Machine Learning for Soil and Crop Management
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Lecture 49
Digital Soil Mapping – General Overview (Contd.)

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Welcome friends to this 4th lecture of week 10 of NPTEL Online Certification Course of Machine Learning for Soil and Crop Management. And in this week we are talking about basic overview of digital soil mapping. In our first couple of lectures, we have discussed the basics of digital soil mapping, digital soil mapping workflow principle, how to take management decisions, using DSM.

And also we have seen different auxiliary variables, SCORPAN plus e model. And also we have seen what is GIS, what are these applications, what are the different types of data in case of GIS, and also we have seen what are the different types of geography coordinate system, universal transverse marketer and also datum we have seen.

And in our last lecture, we have discussed about Geostatistics, which is very important for digital soil mapping, its applications, its concept of Geostatistics, models of Geostatistics, universal model of variation. We have also discussed the inverse distance interpolation, Kriging interpolation as well as we have discussed the Variogram and different parameters of the Variogram.

So, today in this lecture number 49, we are going to discuss and I am going to show you how we can use a software called R for different, different DSM approaches, but before that this

lecture will be a overview lecture for R. I am going to show you how to download R and I am going to show you some of the basic functions for the beginners in R, which you can perform. And I will also distribute this codes in our class platform, so please feel free to ask me any questions in the forum if you have.

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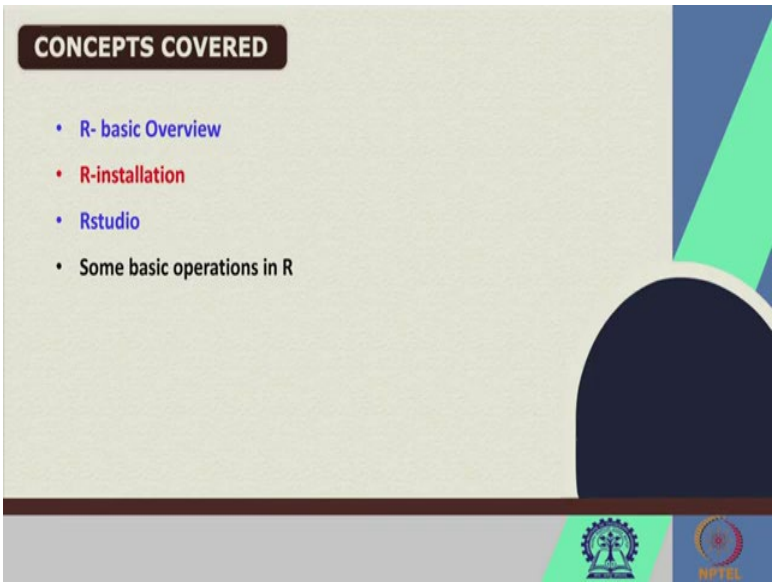

So, let us start. These are the concepts, which we are going to cover in this lecture. First of all the basic overview of R and then we are going to see how to install R. And then we are going to see what is Rstudio. And then we are going to see some basic operations in R. This lecture will be basically focusing on these concepts.

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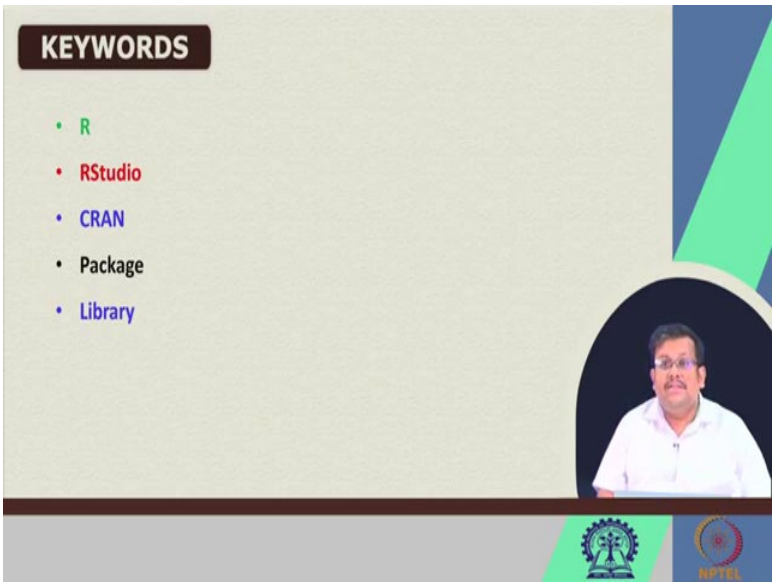

And these are some of the keywords, which we are going to discuss, R, then R studio and then CRAN, then packages and what are the libraries, we are going to discuss in this lecture.

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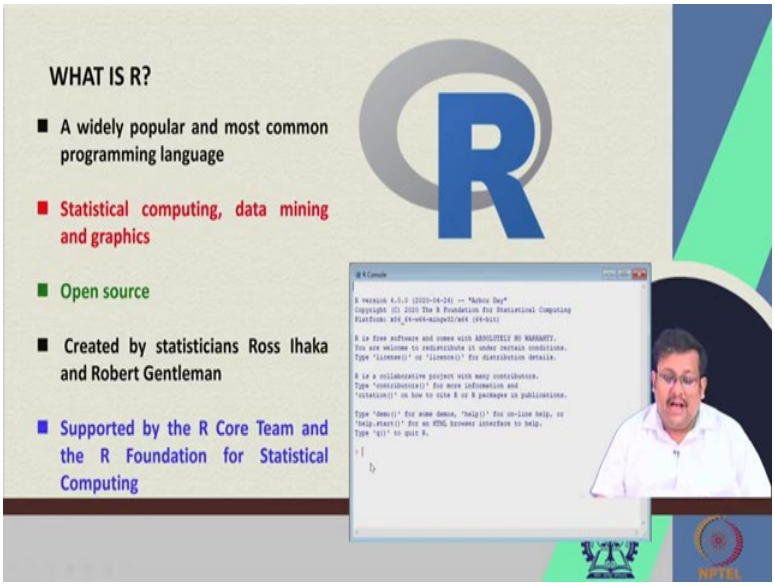

Now, the first question comes to our mind what is R? Well R is a widely popular and most common programming language, it is one of the most widely accepted widely popular and one of the most common programming language. And this helps this language this programming language helps in statistical computing, data mining and graphics. The biggest advantage of using R is it is open source, this R software was created by statistician Ross Ihaka and Robert Gentlemen, these two statisticians have developed this language R.

And it is supported by the R core team and the foundation for statistical computing. So, R generally you can see this is the symbol of R and this is the console or the major console, where you can type all the commands in R, I will show you what is console. And then I will show you how to use this console also.

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So, what is R? R basically is an implementation of the S language. So, S was created originally in 1976, it is a statistical programming language developed by John Chambers from Bell Labs. So, the R project started in 1991 and R first appeared in 1996 as an open source software. So, you can download R freely from this website I will show you and users can another important advantage of using R is users can create packages in R, focusing on specific applications.

