Business Analytics & Data Mining Modeling Using R

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Lecture - 03
Introduction to R

Welcome to the supplementary lecture number 1 of the course business analytics and data mining modeling using R. So, this particular lecture is about introduction to R.

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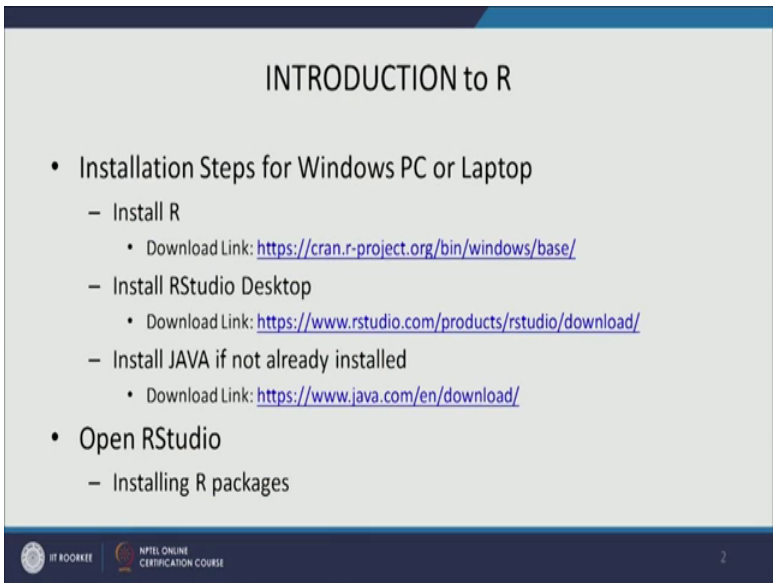

So, we are going to cover basic introductions; we are going to cover basics of R. So, before we start let us understand the installation steps, this is a specifically for windows pc or laptops that is the expectation that many of the students they would be having windows pc or laptop and these instructions are for the same.

So, first you need to install R, so the a link is given here and depending on the your operating system whether it is 32 bit or 64 bit you can download the appropriate file; installation file and the after once you are done with installing R, then you can go ahead and install this R studio desktop version, this is the GUI for R. So, the link is, download link is already given here, again depending on settings all configuration of your desktop or laptop, you can download the

appropriate installation file 32 bit or 64 bit and then go ahead with your installation.

Now, because R studio is actually based on java, so therefore, if your pc or laptop does not already have java, then you can install the java has there before proceeding further. So, the link for java is already been given, so you can download and install it as well. Now, before we can start our data mining modeling in R, we need to have certain R packages installed, so that they could be used many of the functions and libraries could be loaded and the function are available for us to use for modeling. So, therefore, installing R packages is the next step, so what will do?

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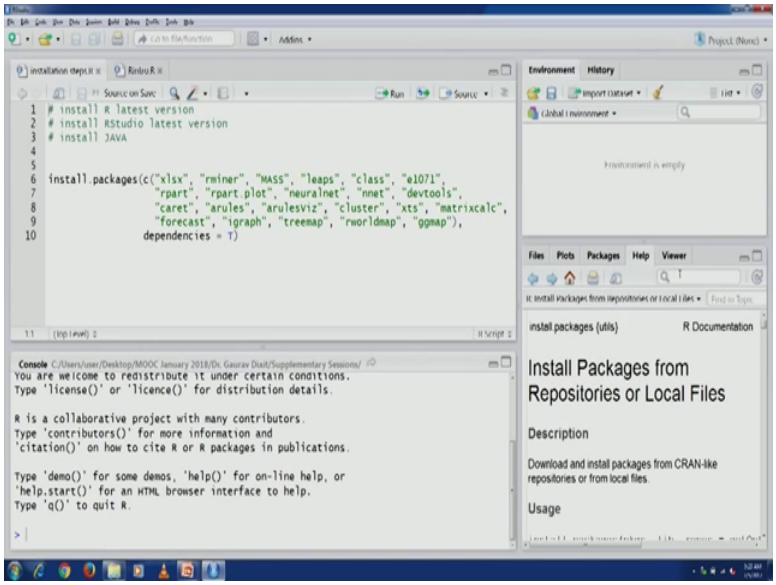

So, these are some of the packages that I have mentioned in this so installed R packages is 1 particular function that is used for installing R packages in your system. So, some of the packages that we are going to use in this particular course I have mentioned then here. So, you can see installed R packages and c is the combined function, which can combined all the strings or names of the packages and in 1 go all these packages would be installed, you would also see I have assigned dependencies the another argument as true.

So, if there are any dependencies for these packages, they would also be installed. So, once you are done with your installation of R and R studio and

java as well then you can go ahead and use this particular function, this particular code to install these packages.

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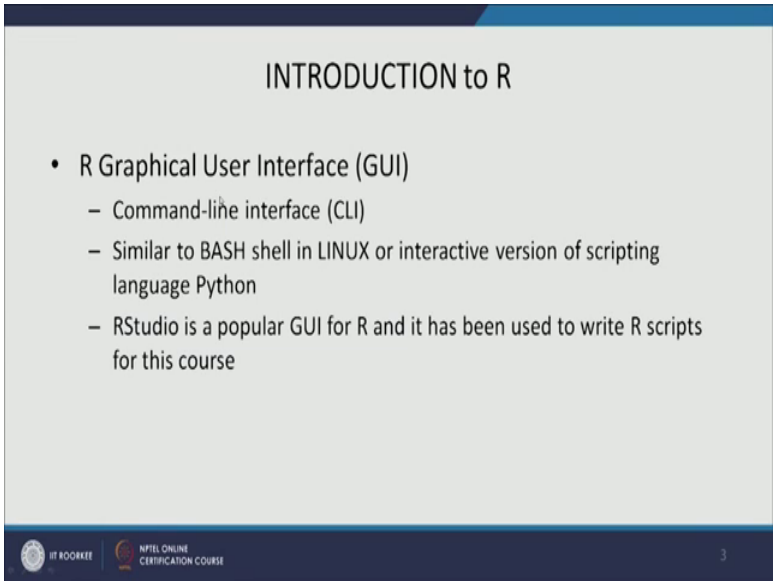

Now, let us understand about R's GUI. So, R's geographical user interface, it is mainly command line interface, it is quite similar to the bash shell that we have in Linux or interactive version of this is scripting language python. So, many people use python as well for data mining modeling and a statistical modeling. So, the interactive version of that particular language is also quite similar, is also based on command line interface. Now, R studio is one of the popular GUI for R and it has been used for this particular course, most of the R scripts have been written in this using this particular GUI R studio.

