sheet, the data contains different ranks of the teaching staff and their discipline, years of service and their gender and salary, these information are existing in the Excel sheet, so if you want to do any kind of analysis or preparing graphs and charts or prepare any kind of analytics,

so that can be; the data can be bought it into R environment using read dot csv file. So, currently we bought this Excel data into R environment.

And we will inspect the data set here, so if you type employ dot data at the right side, if you click on employ dot data at the right side, the window will open showing the data in Excel format, so right now you can; we will try to check what is the class of this employ dot data which we created.

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The screenshot shows the RStudio interface. The console on the left contains the following R code:

```
14  
15 matrix_vector = c(1,2,3,4,5,6)  
16 dim(matrix_vector) = c(2,3)  
17  
18 setwd("C:/Users/dr. Bharath H Aithal/Desktop/NPTEL/datasets")  
19  
20 Employ_data <- read.csv(file.choose())  
21  
22 Employ_data_subset <- Employ_data[1:10,1:5]  
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```

The environment pane on the right shows the following objects:

- matrix_vector: num [1:6] 1 2 3 4 5 6
- dim(matrix_vector): num [1:2] 2 3
- Employ_data: data.frame [397 x 6]
- Employ_data_subset: data.frame [10 x 5]

The console output shows the following commands and results:

```
> setwd("C:/Users/dr. Bharath H Aithal/Desktop/NPTEL/datasets_f  
or_NPTEL/R session NPTEL/Data")  
> Employ_data <- read.csv(file.choose())  
> view(Employ_data)  
> view(Employ_data)  
> class(Employ_data)  
[1] "data.frame"  
> Employ_data_subset <- Employ_data[1:10,1:5]  
>
```

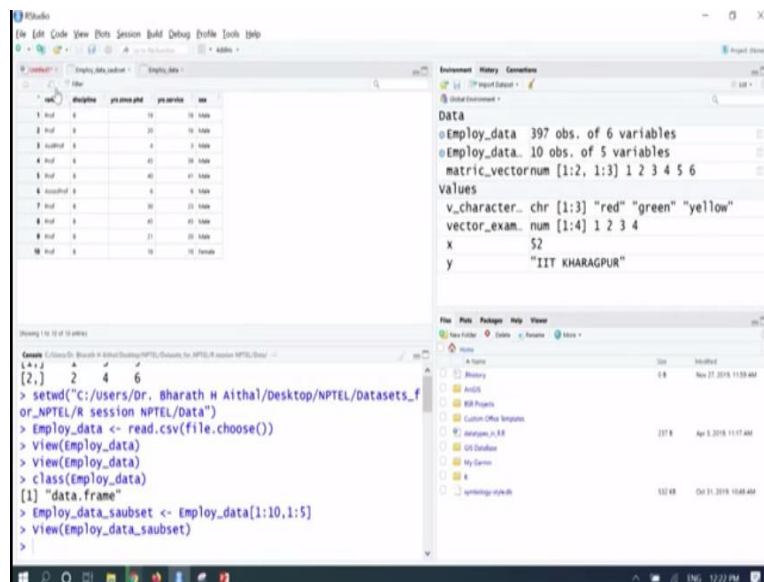
I will just copy employ dot data and just check class of employ dot data and run it, so it says a data frame, so till now we have seen, so how to create a numeric class, a character class, a vector class, a matrix and how to set path in the; directory path in the R environment and how to create a data frame, so these are all different data types in R that is basic data types in R which can be; which need to be understood for further process in R.

So now, till now we have created employ dot data file, so now will try to subset the data, how to subset these data for further processing, suppose so if I do not want the salary information, if I want till only gender for example, the column number 1, 2, 3, 4 and 5 and for example, I need only first 10 rows, so how to subset these data in R, so let us try to subset the data in R, for that we need to use for example, I () (18:32) into a different variable called employ dot data underscore subset is equal to; I need to call the previous variable that is employ dot data.

And then use square brackets, so here we need to use one comma, so before the comma, it is used for filtering the number of rows, after the comma it is used for filtering the number of columns, so I will just mention number of rows; rows is to rows, this is the syntax for filtering the data, columns is to columns, for example in the current data set, employ dot data, if I want from row number 1 to row number 10, so I can write something like this; 1 is to 10.

So that means, from row number 1 to row number 10 it will filter out and then it goes to columns, so if I want columns from first column to column number 5, so this is how we can filter first 10 columns and first 5 rows; first 10 rows and first 5 columns and then run it, so now employ dot data subset has been created.

(Refer Slide Time: 20:16)



So, if you go here and click, we can see only the 10 rows and 5 columns, this is how we can subset the data in R, so similarly subset can be done on the simple vector as well suppose, vector like matrix vector is created, so which is having a data from 1 to 6, this also can be subset as something like this, so we can; for example, I will just; we will just try to see how matrix dot vector appears.

(Refer Slide Time: 20:57)