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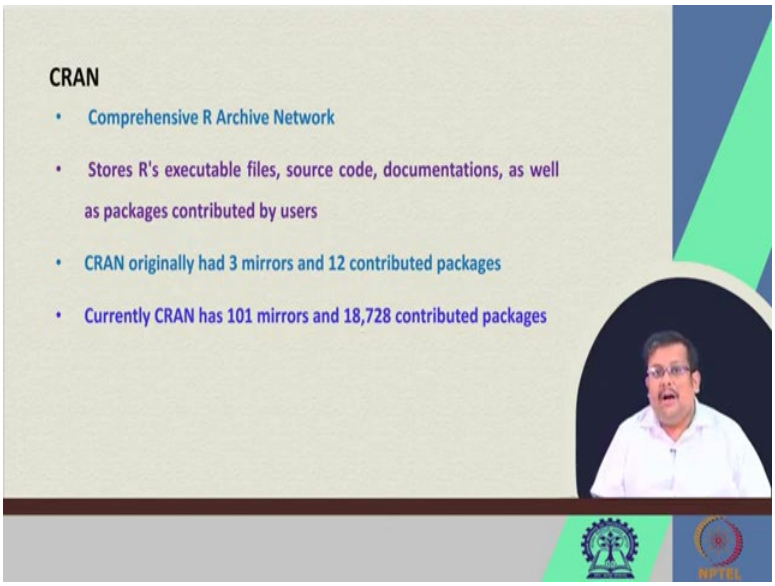

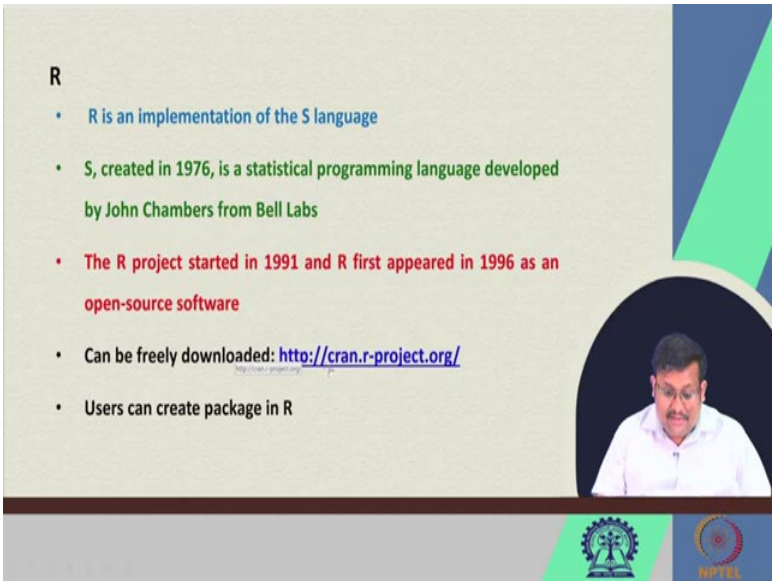

Now, when you download R you will see that I mean if you go to this website also you see CRAN or CRAN what is CRAN? CRAN is basically a short form of comprehensive R archive network. And it basically stores R's all the executable files, source code, documents, as well as the packages contributed by users.

So, for doing any specific operation in R you need to download certain packages. So, these packages are developed by users and you have to for example if you want to, if you want to execute the partial squares regression you have to download or install this PLS package in R.

So, there are numerous packages in R focusing on specific operations, so originally CRAN had 3 mirrors and 12 contributed packages, but right now CRAN has 101 mirrors and 18,728 contributed packages, mirrors are the source sites from where you can download the executable file of R. So, there are different mirrors available, CRAN mirrors are available for different countries all over the world and I will show you how to download this from any a CRAN mirror.

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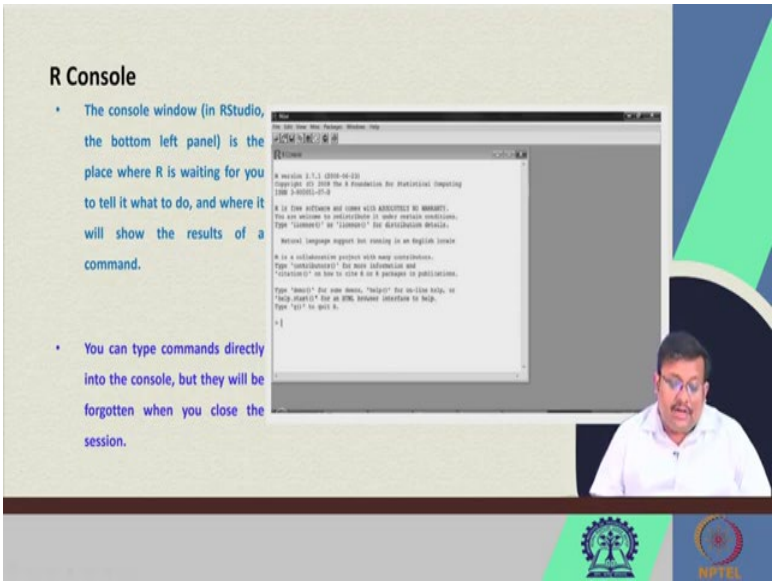

So, this is called the R console, so the console window when you open R, you will see a window this is called the console window and in so it is a place where R is waiting for you to tell it what to do and where it will show the results of a command. So, you can type commands directly into the console, but they will be forgotten when you can close the session.

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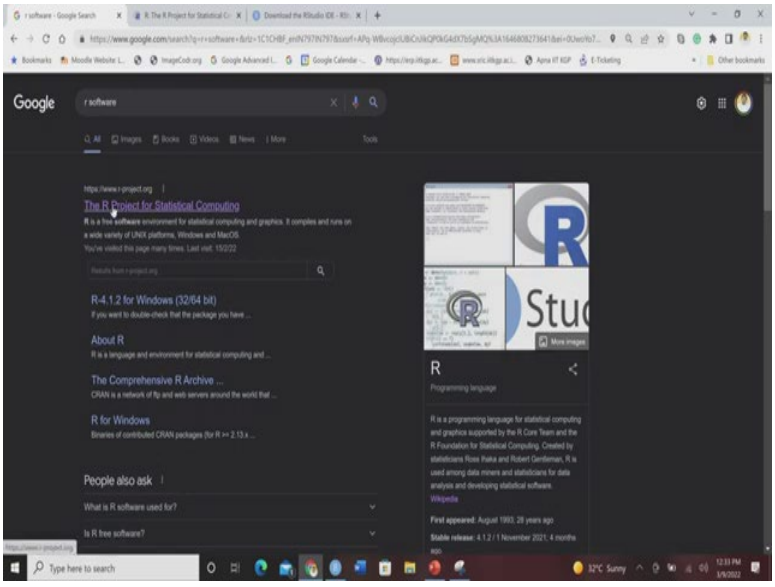

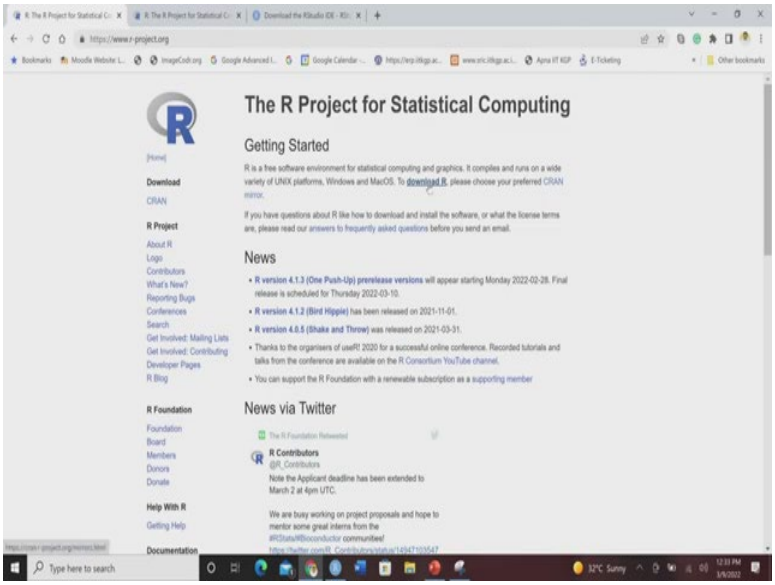
The R Project for Statistical Computing
Getting Started
R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To download R, please choose your preferred CRAN mirror.
If you have questions about R like how to download and install the software, or what the license terms are, please read our answers to frequently asked questions before you send an email.
News
R version 4.1.3 (One Push-Up) prerelease versions will appear starting Monday 2022-02-28. Final release is scheduled for Thursday 2022-03-10.
R version 4.1.2 (Bird Hippie) has been released on 2021-11-01.
R version 4.0.5 (Shake and Throw) was released on 2021-03-31.
Thanks to the organisers of useR! 2020 for a successful online conference. Recorded tutorials and talks from the conference are available on the R Consortium YouTube channel.
You can support the R Foundation with a renewable subscription as a supporting member
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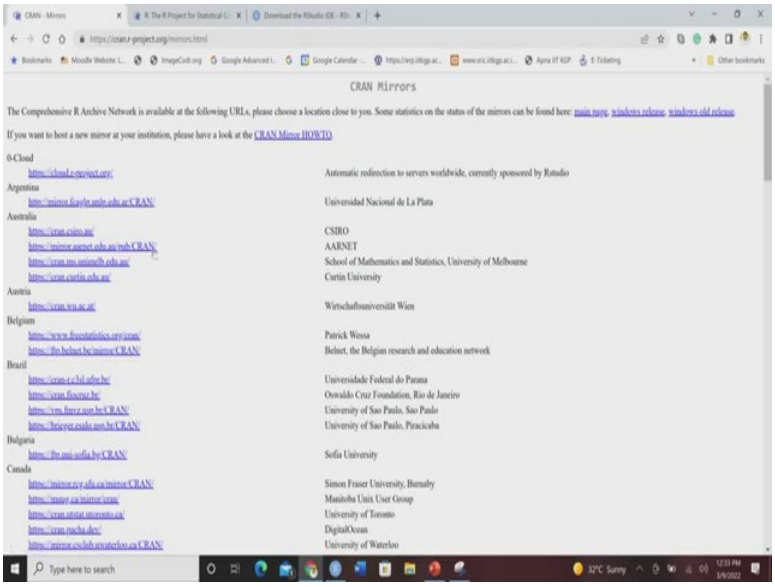
Note the Applicant deadline has been extended to March 2 at 4pm UTC.
We are busy working on project proposals and hope to mentor some great interns from the #RStatsWBoc conductor communities!