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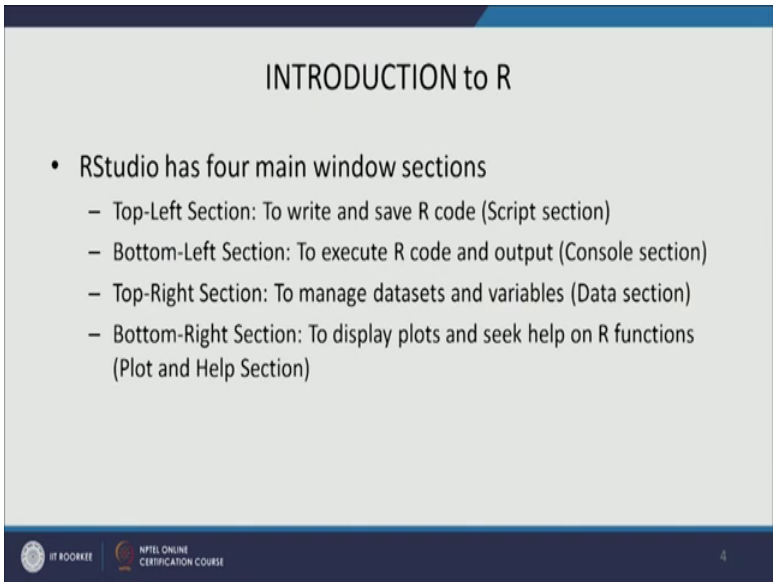

Now, as we have seen before R studio has a 4 main window sections we can see it again. This particular section is the top left section and generally we write and save our R code here in this particular section, you can see the instruction for installing packages is written in this section and has been saved as a file called installation steps dot R. So, most of the R scripts would have this extension name R dot R, so this particular file is saved as installation steps dot R.

Now, bottom left section that is for actually education of R code and to display output; to generate output is also called a console sections. So, this can be called a script section and this is called console sections here we actually see installation of execution of the R code and the related output.

Then, 3rd window section is top right section which is actually can be called data section or environment section, in this particular section we manage our data sets and variables. As we will see later in this particular lecture that many variables that we initialize are assign some values to those variables or data sets they would be a visual here, once they are loaded into R studio or R environment.

Now, the 4th window section is bottom right section, where we actually display plots and seek help for R functions, it can be called plot and help section. So, in this, particular plots right now the plot sub section is active and therefore, any

plots that we generate would be displayed here. Now, you also have help section, so if you are looking for a you know some help, related to some particular function in R you can type that particular name of the that particular function and the help is would actually be displayed there. So, you would see if we type help here, then in the documentation how the help function can actually be used and the details related to arguments and further details, examples, everything else and notes, references, examples, everything you can see over there.

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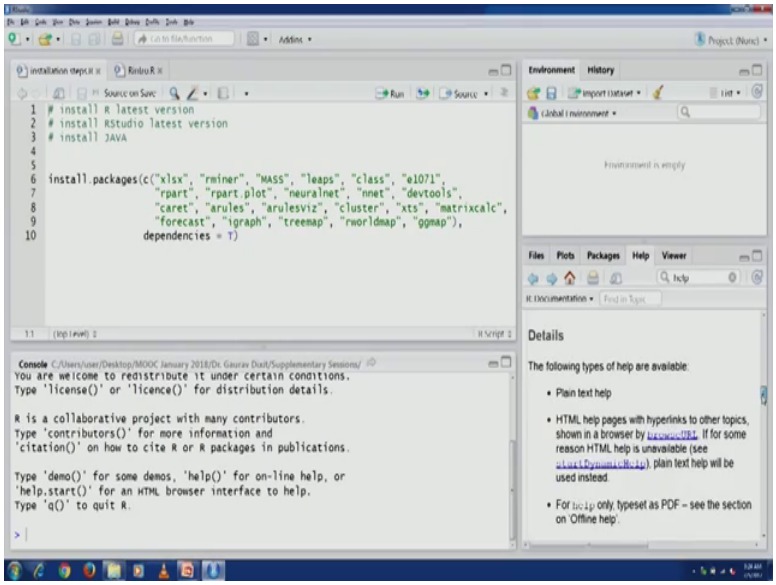

So, whenever you face some difficulty in understanding how a particular function in R is supposed to be used, then you can always look for some help in this particular section.

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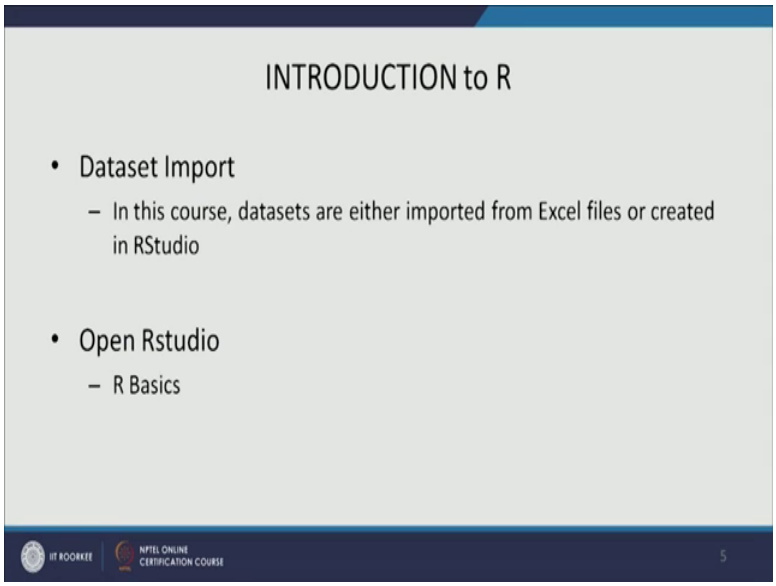

Now, data set import, this is in so far our course for this course data sets are mainly available in excel files. So, we would be importing data set from excel files or we would be creating in our studio itself. So, any hypothetical data set we would be immediately creating in R studio. So, let us with this information let us start our R basics or open R studio.

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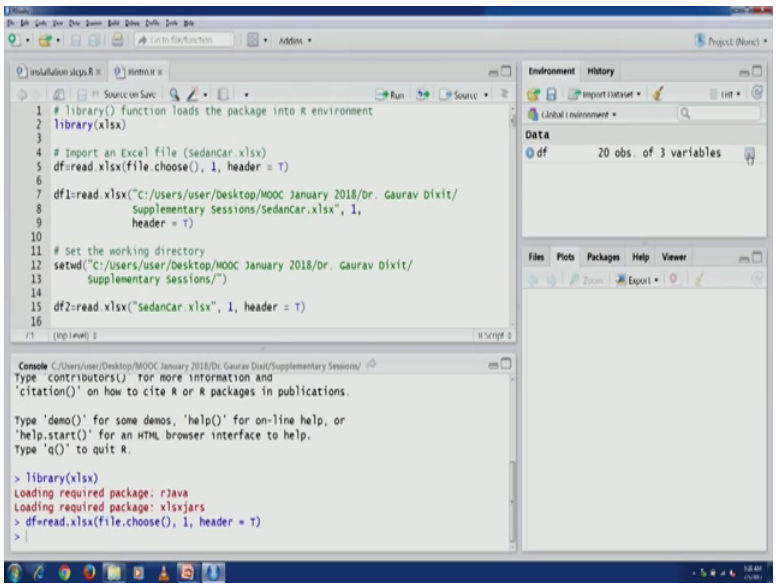

One of the important function that we require before we start is, understanding different packages and load them into the R environment for example, because

as we discussed the data sets would generally be imported from excel files, in this course see I have first line of this particular R script is about this library x less x, so this is the package which can actually be used to import data set from a excel file.

You would see, here in the console section that this particular package has been loaded and the required package is also I have also been loaded. Now, if we are looking to you would like to import an excel file a data set. So, for example, the previous data set that we have used in the lecture 1 sedan car data set that we can actually import. You would see in this particular environment section or data section you would see a particular file has been imported.

