Introduction to R Software

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Lecture – 04
Basic and R as a Calculator

Welcome to the next lecture on introduction to R software. You may recall that in the earlier lectures we had discuss about the basic fundamentals mainly related to how to start and how to work with R. From this lecture onwards in the next couple of lectures we will be talking about how to do calculations in R, and again I will say I will be concentrating on the basic fundamentals and my objective is that I should help you so that you can learn the course yourself. So, here again what I am going to do that I have taken some simple calculations, I will try to show you it online and my request is that you also try to do the same thing yourself on your computer, and not only the examples which I am taking, but try to take more example from your area from your subject and try to solve them, the more you practice better you we will be.

One thing I can also accept that here I am trying to copy and paste the commands from my slides and, but I would request you to at least type those command yourself the advantage of typing the commands yourself is that, you will remember where to put comma and where to put inverted comma, where to put say this say full stop and where to put colon these things can come only when you type the command yourself. So, let us now start with our lecture. So, in this lecture I am going to talk about the basics and how I can use R as a simple calculator. A simple calculator is one where you can do addition, subtraction, multiplication, division and some bracket rules also.

So, let us try to start it, but before that let us try to understand the terminology and the symbols and notation used in R.

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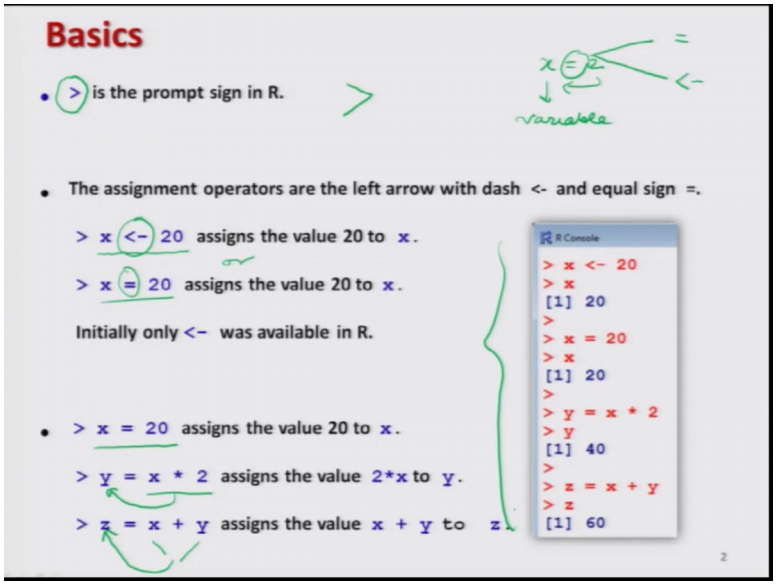

First thing what you have to keep in mind that as soon as we start our R there is a prompt sign and the prompt sign in R is denoted by greater than sign. So, this will always be the sign when you start your R and that will be the first line on the R GUI window that is the R graphic user interface window. Now after this whenever we want to do anything I have to assign a value to a variable.

For example in mathematics you have seen that usually we write x equal to 2. So, the question is this that how to do this thing and what is the meaning of this thing. The meaning of writing x equal to 2 is this that I am trying to consider here a variable, and I am assigning it a value 2 right.

So, in case if I want to do this thing in R, I have 2 options. This equality sign can be used as just as equality sign and another option is this instead of equality sign, this symbol less than and hyphen this can be used. So, if we try to see here I am trying to write down here x less than hyphen 20 or I can also write x equal to 20; now the question comes out why there are 2 symbols for the same job. Actually when are started that was developed on the lines of s plus and in s plus the assignment operator was this one less than hyphen.

So, for some time the R also continued with the same sign, but recently at the updated version of R they replace this less than hyphen sign with an equality sign. So, in the current version of R you can use any one of them. So, similarly if I try to write here x

equal to 20, this is going to assign the value x equal to 20. Now if I say I want to multiply the value of x by 2. So, I can write down here x into 2 and this value is going to be assigned into a new variable y. And now I want to add x and y. So, I am trying to add x and y over here and this outcome is going to be assigned in the value here z. So, I just try to do this thing first on the R and what is try to see do we get the same outcome, although here I have given you a screenshot of the operation, but you still I would try to do it before you.

So, now let us try to come on the R software and here I try to type the same thing which I have done here.

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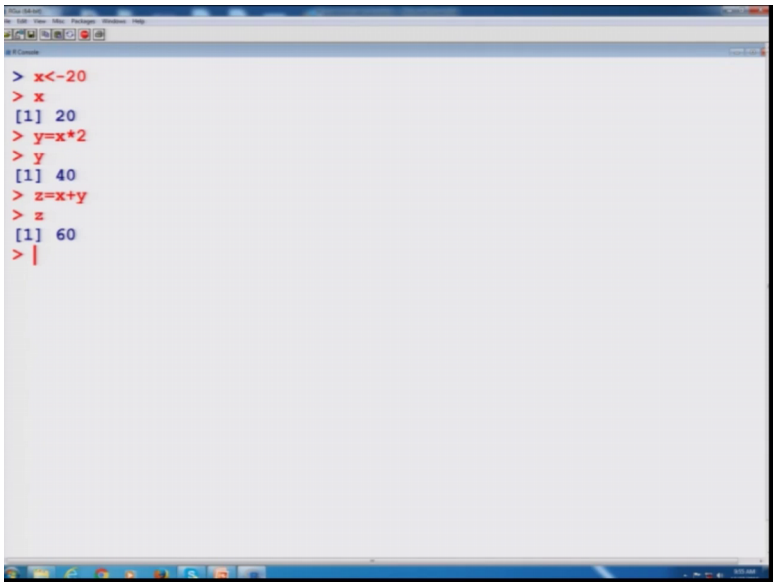

So, I try to type here x less than hyphen 20 and you can see here as soon as I enter it, it is not giving me anything, but it has already assigned the value 20 to small x. So, now, if I try to type here x and I press enter sign, then it is showing me what value has been assigned to x. Now on the other hand if I try to define here a new variable y is equal to x into 2, this one can be defined like this and here you can see I am using here the equality sign whereas, I can also use the equality sign in assigning x equal to 20. So, you can see here now I have here y. So, what outcome do you expect? I already have taken x equal to twenty. So, 2 into 20 is 40.