CRAN Mirrors
The Comprehensive R Archive Network is available at the following URLs, please choose a location close to you. Some statistics on the status of the mirrors can be found here: main page, windows release, windows old release.
If you want to host a new mirror at your institution, please have a look at the CRAN Mirror HOWTO.
0-Cloud
https://cloud.r-project.org/ Automatic redirection to servers worldwide, currently sponsored by Rstudio
Argentina
http://mirror.fcaglp.unlp.edu.ar/CRAN/ Universidad Nacional de La Plata
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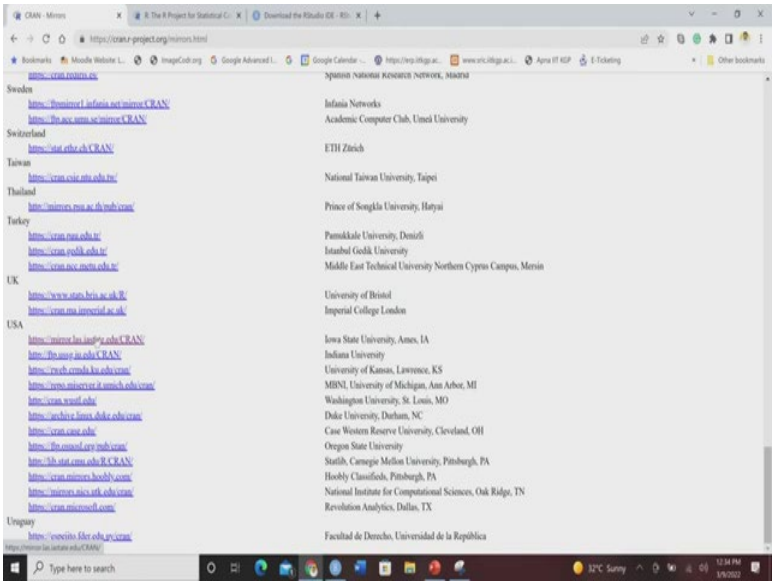
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http://cran.wustl.edu/ Washington University, St. Louis, MO
https://archive.linux.duke.edu/cran/ Duke University, Durham, NC
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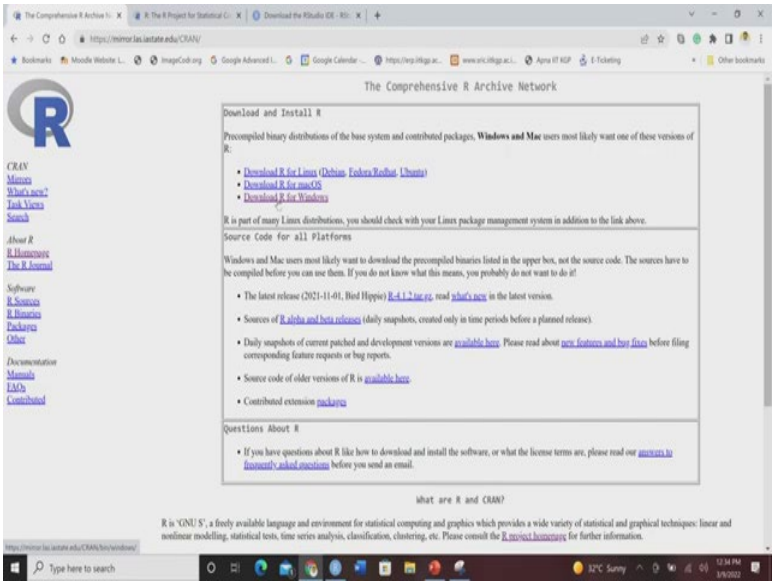

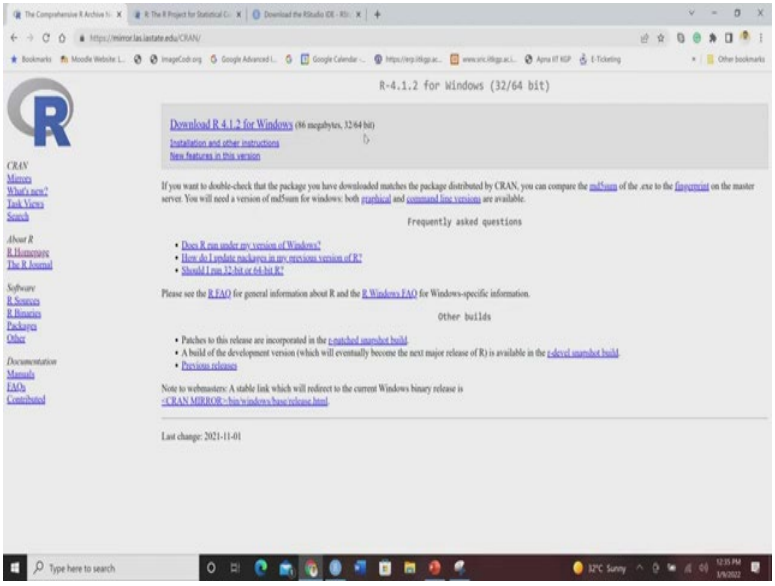

So, let me show you how to download R first, guys, so now I will show you how to download and install R. So, you go to Google and type R software and it will open this, it will show this the R project for statistical computing, you click on it and it will redirect you to download R. So, if you click on it this link of download R, it will redirect you to CRAN mirrors.

So, this CRAN mirrors are as I have told you this is a comprehensive R archive network, it is available at these following URL's. So, every country I mean most of the countries of the world they have their own URL's, unfortunately Indian link was not opening for last couple of days, so probably they have removed it, but hopefully it will be again revived in couple of days.

So, you can download this from any CRAN mirror, for example we can go to this Iowa State University and then we can click on this CRAN mirror link and it will redirect you to this

page, which will show you that you can download it for either Linux based on your operating system, you can download it from the Linux you can download it for a mac operating system or you can download it for windows.

So, here I will show you based on windows, so I will just if you, I will show you how to download it from there. So, click on it and it will redirect you to this page where you will see that this install R for the first time, so those who are installing it for the first time you can click on it install R for the first time so it will again redirect you into this page which is called I mean you can see here a link called download R 4.1.2 for the windows, which is having 86 megabytes and 32 or 64 bit.