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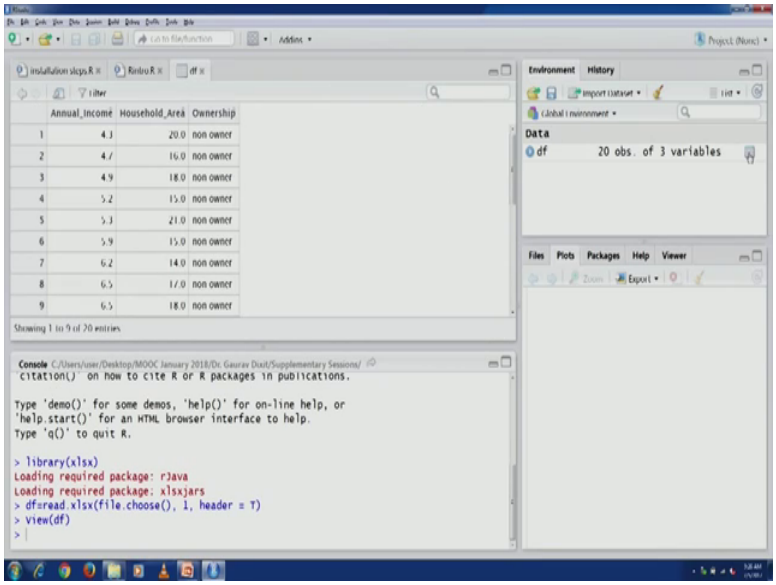

If you click on this particular link, a new window in the script section would be open; file section would be open and you can see the data set there. So, we have 3 variables in this particular data set annual income, household area and ownership and if you scroll down the data set then you can see 20 observation, the same is displayed in the data section as well, we have 20 observation and 3 variables.

Now, this is a 1 way of importing data from an excel file, in this case I have used this particular function filed or choose and this can actually allow this can actually allow us to browse for our file in our windows directories. Another way

to import an excel file into R environment could be using this function read dot xlsx and then giving the whole full complete path to the particular file.

One important difference that we can note here is, in R views forward slash for mentioning the complete path instead of the backward slash as is used in windows systems. So, do not forget to change from back slash to forward slash. Now, another way to import the data set is you can set your working directory, so this is the command. First let us see, how the, a data set can be imported using the full path name.

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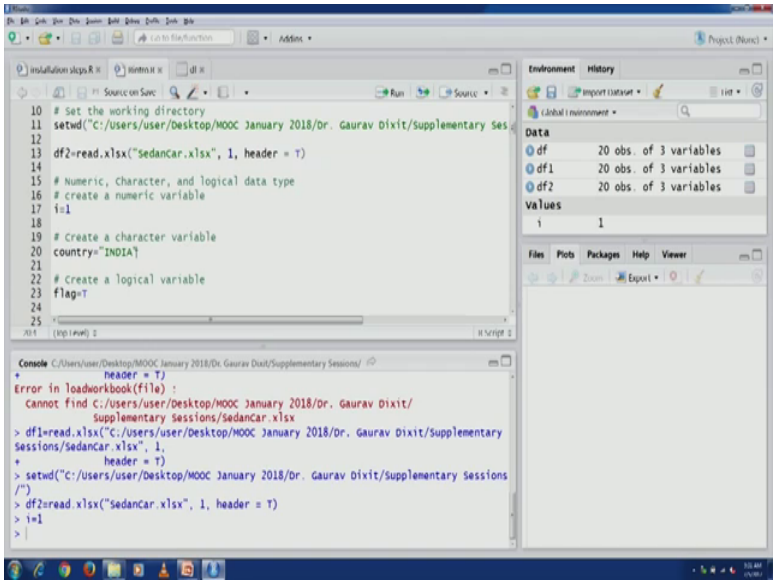

So, let us see how the excel file data set from excel file can be imported using the full pops name of the file. So, you can see the same data it is actually the same data set, but second import you can see here df 1, 20 observation and 3 variables.

Another way of importing data set could be you can set your working directory using this command set wd and then, again you can give the full path name of your working directory, just sued this particular command and then, now because the your working directory has been changed where your excel file is located, then you can simply put simply write the name of this particular excel file and again import the data set, that says you this code and again you would see another file has been imported it is again same data set, so you can see.

3rd instance of the same data set being imported same 20 observation and 3 variables. Now, once you have imported your data set, you can use the data set to the start your modeling to execute different steps related to the particular modeling. So, for example, because this is an introduction to R, we are covering R's basics. So, therefore, we will try to understand some of the basic building block structures that are used in R.

So, first let us to understand the numeric character and logical data type, how are they are used in R? How we can create them and then access them? So, how a numerical variable is created in R? You just need to type this i, i could be numerical available for your code and then you can assign the value and execute.

So, you would see in the data section and i variable has been created and it contains it has this value 1. We want to create a character variable, again you can type the name of your variable for example, in this case we have country and you can assign the value, in this case we have initialized this particular variable with this India as our country.

So, again a dude in this code you would see in the data section country has been created and it has value India, similarly a logical variable can be created. So, for example, in this case we have this logical variable named as flag and the value is given as true, it could be true or false these are the 2 options for logical variables. So, once we achieve this code, you would again see that flag is created in this data section and the value is true.

Now, how do we find out whether the characteristics of these variables? So, these 2 functions could be useful class, the class function can be used to find the abstract class of any particular variable and the type of function can be used to find out a storage type of any particular variable for example, the variable i that we have just created, we can find out the abstract class of this particular variable which is numeric and then type of, of this particular variable which is double.

So, this particular variable is a numeric and it is being stored as a double in the memory, similarly we can check for country. So, you can see country is character the class of this variable country is character and a storage type is character as well. So, similarly we can check for flag.

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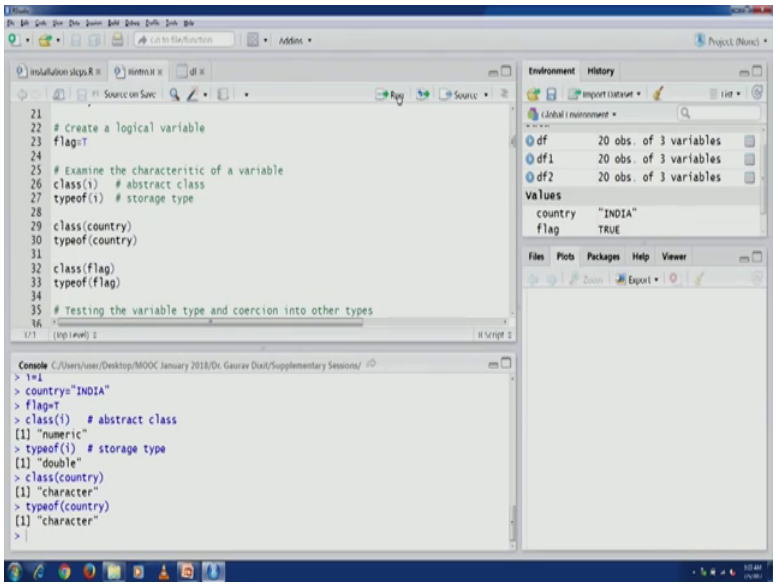

So, class of this variable flag logical variable flag is again logical and this storage type is logical. Now, whether a particular variable is an integer or some other variable type; some other data type that also can be checked into that also can be examined in R and coercion from 1 variable type to another variable type can also be done.

For example, if you want to find out whether the variable we have, the whether the variable i is an integer or not. So, we can use this function s dot integer. So, this code if we exude this particular code we will get an answer as false because the i was created as a numeric variable and not as an integer variable.

