Foundations of R Software
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Basics of Calculations
Lecture - 08
R as a Calculator with Scalars and Data Vectors: Addition, Subtraction, Multiplication and Division

Hello friend, welcome to the course Foundations of R Software and you can see that up to now we have entertained different aspects of R software which are pretty elementary, but I believe that they are important to understand those points so, that you get familiar with the functioning of R software. Now, as we have discussed many time that R is one of the most popular software for doing computation, simulation, calculations etc.

So, from today we are going to begin to learn different aspects of computations in the R software. Now, R has a very unique capability. R has a way of calculating the scalars and vectors which is quite different than many of the software. And, that is why it becomes important for us to understand that how R is functioning and how R is doing the calculations.

Once you understand that how R is doing the calculation, then it will be easier for you to write your own programs and you can write the functions to compute something in the way you want. So, now, when we come to the aspect of calculation, there are several possibilities. First possibility is that R works just like a calculator; that means, you are trying to add, subtract, divide, multiply etc.

Scalars that means 1 is scalar, 2 is scalar, 3 is scalars etc.; second option is that instead of scalars you can choose data vectors. So, now, there are two possibilities that how the mathematical operations are going to be between a scalar and a data vector. And, the second option is how the calculations are going to be done when we are trying to take data vector versus data vector.

So, now, that is our objective; that this is what we want to learn that how R is making some computations. And, after doing the computation you will also learn that there are some built in functions which can compute some of the standard things without any

problem, without any programming, without writing any mathematical computation functions. So, now, let us begin our journey and we try to understand all these things one by one.

So, today in the lecture we are going to understand how R works in the most simple way, I am sure that you all have ah used the calculators, simple calculators. So, this R is also working like a calculator. So, that is what we are going to understand in the lecture today and after that I will try to take up scalars versus data vector, data versus data vector etc.; all those cases. So, let us begin our lecture.

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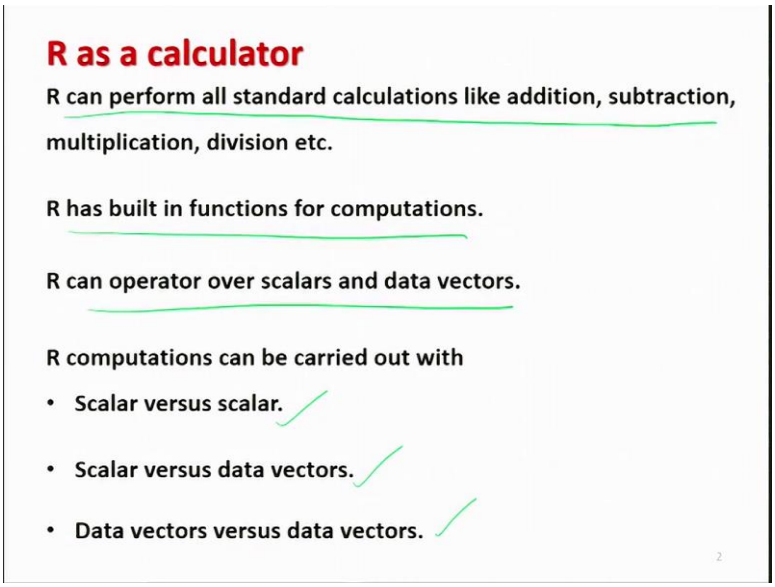

So, as we have discussed that R is a very good software for doing different types of computations, calculations etc. So, R can perform all type of standard calculations like addition, subtraction, multiplication, division, power operation etc. And, R has a built in functions also for doing some computations and R can operate over scalars as well as data vectors. So, the computations in R can be carried out with scalar versus scalar, scalar versus data vectors, data vector versus data vectors.

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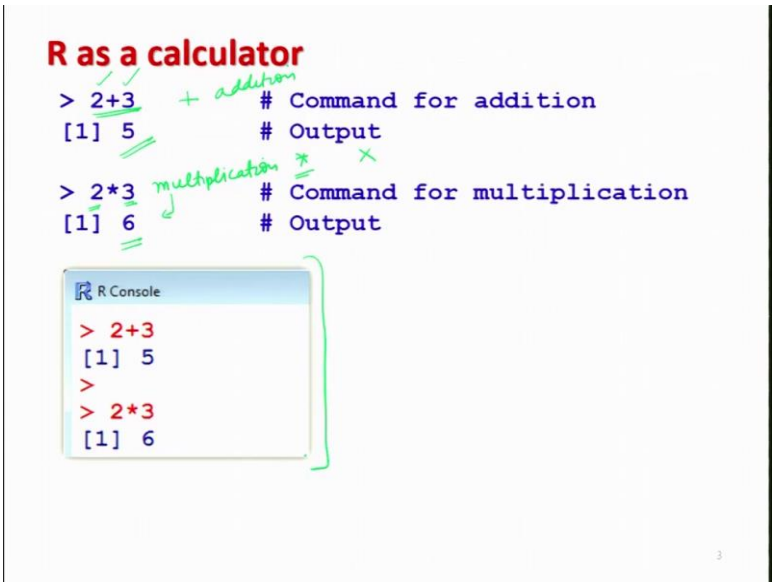

So, now let us try to understand. So, instead of giving you a theory, I will just try to take a couple of examples so, that I can show you that how the things are happening and how the computations are made. So, we are now going to begin with the most simple operations and we are going to consider the aspect of scalars versus scalars. Yeah, I am trying to take here very simple example, but these examples can be extended to any level, ok.