So, now when I try to see the value of y just by typing y and then entering it I get here the value 40 right. Now I try to define here another variable z, which is adding the value of x and y. So, I can write down x plus y. So, you can see here whatever is the outcome of x plus y this has been assigned to the new variable z, now what is the value of z. So, let me try to type here z and then enter. So, you can see here 40 plus 20 is equal to 60. So, this is how we try to assign the value to R variable right ok.

One thing here I would like to tell you that in case if you want to clear the screen then the syntax is control l. So, for example, if I try to press here control, and then by pressing control I will press here l you see the do the screen is clear. Now if you try to see the same thing I also have given on my slide also and so, one thing what you have to keep in mind that if you want to clear the screen you have to press control key plus l. So, this way clear the screen. So, you will see that once we are trying to do it you will need to clear the screen so that we can see something new ok.

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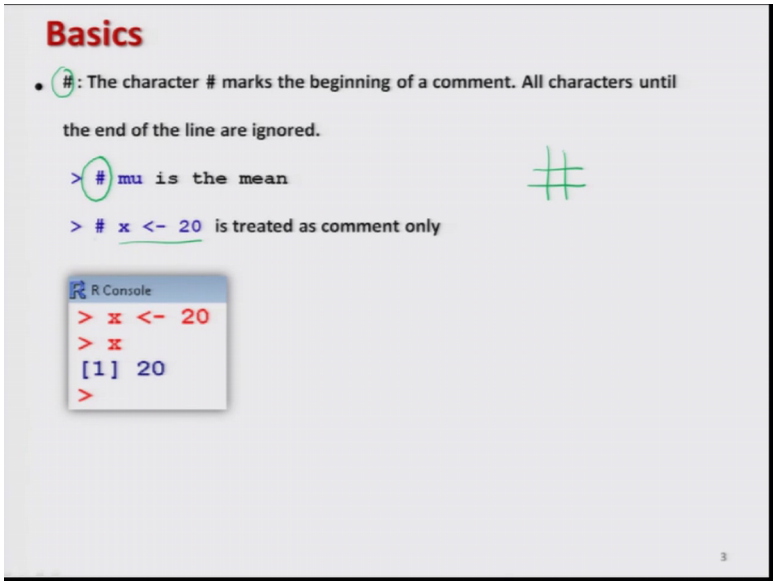

The next point which you have to understand is that, whenever I am using the sign here hash it is something like this, it is available on the keyboard, then this character marks the beginning of a comment what is a comment? For example, when I write x equal to 2; that means, the value 2 has been assigned to a variable x, and when I try to write 2 into x the value of x is multiplied 2 and we get 2 into 20 that is 40, but now if I say x equal to is

a comment; that means, there should not be any mathematical operation over the comment, that will simply appear as a statement.

So, during our programming at many stages, we try to write the comment this helps us in recalling the program at a later stage. For example, if I am using 2 variable x and y by x I am denoting h and by y I am denoting height, then it may be possible that after a couple of months you may forget that what a variable you had assigned to x and what variable you were assigned to y. So, you can simply write inside the program as a comment that x is used to assign the edges and y is used to assign the weights.

So, whenever you want to write a comment, you simply have to write the command starting with a hash sign right. So, you can see here for example, and I try to write down here x less than hyphen 20, this is taken as a mathematical statement, but when I try to put here this hash sign here, then it is treated only as a comment right. So, let us try to do it here under online question also.

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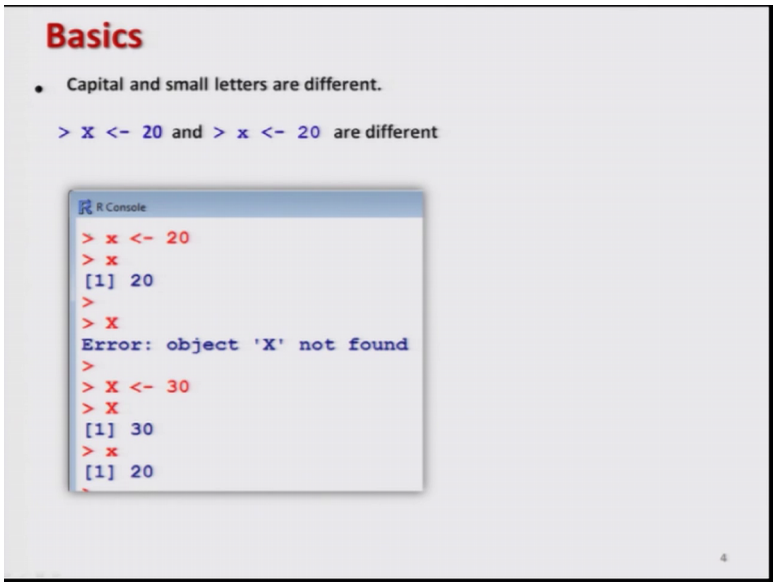

So, now, if I try to assign a value here x equal to 20 it is here.