So, therefore, that can be checked using the function s dot integer. Now, it is possible for us to quotes this particular variable; numeric variable into an integer variable, how that can be done? Let us create another variable j and we assign the value 1.5 to this particular variable you would see that in the data section j is created j can be seen here with value 1.5. Now, let us check whether this particular variable is integer or not because we have created it as a numeric variable it should come as false, so which is the case here.

Now, let us quotes this variable into an integer data type. So, that can be done using is dot integer command, is dot integer function. So, is dot integer function

we can pass on the same variable as argument and we can again store it store the return value in j itself and then we can display the value of j.

Let us execute this line, you will see 1. So, 1.5, value of 1.5 which was stored as j which was created as a numeric variable, has now been changed to 1 because the variable has been coerced into integer data type from numeric data type; now, if we again do a check whether this particular variable j is integer, now we will get an answer as true.

Now, another important function is length. So, length function can actually help us find about the length of a particular variable. So, for example, length of i is 1 length of country and flag these 3 variables length of all these variables run. Now, next to discussion point is about vectors.

So, vectors are 1 of the basic building blocks for data in R, simple R variables that for example, I can be flag if we just created they are actually vectors, now vectors can take values from the same class. So, let us check whether the vector, whether the variables that we just created i country and flag, whether they are vector or not. So, again we can use the function like s dot vector, which is going to tell us whether these 3 variable belong R vector or not.

So, you would see all these, all 3 variables R vector. Now, creation and manipulation of vectors; this, so there is this function combined, which is combined function c or column operator would also be is used. So, c function and column operator can actually be used to create and manipulate vectors. For example, if we want to create a vector of character vector of these 3 values. Three values cricket, badminton and football.

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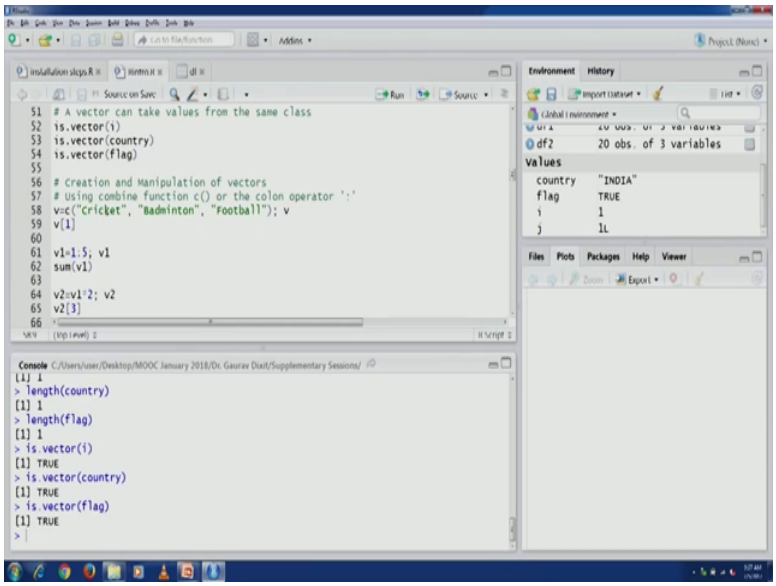

So, this vector v can be created we can use the c function and we can pass on these 3 strings as arguments, greater strings as argument, we will have this vector created as v vector has been created and it has 3 values cricket badminton and football. Now, we want to access individual values then we can do so using the brackets. So, v1, v2, v3 will can be used to access first value and second value and third value respectively.

You can see v1 cricket is v value in the output. Now, column operator can also be used to create a vector for example, v1 1 to 5 so, this particular vector is going to be created with having values 1, 2, 3, 4 and 5, as you can see here. So, in column operator you mentioned the starting and ending values and the middle values are actually filled up by the column operator.

We can sum these values using the sum function, you can see some v1 and we get this particular output 15, similarly multiplication with a constant can be done, we want to access a particular value in this vector and that can also be done using brackets. So, we do 3, so we wanted to access the 3rd value. So, that we can do using v2 3 in brackets and we can see output as 6.

If we want to add 2 vectors that can also be done v1 and v2, but here it is important that both should be having the same number of values, similarly if we want to find out the values in a particular vector which are greater than 8 for

example, in this case there are many values which are greater than 8. So, we want to just find out those values.

So, we can execute this particular line v3 greater than i 8 and we will see the answer is false for first 2 values because they are less than 8 and the true for rest of the 3 values which are actually greater than 8. Similarly, if we want to access the values which are greater than 8 we can do in this form also v3 and within brackets we can again use v3 greater than 8.

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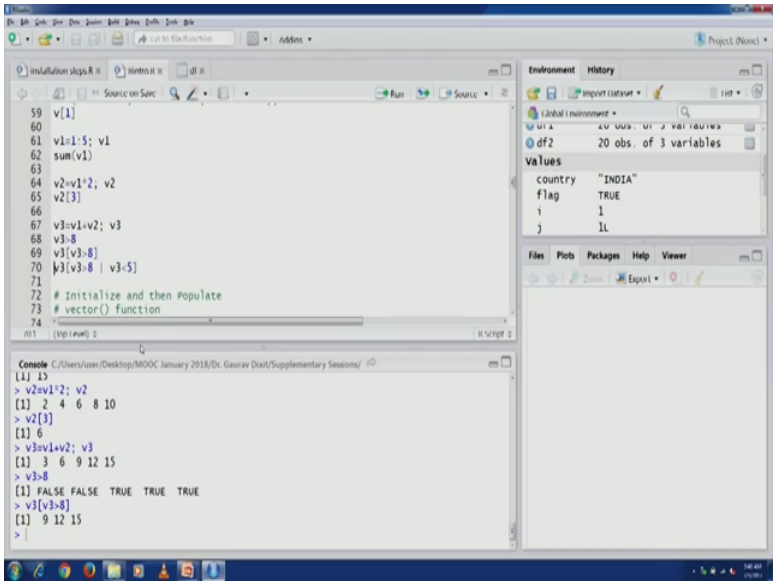

So, it will return the index for all the values which are greater than 8 and then those values would actually be accessed using the brackets. Similarly, if we want to access values which are greater than 8, but less than 5 again a similar thing can be done, you can see the value is 3, 9, 12 and 15 there which are less than 5 or greater than 8.

Now, sometimes we might be required to initialize a vector and then populate it, till now what we have been doing is at the same line at the same instant we were creating variables and vectors and immediately we were initializing them as well, we were populating them as well. So, sometimes we might want to do this process in 2 steps first initialize and then populate.

So, for that we can use a vector function, so vector function can actually be used to initialize vector, by a number in this case a vector function is being used to create a vector of length 4. Now, if you want to, so by default if you use the vector function by default a logical variable, the logical vector is created, if you want to a create a numeric vector then we can do so, we have to mention the mode of mode as numeric in the vector function and that can be done.