```

16 dim(matrix_vector) = c(2,3)
17
18 setwd("C:/Users/Dr. Bharath H Aithal/Desktop/NPTEL/Datasets")
19
20 Employ_data <- read.csv(file.choose())
21
22 Employ_data_subset <- Employ_data[1:10,1:5]
23 vector_example <- c(1,2,3,4,5,6)
24 vector_example_subset <- vector_example[1:3]
25
26
27
28

```

```

> matrix_vector
     [,1] [,2] [,3]
[1,]  1   3   5
[2,]  2   4   6

> vector_example <- c(1,2,3,4,5,6)
> vector_example
[1] 1 2 3 4 5 6

> vector_example_subset <- vector_example[1:3]
> vector_example_subset
[1] 1 2 3

```

So, if you run matrix dot vector, so if you run vector example not matrix dot vector; vector example, let us try to create a vector example one more, if you go here and use command C and write 1, 2, 3, 4, 5, 6, so till 6 elements we have created in this vector, so if you go an inspector vector example, it is a variable, so having the values from 1 to 6, so 1 to 6 are there. If you want to subset this 2 only 1 to 3, how to do these?

So, we can give one more as vector example subset and then using the square bracket 1 to 3 we can do, first element to third element and then run it, so now if you check what vector subset contains is a subset of first vector, so it has 1 to 3. So, similarly so if we are having number of rows and columns, we can use this syntax in which row is to rows, column is to columns, row is to rows, column is to columns and if we have only a single vector, we can use for 1 is to 3 or 1 is to n command to subset the data.

(Refer Slide Time: 22:18)


```
Sequence creation

x = 1:10
>x
[1] 1 2 3 4 5 6 7 8 9 10

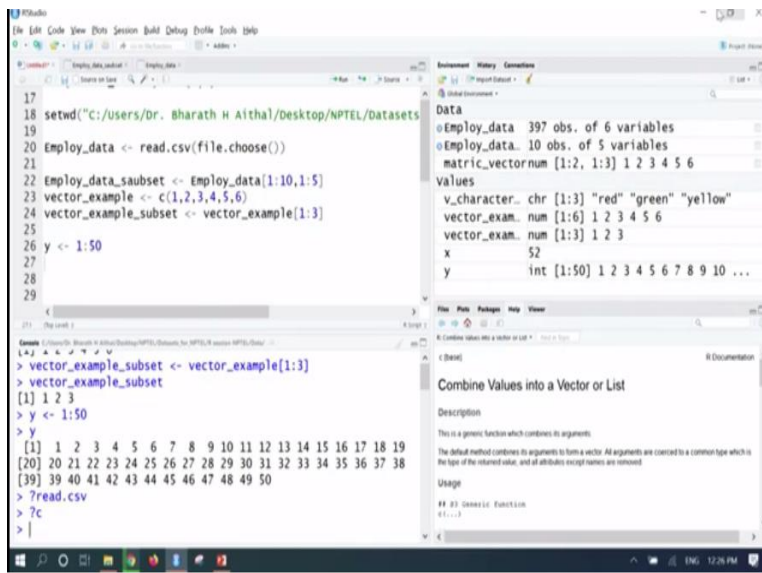
>y = -6:4
>y
[1] -6 -5 -4 -3 -2 -1 0 1 2 3 4