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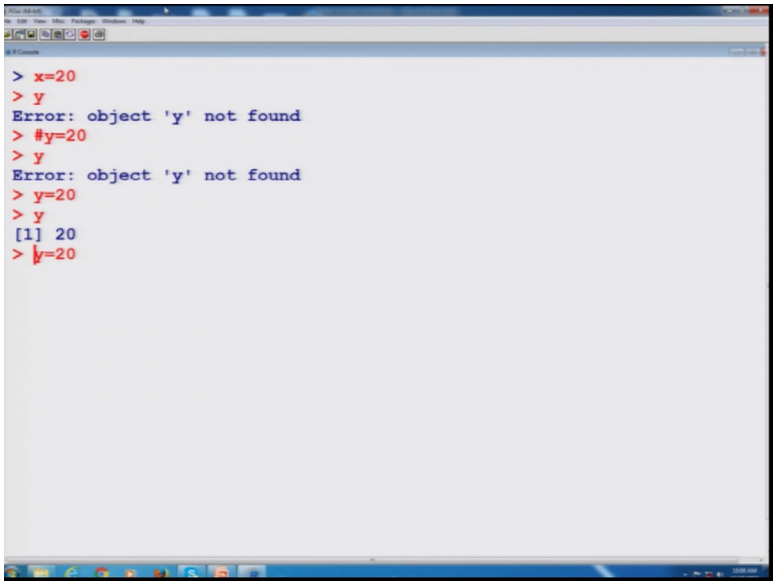

And now if I try to find whether there is a variable y or not, I do not know there is no variable y, but in case if I try to write y equal to 20 and before that if I write the hash sign y equal to 20, you will see here there comes something like this and now if I try to find out the value of here y, it says object y is not found because y is not a mathematical value, but it is only a comment.

Now, on the other hand means if I try to write down here the value of y without this hash, you will see here I get here the value of here y and well and one more operation which you have to notice here that when I was writing y equal to 20, I had not typed y equal to 20, but I had used the earlier command hash y equal to 20 and from here I deleted the value of y how I have done it? I have simply used the arrow keys and I have just came to an earlier command and simply I have edited. So, that is another trick by which we can save our time in typing the command ok.

So, now let us come back to our slides right. So, now, let us try to come back to another aspect. Whenever you are trying to assign a value to a variable then the variable names are given by alphabets and the values are some numerical values. In R you have to keep in mind that there is a difference between small x and capital X, these are not the same these are different for example, here if I try to assign here the value capital X less than hyphen 20 or capital X equal to 20 and if I try to say here is small x equal to 20, these 2

are not the same these are different values right for example, let us try to see here how it happens.

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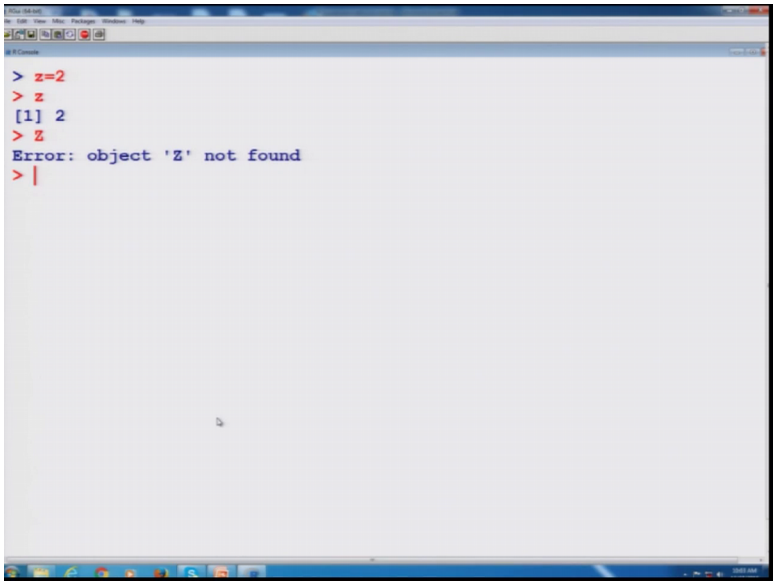

So, first I try to clear the screen. So, I say control l and this clears the entire screen, and now I try to take here a variable here z, z equal to 2 and please note that this is say small z right.

So, and I try to say here 2 it is giving me this value here 2, but now I am asking what is the value of capital Z. Now I am typing capital Z and now when I enter it says capital Z is not found because I have assigned the value to small z not to the capital Z. So, that is a very important point to always keep in mind that whenever you are writing a program the variable names are to be defined carefully and whenever you try to recall the variables name you have to recall them carefully also.

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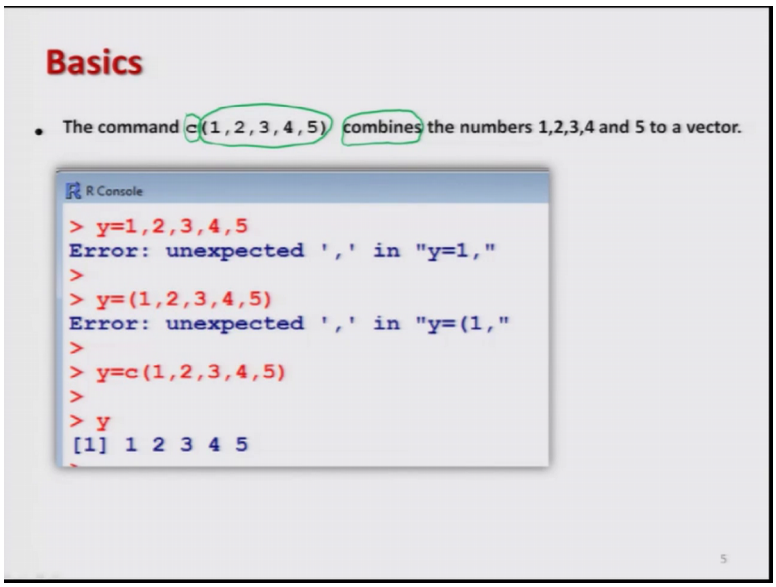

And here if you try to see I also have given here a slide by doing some calculations over here, where I am trying to give here the value here x equal to 20, and then capital X is given here the value 30. So, you can see here when I try to recall the value of capital X this gives me 30 and small s give me the value 20.

So, that is a small exercise which you can do yourself on your computer. So, next command here you can see that I have used here a command here c, and inside the bracket I have written some values right what is the meaning of c? C means combined. So, whenever I am writing the small letter c and inside the bracket I am trying to write down the numbers that is simply trying to assign them inside a vector right. So, in order to understand first we try to do something without using the c right. So, you can see here I have taken here an example, where I am trying to define here my here y as 1 2 3 4 5. So, I try to write down here.