So, if you click on it, the file will start downloading it will take some time depending on your speed, so I have already installed it, so I am not going to download it, but once you download this EXE file you can just follow the normal process of installing it and from there you will be able to install R. So, I am going to cancel it since I have already installed it, it is very simple guys, you just need to install it just like any other software. So, this is how you download R.

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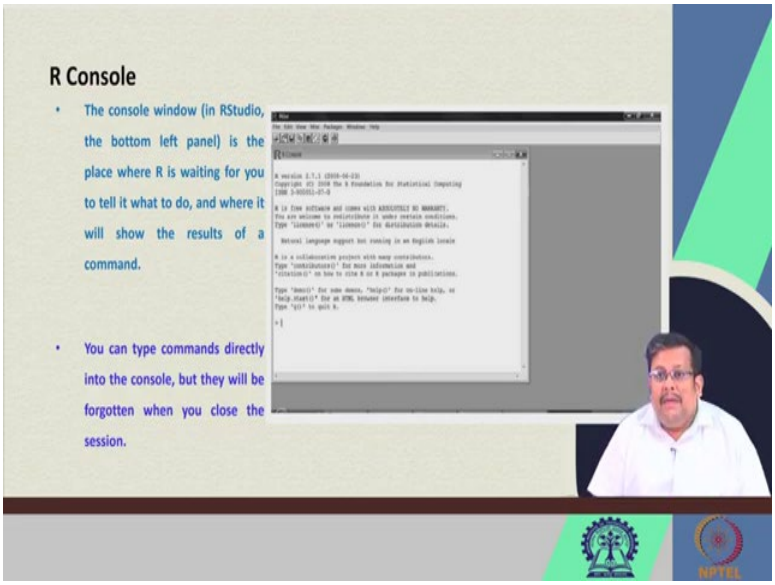

Now, if you go back to this R console, so this R console is the original R graphical user interface. So, here you basically type the functions you give the commands in R and it will you can directly give the comments in R and it will be generating the results here. So, this is called R console. However, this is not so much user friendly, so to make the R more user friendly people are people use different types of integrated development environment.

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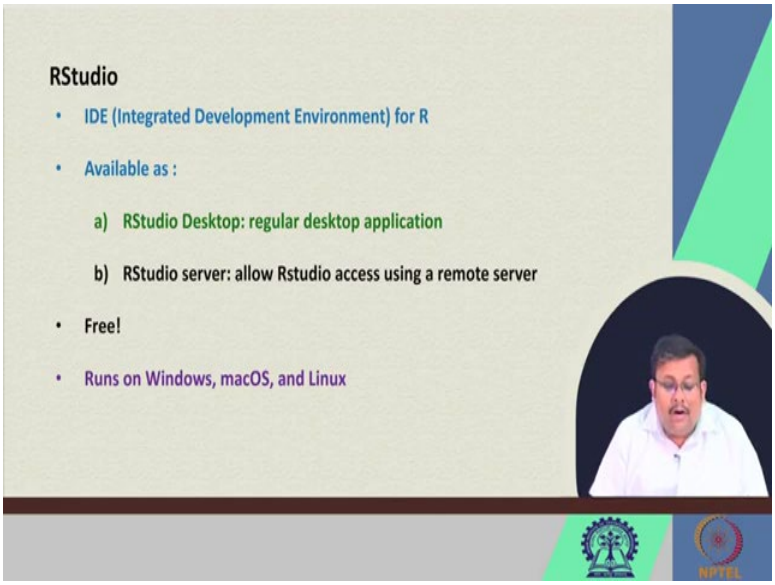

So, one of these IDE for R is R studio. So, there are other IDE's also but this is most popular that is R studio which is available in either R studio desktop, which is a regular desktop application or R studio server which allows the R studio access using a remote server. Again just like R, it is free however there are some premium versions which are available with which has some amount of cost, but generally it is free the R studio desktop, it can run on windows, mac and the Linux.

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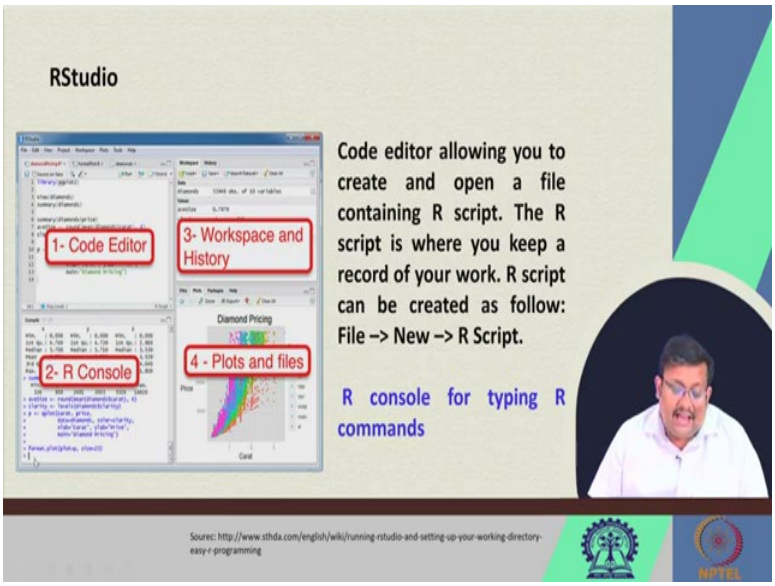

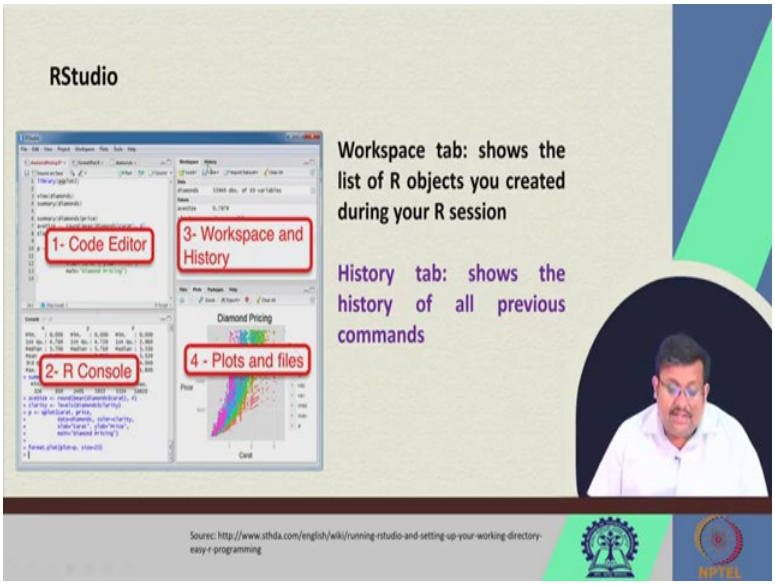

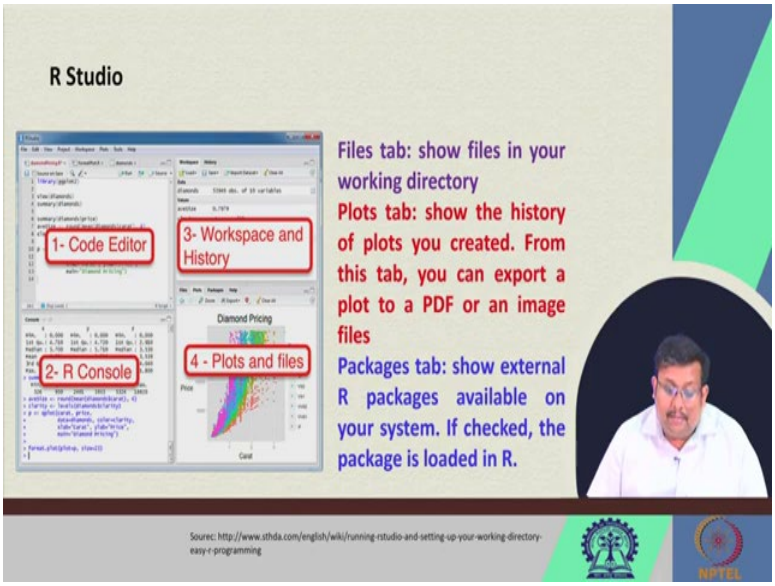

So, if you download, I will show you how to download this. So, if you download it you will get four different windows, one is code editor window or console window, this is a code editor window, second will be a console window, third will be workspace and history window and fourth will be plots and files window.