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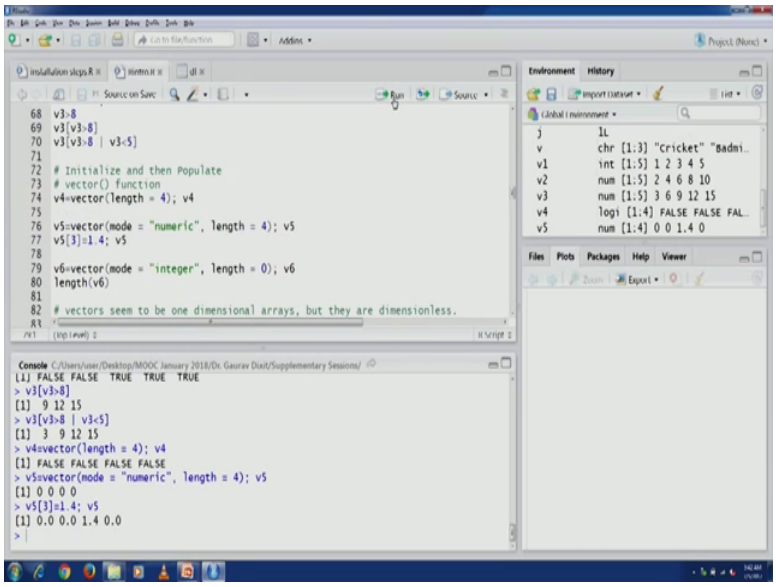

If you want to reassigns 1 of the values for example, 3rd the value, that can also be done you can see 1.4 they are just which varies assigned. Similarly, if we want to create an integer vector that can also be done, we have to mention and the mode argument it as mode argument has to be assigned as a integer, you can see the this particular vector v6 we had created with length 0. So, we will check for it is length again you get you get the right answer as 0, here length function can actually be used.

Now, whatever we have done so far it might look like that vectors are 1 dimensional arrays, right till now whatever examples that we have 1 through they give this impression, but if you really look in R whether they are 1 dimensional arrays or not, but in R they are they are actually defined as dimensionless, that can be checked using these 2 function if we check for the length of this particular vector v5 we will get answer as 4, but if we check for

the dimension using the dim function dim function we would find as null, so which is undefined.

So, vectors are not actually 1 dimensional edits they are actually dimensionless. That brings us to the next discussion point that is arrays and matrices. So, R also has these building blocks arrays and matrices. Now, we have array function which can actually be used to restructure a vector into an array, so how that can be done we can see this through this example.

Now, array function the initialization 0 is given and we are creating an array of these dimensions 4 states, 4 quarters and 3 years. So, this particular array would be created with these dimensions; with these 3 dimensions I am having. So, this we can see here, now we I assigned one of the value as 1000. So, that can also we can check here.

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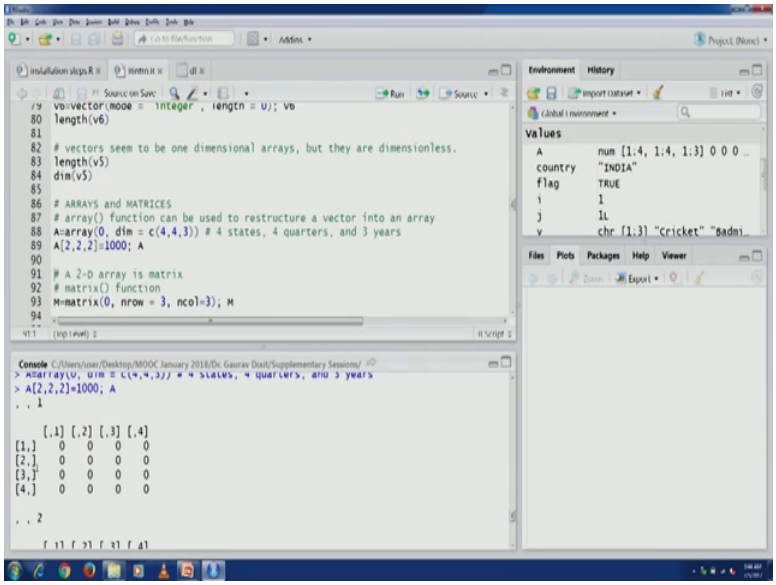

You would see 3 dimensional array; so this is our 1st year, this particular matrix looking structure in this array is for the first year, then this is for the second year, then for third year. So, we had created this array for 3 years, so we can see 3 matrix structures back to back matrix lecture have been created. Now, that brings us to the matrix so a 2 D array is a matrix. So, array can be thought of as a series of matrix and a 2 D array being a matrix. So, we can use matrix function to initialize an array, you can see the matrix initialization with the value of 0 for all

the elements and you can define a number of row as 3 and number of column as 3 in this case so and row and column argument can be used to define.

Now, with a different initialization we can create this per gram matrix M1 you can see here, now a matrix multiplication can be used using this operator percentage as trick and then followed by percentage this. So, this particular operator can be used for matrix multiplication in R. So, this is the result of matrix multiplication M1 multiplied by with M1 itself.

If we want to find out the inverse matrix though so we have the matrix do not inverse function for that, but to be able to access this function, to be able to use this function we first need to load this particular library matrix calc, so we will just do that. So, we can just load this particular library matrix calc, once it is loaded then we can access this function matrix or inverse and for any matrix we will get the inverse of it.

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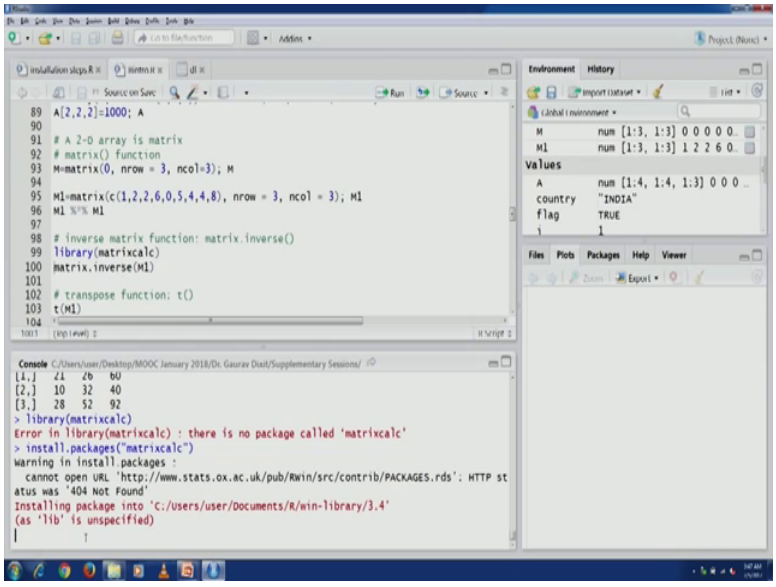

You can see the inverse matrix here, if we want to transpose a matrix then there is this function t transpose function that can actually be used to get a transpose of a matrix. Now, the next discussion point is about data frames, now data frames provide a structure for storing a variables of different data types. So, till now we whatever we discuss vectors, arrays and matrices we were using the

same data type for a storing values of same data type. Data frames can be used for storing variables of different data types.

Now, they provide flexibility to handle many data types preferred input, now they have also because of that they have also become the preferred input format for modeling in R, they can also be understood as a list of variables of the same length for example, the data set that we earlier imported is this (Refer Time: 30:59) data set we can see 3 variables of same length annual income, household area and ownership and you can see 2 of the variables annual income and variable household area are of the same type, they are numeric, but the ownership is different.

So, we can check whether a particular variable is data frame or not, using this program; using this particular function is dot data dot flame. So, we will just check this for df which is true because the in the start of this particular script the files that we imported they were actually in the data frame; they were actually stored as data frame. Now, another important aspect related to data frame is the dollar notation. So, using dollar notation you can access any of the variables which are there in stored in a data frame for example, annual income. We can access using this particular line df dollar annual income, see you will get the values that are stored in this particular variable.