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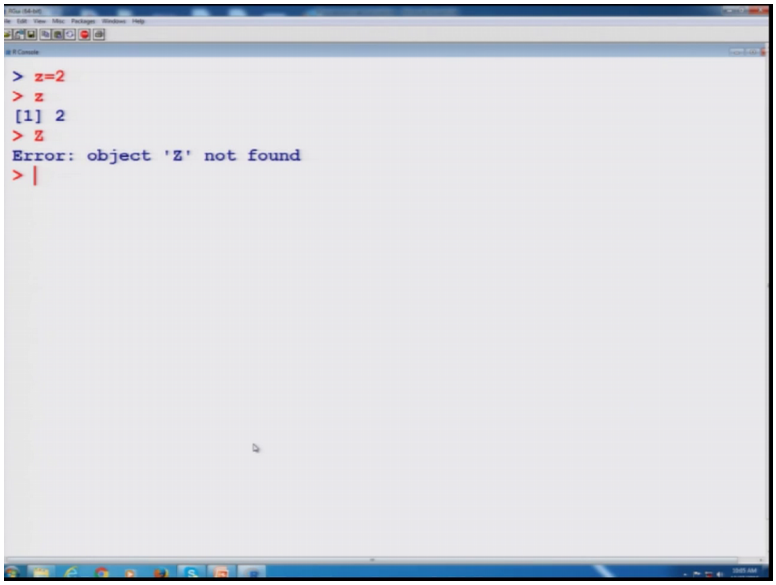

Say here I can write down here y equal to 1 2 3 4 and 5, and you can see here I am not creating anything, but it is showing me something some error and that is a saying that an expected comma is found in y equal to 1 right. So, that is not working.

So, now I try to say put here 2 brackets, and I try to give all these values 1 2 3 4 5 inside the bracket is still that is giving me some error, but now I try to put here c; that means, I am asking my R to combine the value of 1 2 3 4 and 5 in a vector; and when I try to enter it there is no error and when I try to recall the value of y it gives me a vector of one by 5 and that is containing 5 values 1 2 3 4 and 5. So, whenever you want to do any operation over a set of values then you have to give it in the form of a data. So, data is always given using that combined option ok.

So, that you have to keep in mind. So, now, let us again come back to our slide right. So, there. So, the same thing I have given here in the slide you can also try it yourself ok.

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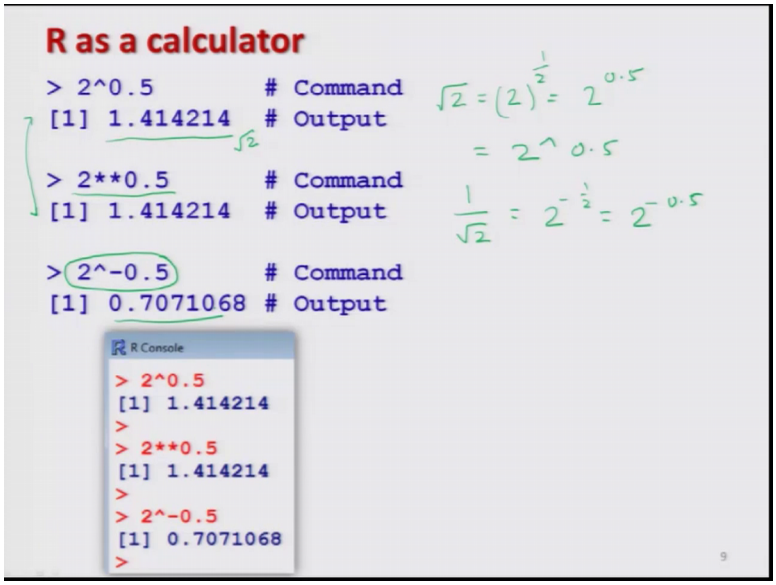

Now, I am going to show you here that how to do the basic operations like addition subtraction multiplication division. So, this operation are just like as you try to do on a calculator. Just come to the prompt in your R and simply try to type your commands exactly in the same way as you do in a simple calculator for example, and I want to do here addition, I simply try to do here 2 plus 3 and this will give me the value 5.

Similarly, if I want to multiply 2 and 3 I will say 2 star 3; star is the sign of multiplication and this is the same sign that is available on any simple calculator also and you can see here I have given here the screen shot of 2 plus 3 and 2 into 3, I will try to show you also. Similarly if you want to do the subtraction the subtraction can be done only by here just like calculated 2 plus 3 and the outcomes will be here minus 1. Similarly if you want to do division 3 by 2 something like 3 by 2, just like it as in a calculator it is written here as say 3 by 2 and it will give you the value value 1.5.

In case if you have a little bit a longer mathematical expression then the same rule that first division, then multiplication, then addition and then subtraction is performed. So, I have taken here a simple expression where I am trying to multiply 2 and 3 minus 4 plus 5 divided by 6. So, if you try to try to do this operation we will get the same outcome. So, before I go forward let me try to do all these things before you so, that you can understand it right.

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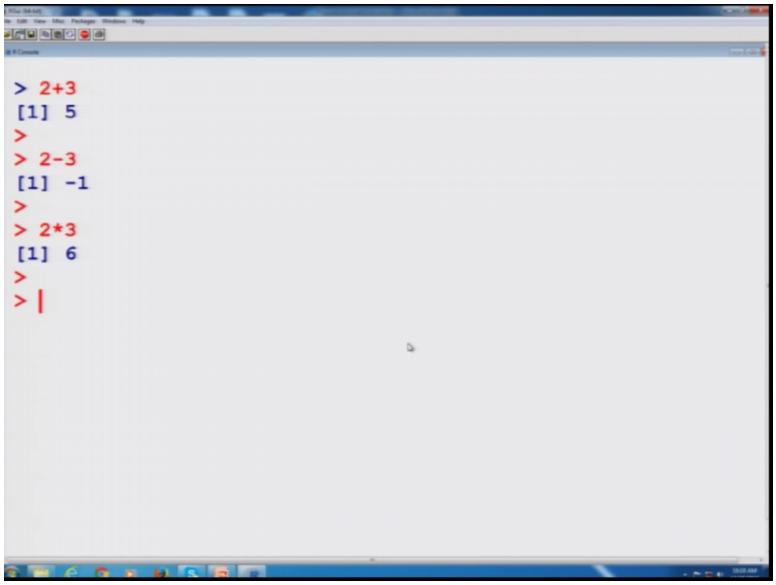

So, now, if I want to add here 2 and 3, I have to simply type here 2 plus 3 and it gives me 5 similarly if I want to subtract 3 from 2. So, this is 2 minus 3 and I get here a value minus 1 right.