>z = seq(from=2,to=20,by=3)
>z
[1] 2 5 8 11 14 17 20

>m = rep(1,4,3)
>m
[1] 1 2 3 4 1 2 3 4 1 2 3 4
```

So, next let us try to create a sequence, so how to create a sequence in n, if you want to create a number of elements for example, if you want to create elements from 1 to 10 or 1 to 100, so how do that.

(Refer Slide Time: 22:36)



```
17
18 setwd("C:/Users/Dr. Bharath H Aithal/Desktop/NPTEL/Datasets")
19
20 Employ_data <- read.csv(file.choose())
21
22 Employ_data_subset <- Employ_data[1:10,1:5]
23 vector_example <- c(1,2,3,4,5,6)
24 vector_example_subset <- vector_example[1:3]
25
26 y <- 1:50
27
28
29
```

Environment

Object	Class	Attributes
Employ_data	data.frame	397 obs. of 6 variables
Employ_data_subset	data.frame	10 obs. of 5 variables
matrix_vectornum	matrix	[1:2, 1:3] 1 2 3 4 5 6
v_character	chr	[1:3] "red" "green" "yellow"
vector_exam	num	[1:6] 1 2 3 4 5 6
vector_exam_num	num	[1:3] 1 2 3
x	int	52
y	int	[1:50] 1 2 3 4 5 6 7 8 9 10 ...

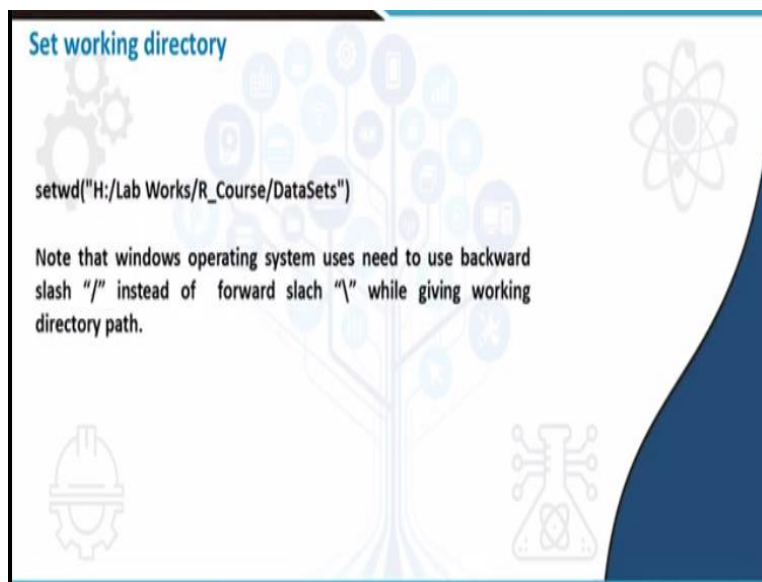
```
> vector_example_subset <- vector_example[1:3]
> vector_example_subset
[1] 1 2 3
> y <- 1:50
> y
[1] 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
[20] 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
[39] 39 40 41 42 43 44 45 46 47 48 49 50
> ?read.csv
> ?c
> |
```

So, you can go to R console, mention, let us mention a variable called Y; Y is equal to 1 is to 50 and run it, a variable called Y will be saved, so with the value from 1 to 50, so we can see it in console here, if you use Y and run, a value from 1 to 50 is created, so then you can use this particular data for further analysis or for creating this kind of subsets for further analysis as well and one more thing; the important thing here is that so we can use a question mark.

And any command if you want to get the information about the command, you can use question mark and this command you can type it, for example if I want to know how read csv works, right, question mark and this command and then run it, so in the right side in the help table, it gives the description about that, so it is coming from the tool called utils, so read dot table, so here so, what are the different variables or parameters can be given.

To read at csv file, all these things and some examples as well also mention, so at the bottom; if you come at the bottom some syntaxes along with the examples, how to run read dot csv is also mentioned, if you want to know about any details about the command, so we can use question and that particular command, if you want to use question and C, so this particular command is used to add a vector or released.

(Refer Slide Time: 24:27)



Set working directory