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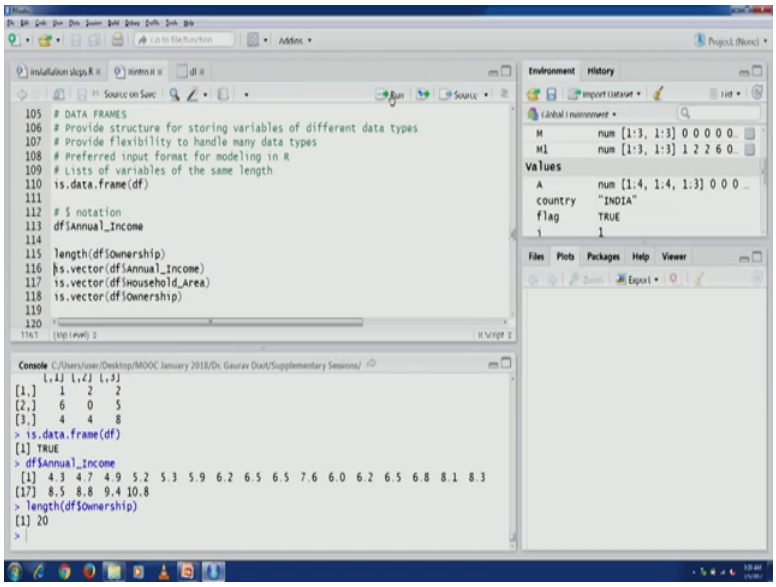

We can also check the length of individual variables in stored in a data frame using the same notation and passing it as argument to the a length function, you can see a still the answer is 20. Similarly, we can also check, so all these variables as we discussed before the variables are actually a vectors in R. So, we can check for the same is dot vector for annual van income and household area and ownership and we will see all these variables are actually vectors.

So, data frames can also be considered as having vectors of same length. Now, if we look at 1 particular variable ownership it is actually a categorical variable which is actually called a factor in R. So, if we want to check whether this particular variable is a factor or categorical variable we can do so by using this particular function is dot factor. So, you will see the answer true.

So, ownership is actually stored as a; this is actually a categorical variable and it is stored as a factor in R. Now, another function is str, this function is to display the structure of a data frame or a list will later see the data frames are also a form of list. So, let us exude this line you see that in the data frame you have 20 observation 3 variables and you get some details about the variables or vectors that are there, annual income numeric, num household area and numeric and owners if you would see factor with 2 levels non owner and owner.

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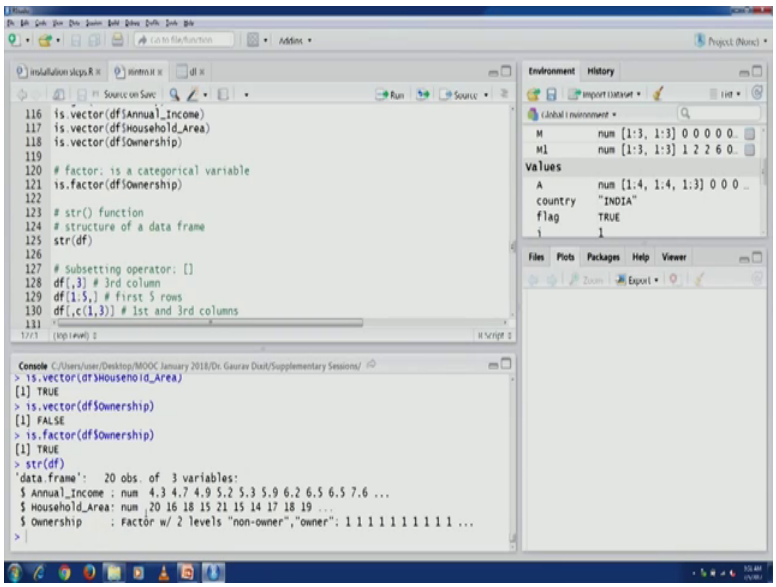

So, this kind of a structure of these variables can actually be displayed using str and the structure command. Now, next important operator is sub setting operator, so actually the brackets can also be used to subset a data frame for example, if you want to access just the 3rd column of a data frame, so instead of using the dollar notation we can actually use this particular subset operator that is actually brackets. So, first 1 is for rows and the second is for columns. So, as I have mentioned 3 year, so we will be accessing 3rd column.

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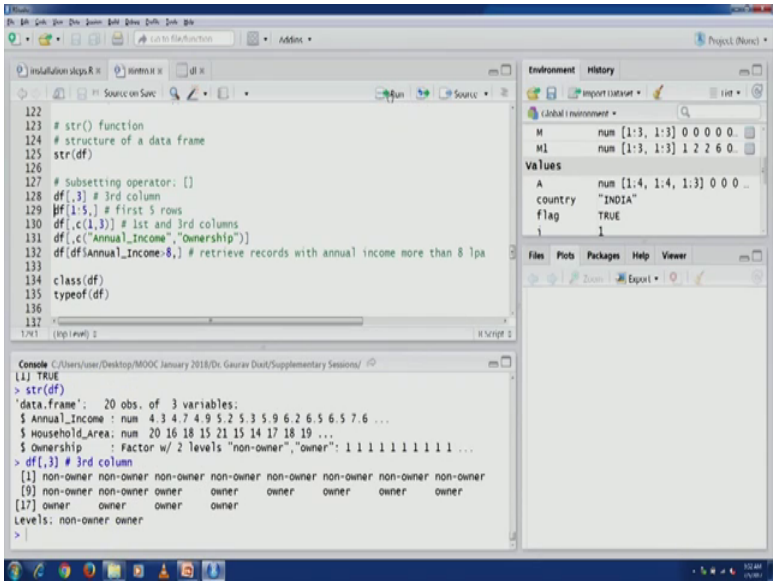

You can see 3rd column the ownership related values are there. Now, if you want to access this first 5 rows, you can mention that the same here 1 to 5 using the column operator and for the column the space that nothing is mentioned there, so all the columns would be displayed, would see. Another, if you want to access 2 columns in 1 go we can do so by using combined function in the brackets, if you want to; if we do not remember the index whether it was a first column or third column we can actually use the combined function mention and mention the actual name of those variables or vectors and then again we can access the same data you can see here same data has been accessed.

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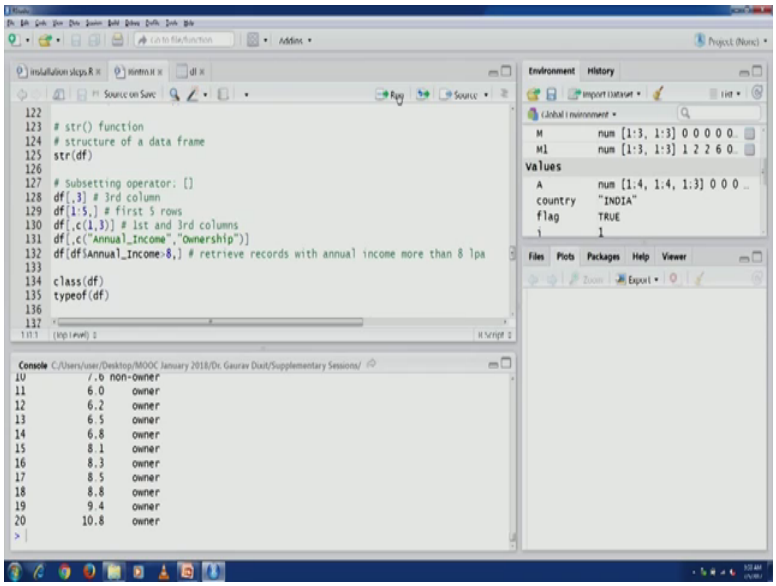

Now, if you want to create; if you want to display some you know the t few recalls using these greater than using these operators for example, annual income having greater than 8 lpa, so that can be retrieved using this particular command. So, all the rows where the annual income is greater than 8 all such columns would be displayed, you can see here all the values are greater than 8, 8.1, 8.2 up to 10.8.