Similarly, if I want to multiply 2 and 3. So, this is 2 into 3 this is a here 6, and similarly if I want to divide 3 by 2 this is 3 by 2 and it is giving me here the value 1.5. So, you can see here that this operation is just like save as in the calculator right, and now we again come back to our screen and so, you can just do all this operation over here yourself and can try.

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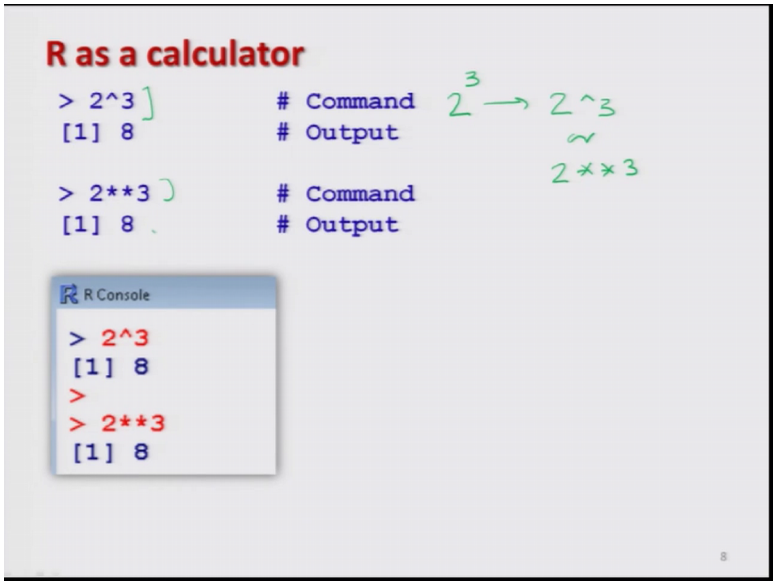

Now similarly If I want to find out here 2 cube, then this is written here as I say there are 2 options either I can write down here 2 and say has hat and here 3 or this can be written here 2, 2 stars 3. So, in case if I am putting here one star, that may indicates only multiplication and when I try to put 2 stars then it will indicate their exponents.

So, it this is 3 2 star star 3 and then you can see here when I try to write 2 cube this is 2 3 and then this is here eight and the same thing with 2 star star 3 and this is also giving me here the value 8. So, you can try it yourself on your computer and you will get the same thing. So, and similarly if you want to find out the square root, a the square root is something like 2 raise to the power of 1 by 2, which is equal to here 2 raise to the power of here 0.5 and so, once you try to do it for example, I am trying to write down here this here as a 2 has 0.5 you can see here I am getting the value of here square root of 2. And the same thing I can also write by writing 2, 2 star star 0.5 and because this is again giving me the same value s square root of 2 o upon 1.4, 1 4 to 1 4 and if I want to find out suppose 1 upon square root of 2 this can be written as 2 raise power of minus 1 by 2, and this is 2 raise to power of here minus 0.5.

So, this I am trying to write down here 2 hat minus 0.5 and then I am getting here the value of this thing right. So, let us try to just do this operations on the R GUI window also. So, if you try to see here if I try to write down here 2 hat 3 this is here 8 and so, here 2 star star 3 this is again here 8 and if I try to write down here 2 hat 0.5, this is

square root of 2 and if I try to write down here 2 hat minus 0.5 this is giving me here the value of 1 upon a square root of 2 right. So, now, I come back to our slides and we can continue again.

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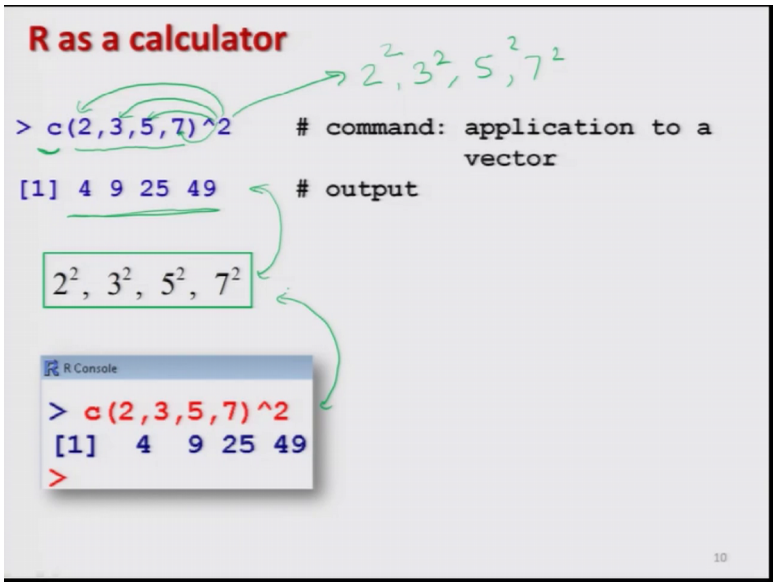

So, now, after this simple operation little bit more complications, if you try to see here what I have done here I have taken here 4 values 2 3 5 and 7 and these values have been combined inside a vector, and then I am trying to find out the square of this combined vector of 2 3 5 7 if you try to do so, you get this outcome.