So, in the code editor, we generally write the codes, the codes will appear in the console, the results will appear in the console. In the workspace, you will see the files which you are, you are creating and in the plots and files window you will be generating the plots you can, you can export this plots into different formats like JPG, then PDF and so on.

So, this code editor, the window will allow you to create and open a file containing this R script, the R script is where you can keep the record of your work and R script can be created as follows, so you can click on this file tab it will open a new and then you go to R script.

And this R console will help you for typing the commands, so you can directly type the command here in the R console or you just play you just run the commands from the code editor window also.

So, this is the workspace tab, so this workspace tab shows the list of R objects you created during your R session and finally this is the history tab which shows the history of all the previous commands. So, here I am sorry, there will be history tabs here, so the history you can see all the history and these the plots and files window.

So, this plots tab you can see history of the plots we have created from this tab you can export the plot to a PDF or an image files and there will be a file tabs also, so from there also you can see the files in your working directory. And there will be packages tab also, which show external R packages available on your system, so you can download the package on download and install the package in R using this command, using this, using this package tab.

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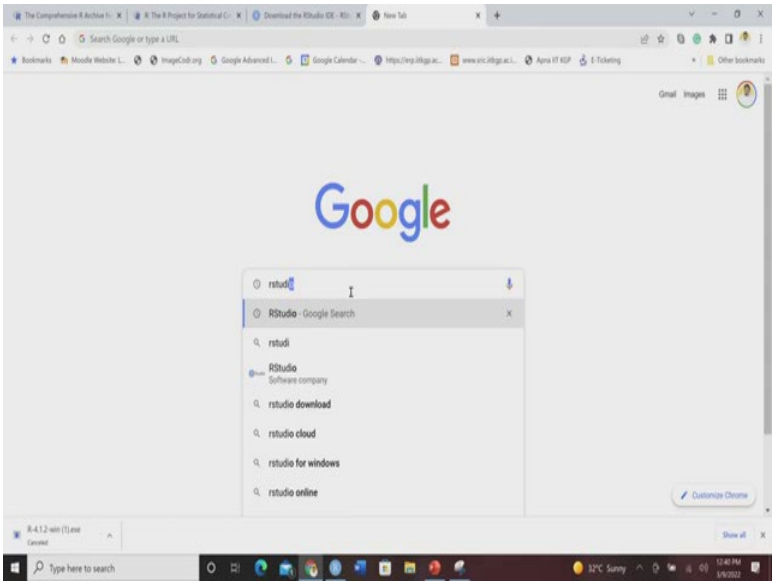

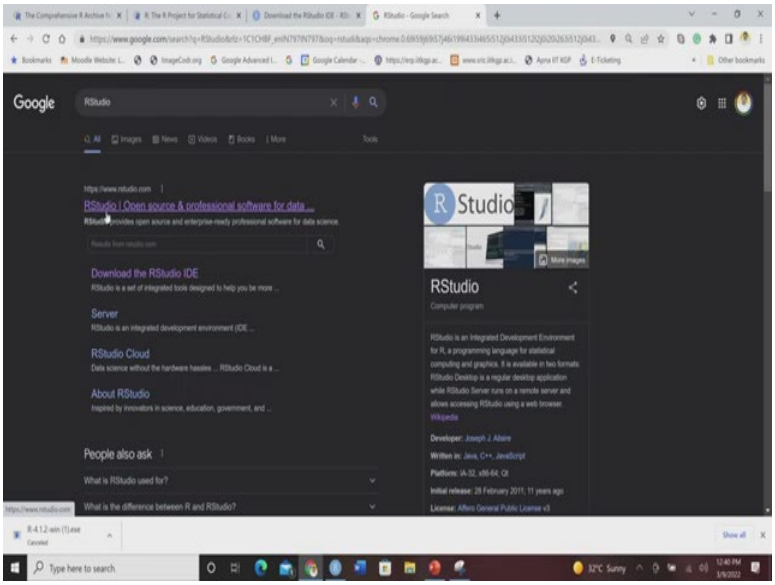
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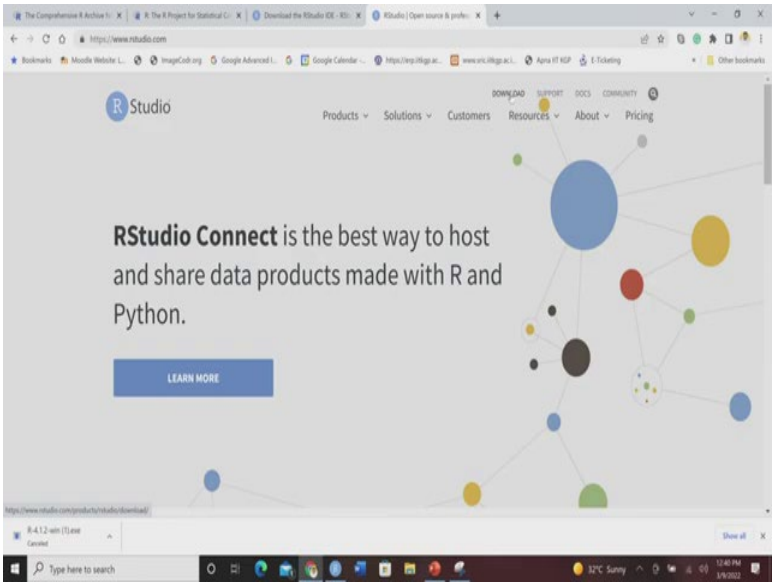
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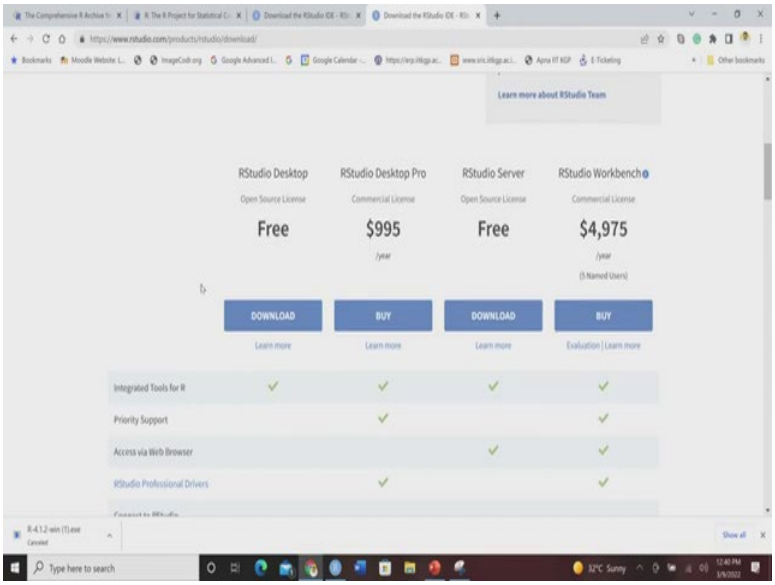
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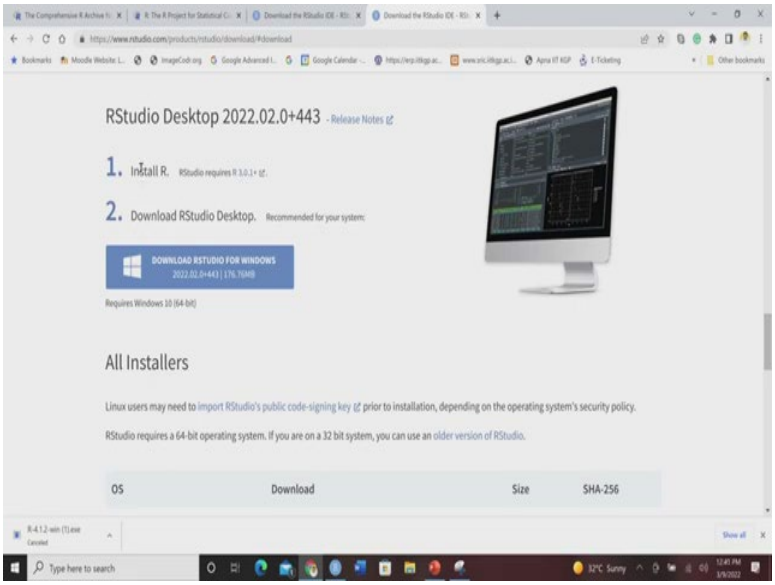