```
setwd("H:/Lab Works/R_Course/DataSets")
```

Note that windows operating system uses need to use backward slash "/" instead of forward slash "\" while giving working directory path.

This is how we can use the help button in R, so till now we have seen so how to set a directory.

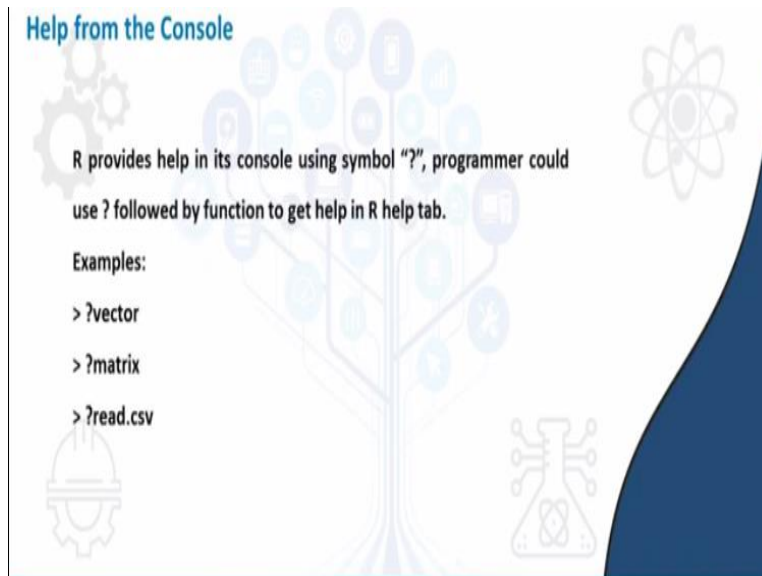
(Refer Slide Time: 24:34)

Help from the Console

R provides help in its console using symbol "?", programmer could use ? followed by function to get help in R help tab.

Examples:

```
> ?vector  
> ?matrix  
> ?read.csv
```

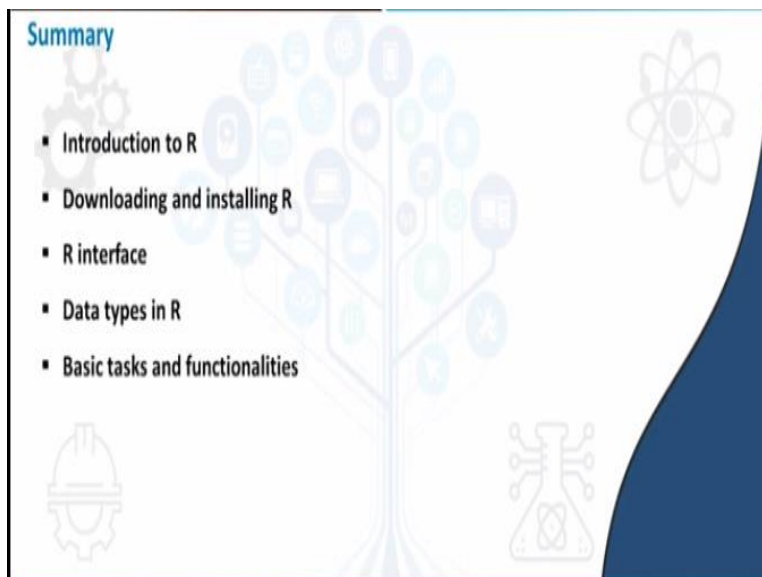


And how to take help from the console.

(Refer Slide Time: 24:39)

Summary

- Introduction to R
- Downloading and installing R
- R interface
- Data types in R
- Basic tasks and functionalities



So, in a nutshell in this particular session, we have seen introduction to R and downloading and installing R and basic R interface and different data types in R, for example we have seen how to create numeric, how to create character, how to create vectors, how to create data frames, how to bring in data; excel data to R and some basic functionality such as filtering and asking questions or making help, taking helps from R console and finally, we have seen setting working directory as well, so in the next session, we are going to look at so how different raster functions or vector functions that as related to GIS can performed in R, thank you.