So, now we have to understand, what is really happening when I am trying to do so. When I write this a statement, this is actually trying to square each and everything. So, this square goes over here this square goes over here, this square goes over here and this square also goes over here. So, this becomes here 2 square, 3 square, 5 square and 7 square and these are the value which have been obtained over here and this is the screenshot. So, you can be sure that the same outcome is being obtained. So, the moral of the story is this whenever you are trying to make a mathematical operation over a vector then you need to understand what is really happening. Now I will try to take some more example where I will try to clear that one has to be very careful when it is trying to operate with vector manipulations ok.

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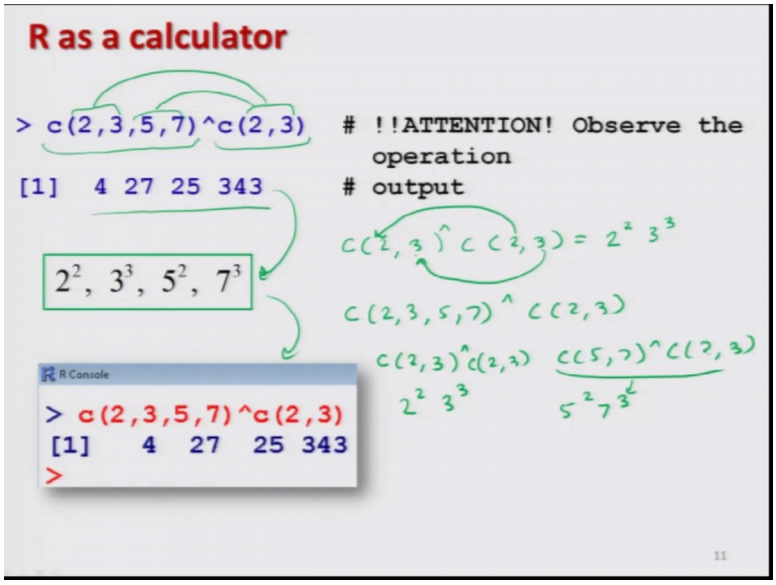

Now, in the next slide you see I am now taking an example, where I have a vector which is combined with the values 2 3 5 and 7 and the exponent of this vector is something like another vector which is combined with 2 and 3 and if you try to get the outcome, the outcome looks like this right. So, now, one has to observe what is really happening. The rule is this when I am trying to take an exponent then the exponent is going like this the set of these 2 values 2 and 3, this is coming over the set of these 2 values first and then the same thing is being repeated in the set.

So, what is really happening when I am trying to write down here c, 2 3 x c 2 3. So, what is really happening that this 2 is coming over here and 3 is coming over here. So, we get here see here 2 square and say 3 cube and when I am trying to write down here 2 3 5 7 with c, 2 3. So, this is happening c 2 3 hat, c 2 3 and c 5 7 hat c 2 3. So, this is actually 2 square 3 cube and then again from here this gives me 5 square and 7 cube and these are the values which have been obtained over here and this is a screenshot of this thing which is obtained here.

So, you can see that whenever we are trying to multiply a vector by a vector then how the operations are being carried out, but please note one thing here that here the number of multiples are the same; that means, everything is being multiplied by in a factor of 2 values. Now let us try to take more complicated example and let us try to see what happens.

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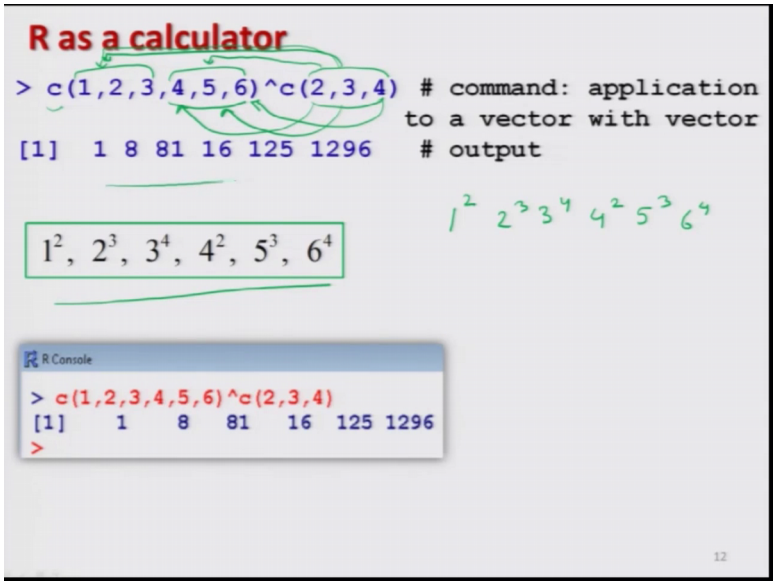

So, now, I am trying to take here 6 values which are combined in a vector here c, and these values are being multiplied by another vector that contains 3 values. So, here now what will happen that, we try to divide them in the multiple of 3. So, these 3 values will go over here in the same order and these 3 values will also go here in the same order.

So, what happens here that when I try to multiply it here, when this value is going to this thing this becomes here 1 say square something like this one with this thing, 2 with 3 and 3 with four. So, this becomes here 1 square 2 cube and 3 is power of here for and when I try to multiply this 4 5 6, let me try to clear it so that I can explain you better, when I try to take here this 3 5 6 with 2 3 4 then 2 comes here, 3 comes here and 4 comes here. So, this value becomes here 4 this power of square, 5 the power of cube 5 cube and 6 raise to the power of here 4 and this and this is the value which is being calculated here right and the same outcome is being obtained over here also in the R graphic user phase interface window.