So, let me show you how to download and use this R studio. So, again just like R you just go to Google and type R studio, like right now I am typing R studio, so if you click on it you will see that R studio, so there are different versions of R studio, of course as I have told you go to download, you see that R studio desktop it is free, but there are some R studio desktop pro or studio server also this free anal studio workbench.

So, these are some commercial licenses, but you do not need that at this point of time, you just download it from here and remember one thing that before you download the R studio desktop you need to download and install R, this is mandatory. So, once you install R, then you download R studio for windows, you just click on it and it will start downloading so it is around 169 Mb. So, it will take some time just like R this installation is also very simple, so you can download it and you can install it just like R, okay guys.

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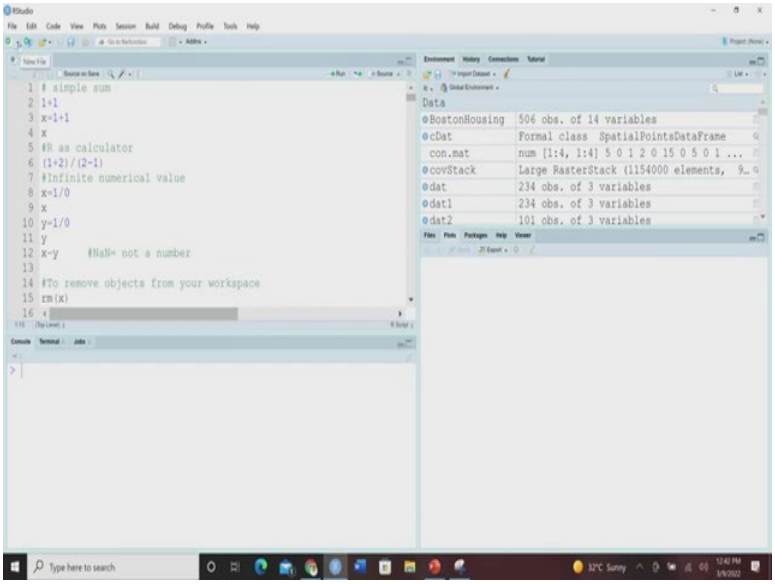
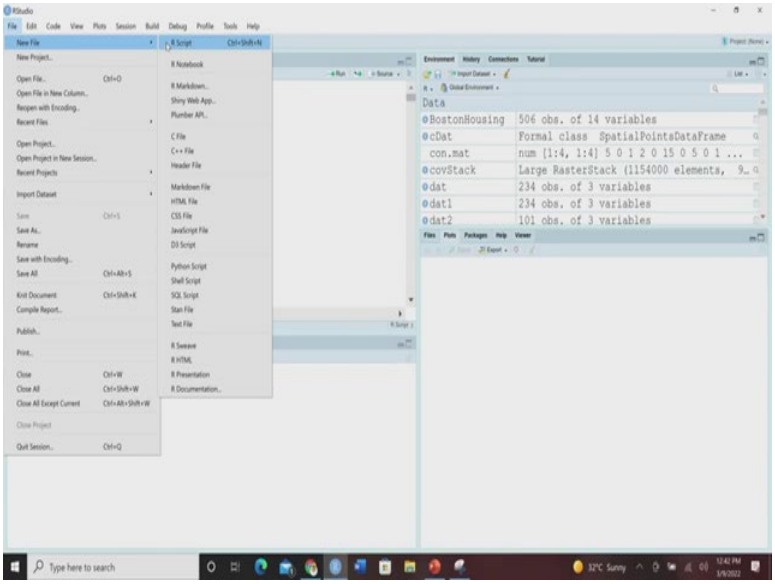
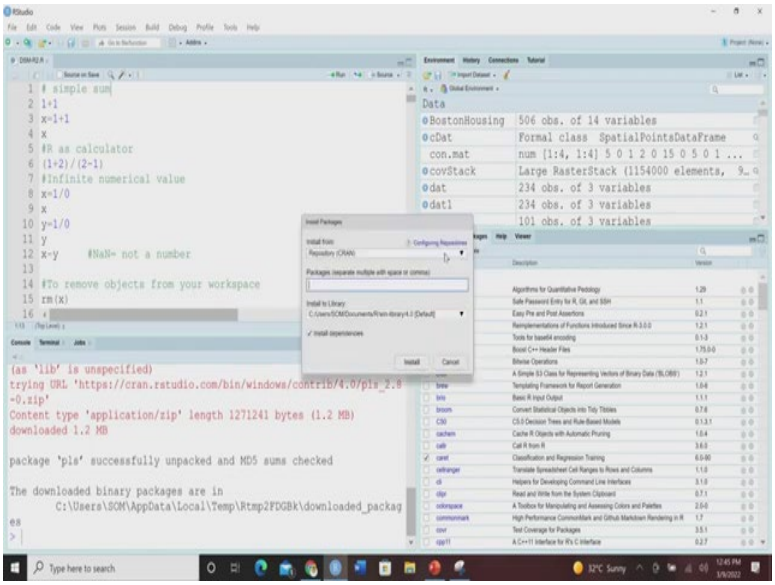
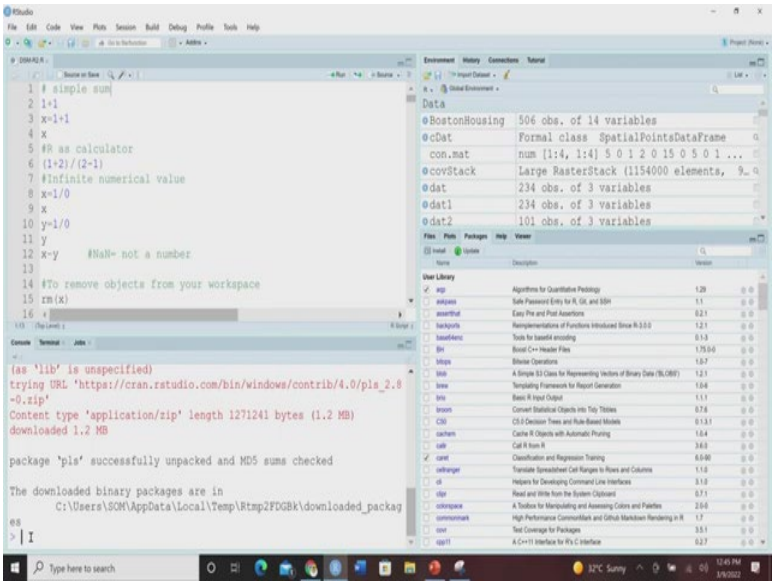








So, now we have downloaded and install R studio, now when you open the R studio, these are some of the codes which I have already prepared for you, but you can write your own script by click on this file and then you can click on this new file and you can create your own script also.