Now, we want to check for the class of df or type of df, that can also be done. You can see class of df is mention as data frame and type is a list. So, data frames are basically a list, a R actually list. So, what are lists? So, list are a collection of objects of various types including other lists. So, list function can be used to again create and a great list, double bracket notation also will come across the double bracket notation, we will see what is that.

So, a list can be generated for example, this lists. So, different objects can actually be used as obviously, we have created these objects. So, i, j, v, m and this is another addition that we are using for this list initialization and creation. So, this using a list function we can create lists. So, you can see here, list has been created. So, list can store objects of various type and they can be of different length.

So, 1 big difference is the objects in list they can be of different types various types and they can be of different length as well, while in data frame the variables I tribes could be different, but they have to be of same length. For example, you would not see angle the see double bracket notation and see first you know a list element is this Roorkee which being slide and second list element was actually i and values 1 the 3rd list element was actually j value was again 1 and the 4th element which actually this particular character vector cricket, badminton and football and then 5th element is actually this matrix.

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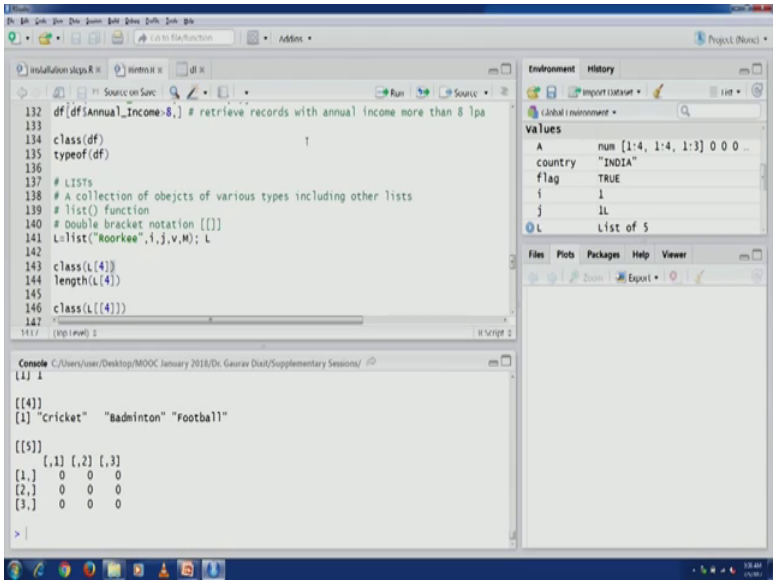

So, if we check for class and length of a particular element of a list we will see this we will get this. So, we want to actually check for a particular vector, then we will have to use double brackets now you would see that l and for within double brackets you will see a character vector, which was actually just we saw and the output this one. So, this is the character vector and length of that character vector is also displayed as 3. So, a structure command can also be used with lists as well as data frame, which are also lists.

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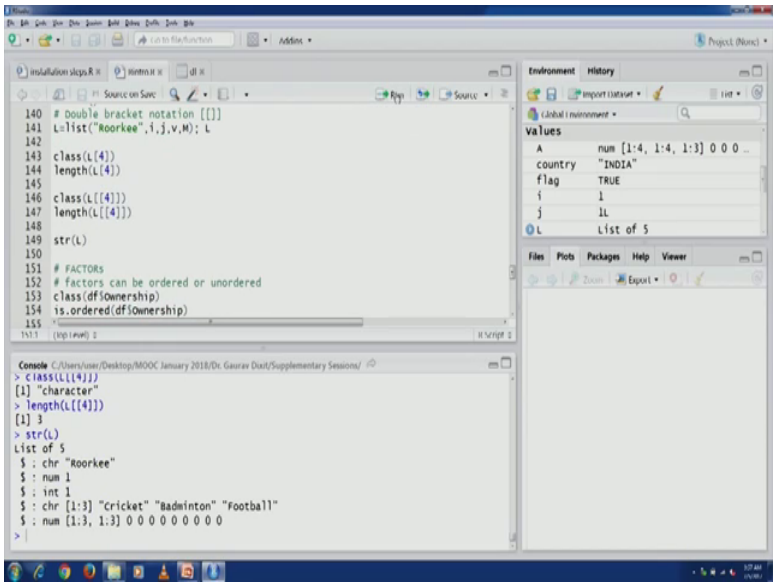

So, you can see 5 elements of list and the a structure of all those elements is displayed for example, Roorkee this was character, then you have numeric vector and integer vector and then the and the character vector followed by a numeric. Now, our next discussion point is factors, so factors are as we discussed before they are categorical variable, they are called factors in R. So, they can be ordered or unordered as we discussed in before in previous lecture that factors categorical variable could either be nominal or ordinal. So, here in this case categorical variables are called factors and ordered or unordered they are called ordered variable can are generally called ordered and nominal variable are generally called unordered.

So, we have ownership variable already in our data frame, let us check whether; let us check the type of class of that particular variable and find out whether it is a ordered or unordered variable. So, as you can see the class of this particular variable is factor which is categorical and then let us check whether it is order or not. So, you will get answer as false because there was no specified order there.

Now, there is another this function head which can be used to actually display first 6 values and if it is a factor variable then levels would also be displayed. So, let us run this and you would see that levels non over an owner for a factor variables are displayed. So, all the first 6 values in case of a integer or numeric

variable we would have just seen the values, in case of a factor variable are knows that it is a factor variable, so in the output they also display the levels that are used in the and this particular variable; factor variable.

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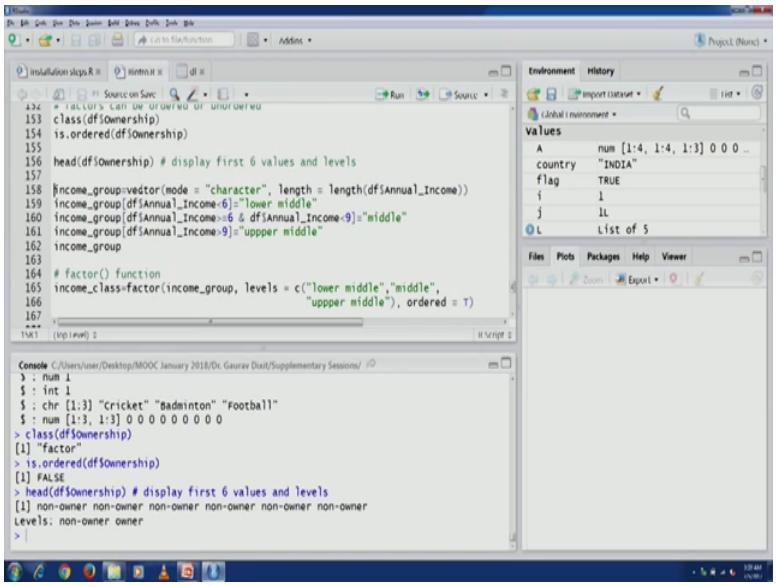

Now, how can we go about; how can we actually a go about creating factor variables for example, we have 1 particular variable in our data set that is annual income if we want to a create groups off those and those households and we want to create a factor categorical variable, where it says some houses would belonging to lower middle class, some would be belonging to the middle class and some would be belonging to the upper middle, how that can be done?