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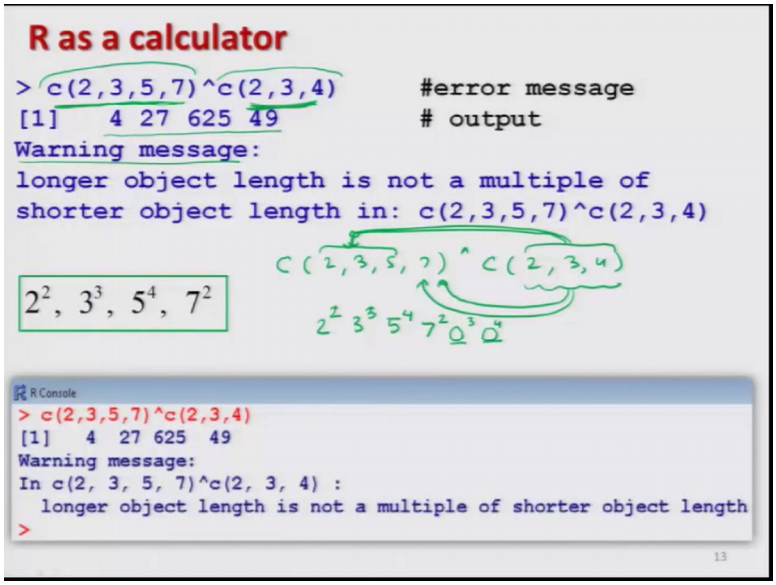

Now, I am trying to create some troubles right up to now we have seen that that everything was nice, now I am trying to take here another example where I have a combined vector of 4 values 2 3 5 and 7, and then I am trying to take an exponent with respect to c here another vector which has only 3 values. So, you can see here that the number of values in this vector here are 3 that is 2 3 and 4, and this is not really an exact multiple of the number of values in the first vector which has got 4 values. So, when I try to do it then it gives me this outcome, but it also gives me a warning message. And this warning message is longer object length is not a multiple of shorter objective length in this thing.

So, it is. So, although it is giving us an outcome, but it is also giving us a warning. There is a difference between a warning and an error. Error is something like fundamental mistake in case if I try to make a make an error in sale in the program the program will not run and it will give me an error message, but in this case it is giving us a warning. Warning means well I am trying to do your job, but you have to be careful and you need to check whether the outcome is correct and it is as per the objective what is happening here. So, if I try to write down here this vector 2 3 5 7 which is being exponent by another vector c 2 3 and 4. So, you can see here this 2 3 and 4, there are 3 values and these 3 values come over here with these 3 values.

But now in the next slot when this 2 3 and 4 comes over here there are not 3 values, but there is only one value. So, what is happening that when this is coming over here we get here 2 square 3 cube 5 raise to the power of here 4, but when this comes over here then I get only here 7 raise to the power of here square, there is no value here on which I can put here 3 and 4. So, that is the reason that it is trying to give you a warning that these 2 combined vectors are not of the multiple times length. So, and the same thing I have given here that you can try yourself just type this thing and then try to see the outcome in your R GUI window ok.

Now, I come to another aspect now I am trying to multiply a vector by a value.

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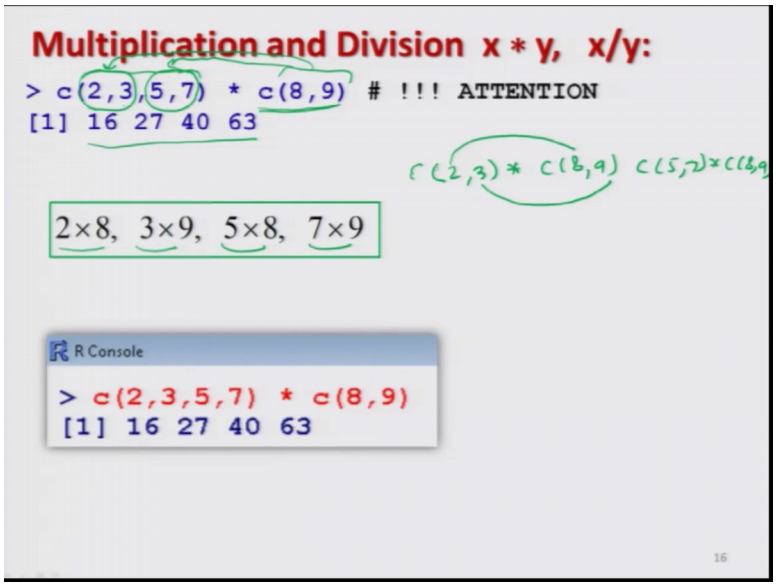

So, here I have got here a vector of 2 3 5 and 7, 4 values which are combined by the command c and I am trying to multiply this vector by a numerical value 3. So, now, what is really happening? You can see here now each of the element 2 3 5 and 7 they are being multiplied by the value here 3. So, 2 is being multiplied by 3, 3 is being multiplied by 3, 5 is being multiplied by 3 and 7 is being multiplied by 3 and this is the outcome that we are getting. 6 9 15 and 21 and this is here the screenshot. So, you can be confident that I am going to get the same outcome. So, the rule is that whenever we are trying to multiply an element inside the combined vector, each and every value is being multiplied as a rule of thumb I can say that whenever we are trying to do any mathematical operations on our vector by a scalar then the same operation is being carried out over each and every

element in that combined vector the same thing will be true with addition or subtraction multiplication or division let us try to take some more examples.

Now, I have taken here a vector of 4 values 2 3 5 7 which are combined by the command c, and here I am trying to take another vector of the values minus 2, minus 3, minus 5 and 8 and I am trying to multiply both these vectors. If you try to do so, the outcome will come like this. So, what is happening? That each and every element is being multiplied by its own respective position for example, if 2 is here the first element the first element is being multiplied by the first element of another vector, if 3 is the second element then 3 is being multiplied by the second value 5 is at that third place. So, 5 is being multiplied with the third value and 7 this is at the fourth place. So, the this is being multiplied by here the fourth value, and we get here 2 into minus 2 3 into minus 3 5 into minus 5 and 7 into 8 and we get here this outcome. So, you can see here that when we have a vectors of the same length then their respective positions are being multiplied together right.

And similarly when I am trying to take a vector of 4 elements which are combined together, the values are 2 3 5 and 7 and they are being multiplied by another vector right then in that case we get an outcome here something like this 16, 27, 40 and 63 now we have to see what is being happening. This is a similar rule what we have done earlier that these 2 values are being multiplied first on these 2 values and these 2 values are being multiplied again with these 2 values. So, if I try to write down here what we are trying to do it is something like 2 3 multiplied by c 89 and c 5 7 multiplied by c 89 and this is what we are getting here that this multiplies, that this multiples are coming 2 into 8 3 into 9 5 into 8 and 7 into 9 and this is the screenshot of this thing right ok.