So, you can type it here also, but I am going to show you some of the already made scripts. So, we do not waste time, so let us just remove that, so this is the R studio and as you as we have discussed this is the editor window and this is the console window, this is the R environment tab and this is the files and plots window.

So, in this editor window, will we can type the codes and it will appear here in the console and then we can see, we will see some of the files which are we are going to create, these are some of the files which I have already created for my own work and for my other classes, so other courses and in the plot window we will be seeing different types of plots, which we can create by using R.

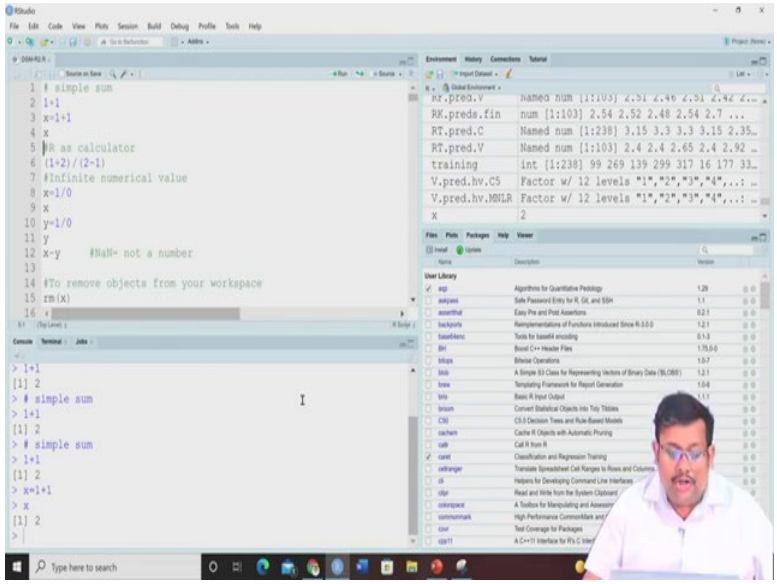
So, in R remember that some important aspects is you have to, if you want to annotate some lines you have to start it with this hash sign, so anything which starts with hash basically gives some annotation. So, suppose you want to use a command and you want to remember for what you have used that command you can give some explanation starting by this hash, starting by this hash.

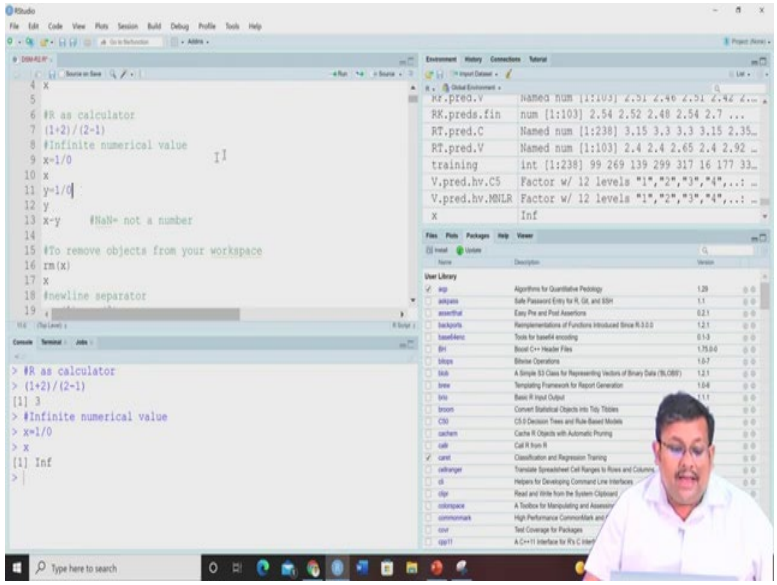
So, here I am going to show you some basic operation, but before that let me tell you one important thing also, here you can see the package tab, so in this when you click on this package tab you can see there a list of packages which are available, so you can get a package

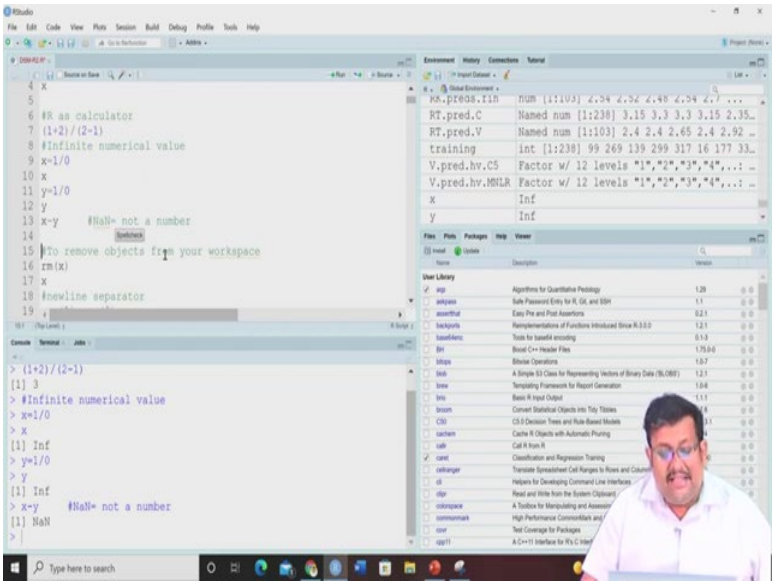
from here I am just caret package for example or suppose a aqp package for example, and then you can hit install and this package will be installed or you can directly type a package called pls package and in this pls package you can and then you can type install and it will be installing this whole pls package.

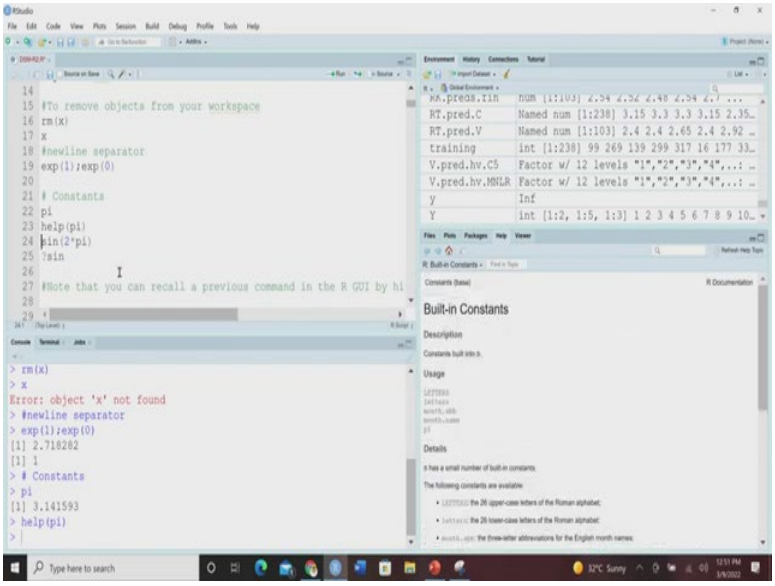
So, you can see that it is showing install packages pls, so it will take some time and when the package will be installed, then this package pls is successfully unpacked and MD5 sums checked, so that means this pls package has been installed. So, this by this way you can you can download any package and install any package which is not originally contained in R, so you have to basically go and you have to select that particular package and then you have to hit this install button.