So, let us first create a vector of called income groups and mode is going to be the character because we are going to be storing these strings, we did last lower middle class and upper middle class and the length would be same as the annual income. So, let us create this vector and then any record which is having annual income less than 6 can we called lower middle class.

So, let us assign this value, any household which is having income greater than or equal to 6 and less than 9 can be called middle class so let us do that and then any household having income greater than 9 can be called upper middle class, now let us check the values you would see all the values have been assigned with lower middle class or middle class or the upper middle class.

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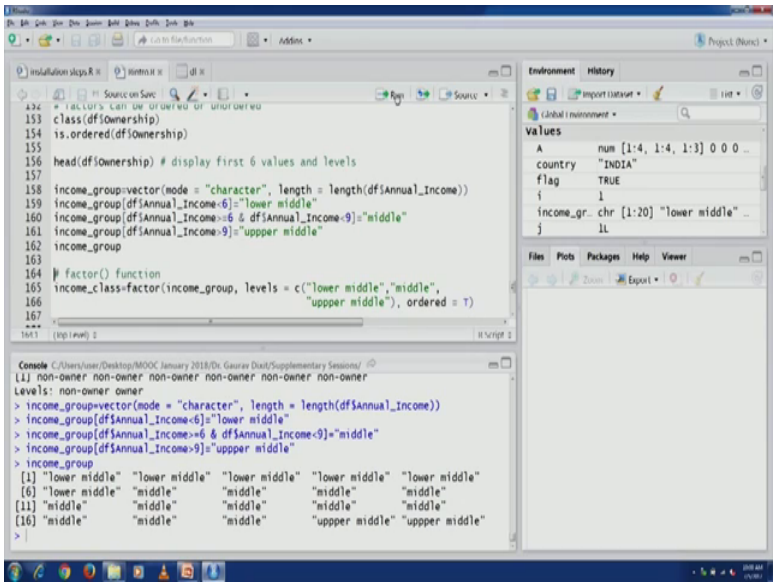

Now, how do we create a factor of it? Factor variable from this now let us create another variable income class which is now going to be a factor variable, now we are using the income group the character vector that we had just created and levels so because the factor variable are going to have levels. So, therefore, we need to assign some levels.

So, in this case we already know lower middle, middle and upper middle and you can see here ordered is true. So, we are ordering these variables, so lower middle, then middle and then upper middle, so this is the order. So, we are giving the names of the levels and also we have paired this ordered or women dash true, now this particular factor ordered factor would actually be created.

Now, we can combine this variable in our data frame df. So, c bind command can actually be used to combine variables column bias, so we can use this c bind command. So, income class, but now we actually be combined in the data frame, we can check the same using the structure command, str command you can see income glass ordered factor with 3 levels.

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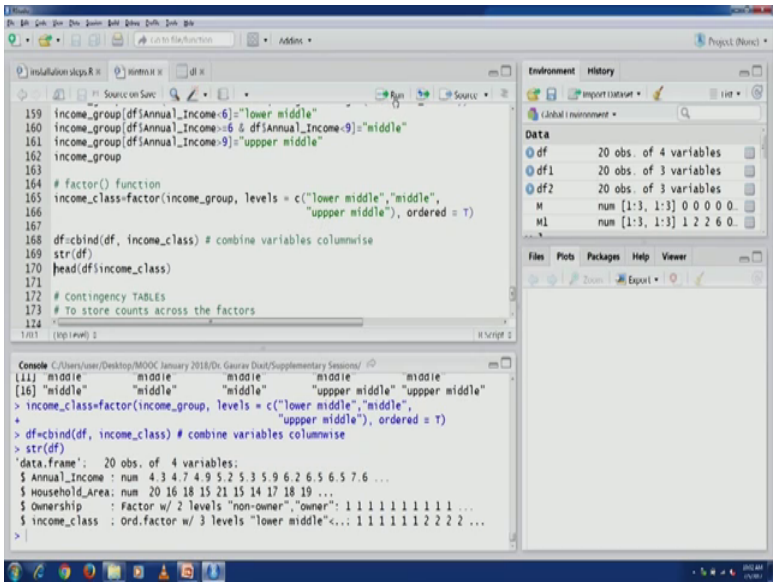

We can again run the head command to find out a clear visibility of what are these levels and their order you can see now the values are mentioned and levels in the level you can see lower middle is less than middle and which is again less than upper middle, so you can see an order in these variables. So, this particular factory you has been created as a ordered variable.

Now, the another discussion point is on a contingency table. So, in our in this particular course we would be for especially for classification tasks, we would be using contingency tables to understand the results of a particular classification related technique or algorithm. So, first in we need to understand these tables, so table is the command which can actually be used to create. So, it is generally used condition c table generally is used to store counts across the factors. So, let us see through an example, so we have df, we have ownership variable and income class that we have just created.

Now, let us see how many owner and what are their classes? What are their numbers across different classes and for how many non owners? What are their numbers across different classes? So, let us create a contingency table using table command. So, we just need to mention these 2 factor variables and it will be done.

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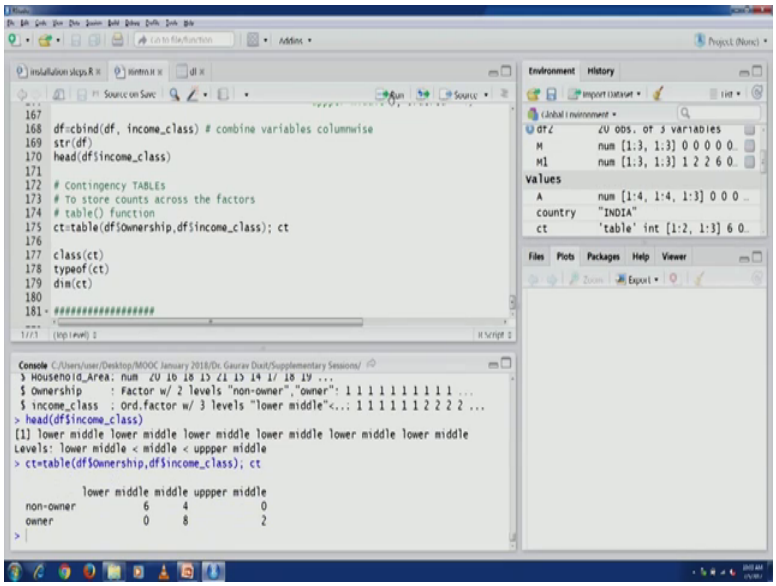

You would see that first row is about non over, second row is about owner and you will see 3 columns as lower middle, middle and upper middle; you would see a non owner you know 6 lower middle class non owners are there and then 4 middle class owners are there and the 0 upper middle class non owners are there.

Now, if we look at the owner row you would see that 0 lower middle class owners are there, 8 middle class owners are there and 2 upper middle class owners are there. So, this kind of count we can always get using table command. So, this particular command is going to be useful for us when we do our classification task. Now, we want to find out the class and type off and dimension of this particular table. So, we can execute these lines you can see table and integer and the dimensions are also mentioned 2 and 3. So, this ends the introduction of R. So, in the next class, next supplementary lecture we are going to cover the basic statistical technique.

Thank you.