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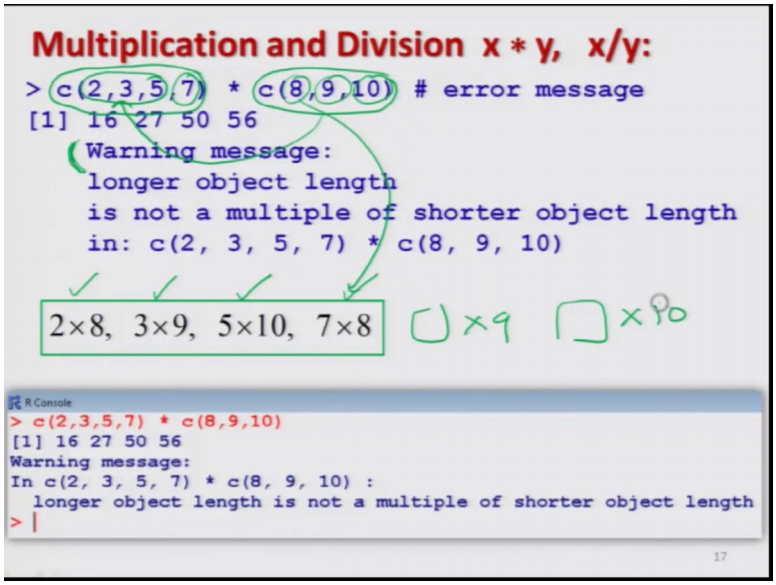

Other hand if I try to make this example a little bit complicated. So, here I am trying to take a vector of order 4, there are 4 elements and I am multiplying it by another vector which has only 3 elements. So, again the same thing is happening I am getting here a warning message because when I am trying to multiply it this is there are 3 values 8 9 and 10, these 3 values are being multiplied by here with the these 3 values. So, I am going to get here 2 into 8, 3 into 9 and 5 into 10.

Now, when this operation comes again over the next set of values, then there is only one value which is 7 and 7 is being multiplied by the first element here 8. But there is no value here which can be multiplied by 9 and there is no value here which can be multiplied by here 10 and so that is why we are getting here a warning message. So, that is what we have to be careful when we are trying to play with the vectors and matrices; and similarly when I am trying to make here addition and subtraction you can see here we have the simple rule that I am trying to take here a vector of 2 3 5 7 and I am adding here one scalar value 10.

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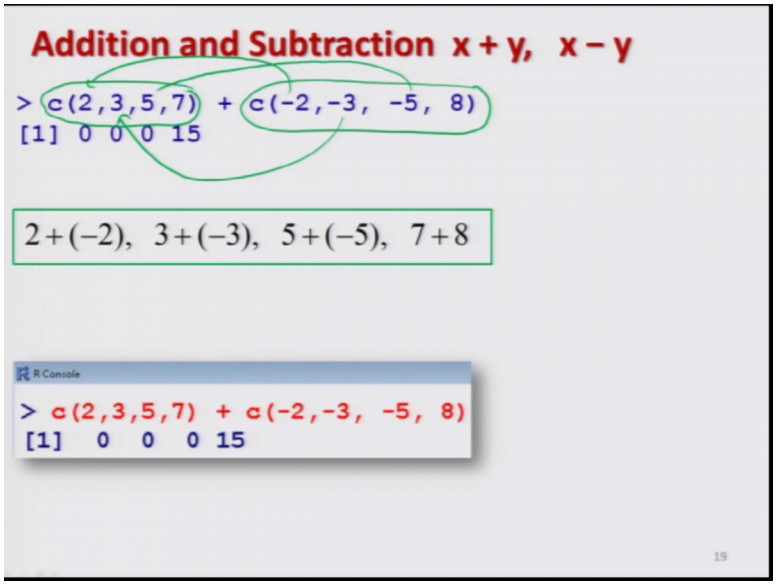

Then this value is being added on each and every element right and I am getting here 2 plus 10, 3 plus 10, 5 plus 10, 7 plus 10 and ultimately we get here this outcome and this is the screenshot.

Similarly, and I am trying to add 2 vectors then I am trying to take here a vector of 4 elements and another vector of 4 elements and then I am trying to when I am trying to add them then this is being added to this, this is being added to this, third place is being added to the third place and so on. So, again the same rule continues here that the respective positions values are being added. So, this is the operation which is happening here 2 plus minus 2, 3 is being added to minus 3, 5 is being added to minus 5 and 7 is being added to 8 and we get the this screenshot over here. So, the rule is similar as we have done earlier. So, now, I am trying to take another example where I have a vector of 4 elements and I am trying to add another vector of 2 elements. So, what is really happening that these 2 elements are being added to these 2 vectors and these 2 elements are again added to this vector.

So, practically we get here 2 plus 8, 3 plus 9 and again I get here 5 plus 8 and 7 plus 9 and to see the outcome that we are getting over here, and this is the screenshot right. Similarly if I try to click here a vector of size 4 and I am trying to add here another vector of size 3. So, again you can see this is not the multiple length of the first vector. So, in this case what is really happening that these 3 values 8 9 and 10 they are being

added to the first 3 values 2 3 and 5, and in the second case it is not happening. So, I am trying to add here 2 plus 8, 3 plus 9, 5 plus 10, 7 plus 8 and when I am trying to add here say here 9 and 10 once again then there is no value. So, that is why it is giving us a warning message. So, and this is the screenshot. So, you can try with these things.

So, now you can see that I have taken here several examples with different types of combination of the problems and I have tried to solve it, but definitely you will learn it only when you try to do it yourself and do some more practice. So, try to take some more example from the assignment or try to do it yourself and you will see you in the next lecture till then good bye.