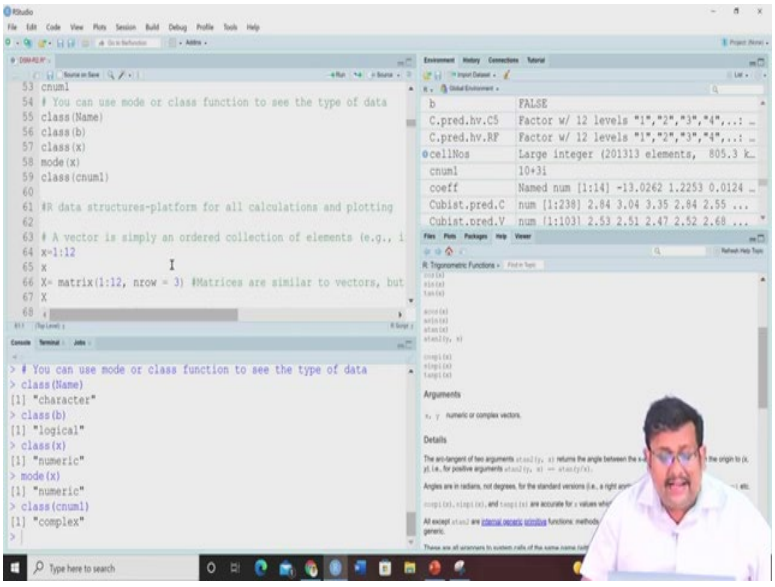
(Refer Slide Time: 19:51)






#R as calculator
(1+2)/(2-1)
#Infinite numerical value
x=1/0
x
y=1/0
y
x-y #NaN= not a number
#To remove objects from your workspace
rm(x)
x
#newline separator
> (1+2)/(2-1)
[1] 3
> #Infinite numerical value
> x=1/0
> x
[1] Inf
> y=1/0
> y
[1] Inf
> x-y #NaN= not a number
[1] NaN


#To remove objects from your workspace
rm(x)
x
#newline separator
exp(1);exp(0)
# Constants
pi
help(pi)
sin(2*pi)
?sin
#Note that you can recall a previous command in the R GUI by hi
> rm(x)
> x
Error: object 'x' not found
> #newline separator
> exp(1);exp(0)
[1] 2.718282
[1] 1
> # Constants
> pi
[1] 3.141593
> help(pi)
Built-in Constants
Description
Usage
Details


cnum1
# You can use mode or class function to see the type of data
class(Name)
class(b)
class(x)
mode(x)
class(cnum1)
#R data structures-platform for all calculations and plotting
# A vector is simply an ordered collection of elements (e.g., i
x=1:12
x
X= matrix(1:12, nrow = 3) #Matrices are similar to vectors, but
X
> # You can use mode or class function to see the type of data
> class(Name)
[1] "character"
> class(b)
[1] "logical"
> class(x)
[1] "numeric"
> mode(x)
[1] "numeric"
> class(cnum1)
[1] "complex"
Arguments
Details

Now, let me show you some of the important operations, very basic operations, we are going to start from the, for the beginners. So, let us do some simple sum so I have annotated it with this hash and we can do some 1 plus 1 and then we can we can directly click on this run button or by taking this cursor here.

So remember that when you want to run something you can either directly copy it or you can take this cursor just here you can either hit run or you can just click control enter together, they will have the same outcome. So, run or control and enter you can control plus enter together will give you the same output.

So, here you can see here we are putting 1 plus 1, so directly we can get the results in the console, so that is 2 and this first parenthesis I mean in the third bracket we are getting the line, so sometime you will see the output will come in multiple lines, so these starting parenthesis will show which line this we are seeing currently.

So, here let us assume that we are creating a variable x with 1 plus 1 and this 1 plus 1 you can see we are instructing R that you should understand that x is basically 1 plus 1, so we are running it and let us see what it if you click on it, if you just type x and click run, so you will see that the output will be given also here.

So, another important thing I forgot to mention that whenever you install any package you have to upload that package by using a command called library, I will show you. So, we have just for an example at this point of time, since we have already installed this R package called pls, let us just use this library pls also. So, I am typing this library pls, so actually (())(22:20).

So, now we have seen that how x can we can create a variable and assign some values, so now let us see how we can use this R as a calculator. So, you can see that 1 plus 2 by 2 minus 1, so if we type it so and run it you will see that the values will come and then infinite numerical values, so when x equal to 1 by 0, of course and you want to know what is the value of x it will show the Inf, Inf stands for infinity.

Similarly, y equal to 1 by 0 and then y equal to and y we want to see that is infinity and x and y both are infinity, so of course when you subtract them together will not will get a this NaN, which stands for not a number. So, suppose you want to remove any object which you have already created so this object which you have already created x equal to 1 plus 1.

So you want to remove this object from your workspace, so you see here whenever we created these two objects x and y, which is infinity, infinity, so we want to remove this x

which is infinity. So, we are going so these two have been already populated in this global environment tab. So, we want to remove these x now, so that has been removed now if we type just x, so you will see that error object x is not found.

So, we can see we can remove any object from our workspace, so that we can we can see the desired results. New line separator if you want to separate any lines, so we can use for example here exponential of 1 and exponential of 0, if you want to separate the output you can see here the separating the output and then you can see the constants, different types of constants.

So, here this is pi and you can see the value of 3.14 and if you want to know any help if you want to have any help of understanding pi, so you have to use this help function and just click on it and then it will open these built in constant. So, pi all the sign these are built in constants and functions, so if you just click help and it will open a sheet where you will have all the information's, which are required for understanding that particular function.

So, similarly if you want to have sin 2 multiply pi, so you will see that the values will be generated and if you want to know what is the sin, so of course all trigonometric functions will appear and their arguments will also be generated, remember you can, you can recall a previous command in R graphical user interface by hitting the up arrow on your keyboard, so if you can just go to this console and hit the up arrow you will see the previous command will be generated, all the previous command will be generated.

So, suppose you want to assign the same value to several symbolic variables you can use this x and y and z equal to 1 and you can then list them, those variables, so here you can see in the global environment x, y and z are being created. Now, remember one very important thing that R is very much case sensitive, so if you using R you must be very, very careful about the case R will not understand, if you change your case.

So, here you can see x is lower case, so 1 plus 1 and if you want to know, if you want to if you want to get the output of capital X, then it will create problems. So, capital X have been already created before in one of my, one of my previous application. So, let me remove this capital F.

Now, let us see this small x equal to 1 plus 1, we know it and let us now see capital X and you will see there is an error will appear in red text, so object x is not found. So, if this object

x was not created previously and only you have created an object small x, if you type it you will get this type of output that this is not. So, R will not understand if you change your case.

So, if a command is not completed in one line, then typical R prompt is so you can just go to the next line and R will basically assign will just automatically give this plus sign. So, here we are selecting the whole line and then running it and then will get the value of x here directly, so 2.

So, there are different types of data numerical data of course you can see here 10.2 it is a numerical data, then if you want to have the character data of course remember that it must be in the code. So, John Doe is a name and so you have to un you have to instruct R that John Doe is a character and so to instructor you have to put them within this in a in code and you can click on it and then you can see that the same thing will be reproduced.

So, logical data generally gives the output in true false and not applicable. So, if 4 is less than 2, if we want to if we want to make a query of course the output will be false and if we have if you want to give and we create an object b with that and we want to see the object output then also you will see the false.

Complex numbers a complex number we are suppose here one complex number we are creating by the name of C num1 and 10 plus 0 plus 3i and if we click on it will say and then let us see it is a we are running it, so this is a complex number and we can use the mode or class function also to see the type of data.

So, suppose we have created a object called name John Doe, so you want to see the class of that name, so we can see here it is a character and then if you want to see the class of b of course it is a logical, it is a logical and class of x it is a numeric and or mode of x also it will be numeric, so and then class of this C num1, which is a complex number, so you can see it is a complex number. So, all these type of different types of output you can get from R.

So, let us wrap up our discussion here, in our next lecture, we will be starting from here and I will show you how to use the data frame using R, how to handle the different vectors in R and what are the preparatory stages of of R for how to how to prepare the data before going for the standard DSM application.

Remember one thing guys that, once you download any package you have to upload, you have to you have to, you have to use the library command, I will show you in our in our next lecture. So, once you install any package you have to call that library, before you want to

perform that particular operation without calling the library it is not possible to execute that particular operation in R.

So, guys let us wrap up our lecture here and I hope that you have gathered some useful knowledge and thank you for your attention and let us meet in our next lecture to discuss more about R, I will show you how to use R for DSM in upcoming lectures in more details. Thank you.