So, first I try to show you how you can do the addition. So, addition is very simple, the symbol is the usual plus symbol. So, in case if you want to add 2 and 3, you simply have to write 2 plus 3 on the prompt side. And, you as soon as you press enter, you will get here the outcome 5; so, this is for addition. And similarly, if you want to do the multiplication, then the usual symbol here is star. Well, in mathematics we use the symbol like here this cross, but in calculator, you always use the symbol star.

So, in case if you want to multiply 2 and 3, you simply have to write 2 star 3 and as soon as you enter, it will give you the value here 6. So, you can see here this is the screenshot of the outcome and yeah, I will try to show you it on the R console also, ok.

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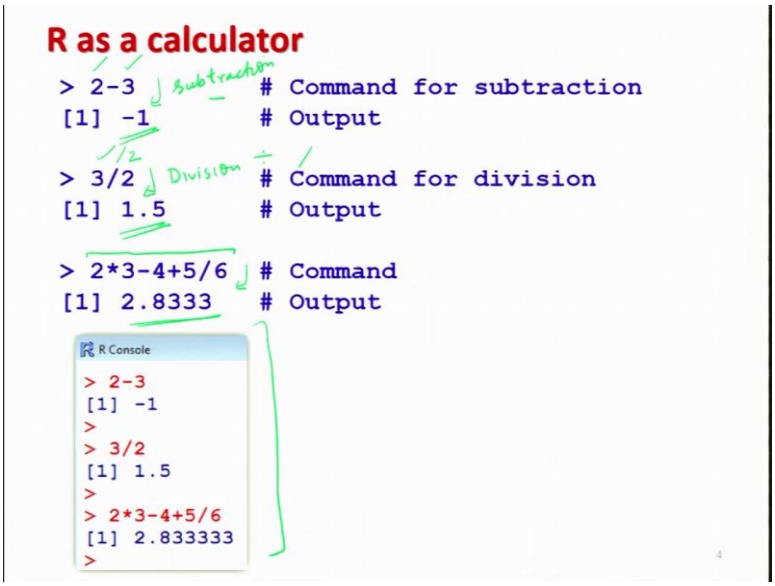

Now, similarly if you want to do subtraction, then we have the usual symbol minus sign. So, in case if you want to subtract 3 from 2; so, you have to simply write 2 minus 3 and then as soon as you enter, the answer will come out to be here minus 1. And, for division the usual symbol in mathematics is like this, but in calculator as well as in the R software that the symbol is like here slash sign.

So, in case if you want to divide 3 by 2; so, it is 3 slash 2 and then as soon as you enter it will be here 1.5. And, beside those things R can also follow the usual mathematical operations when you try to take more than 2 digits, more than 2 numbers as well as if you try to take different combinations of this mathematical operations. For example: in case if you want to have a computation in which you involve addition, division, multiplication, subtraction.

So, for example, if I try to write here 2 star 3 minus 4 plus 5 divided by 6. So, in this case the usual mathematical rules are applied and R also follow the same rule what have been taught in our class and using those rules, it will compute the expression. For example: as soon as you press here enter you get here the value 2.8333 and this is here the screenshot of the same outcome, right. So, that you can see here.

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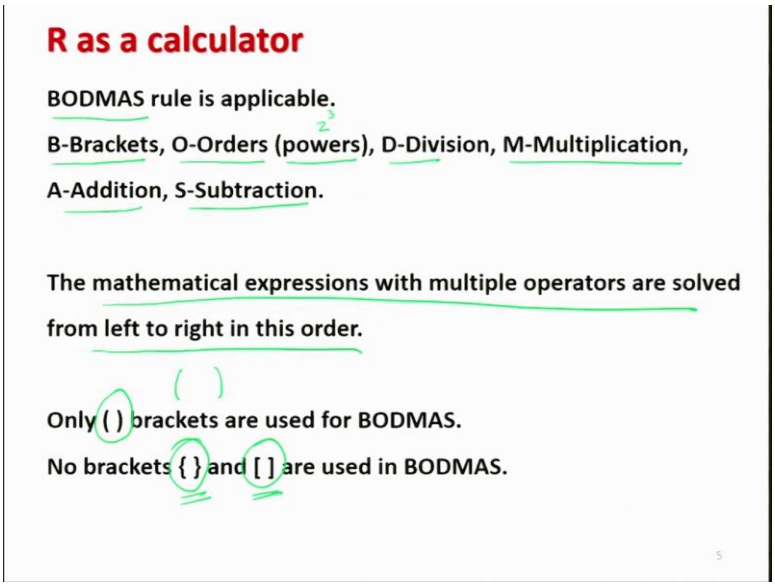

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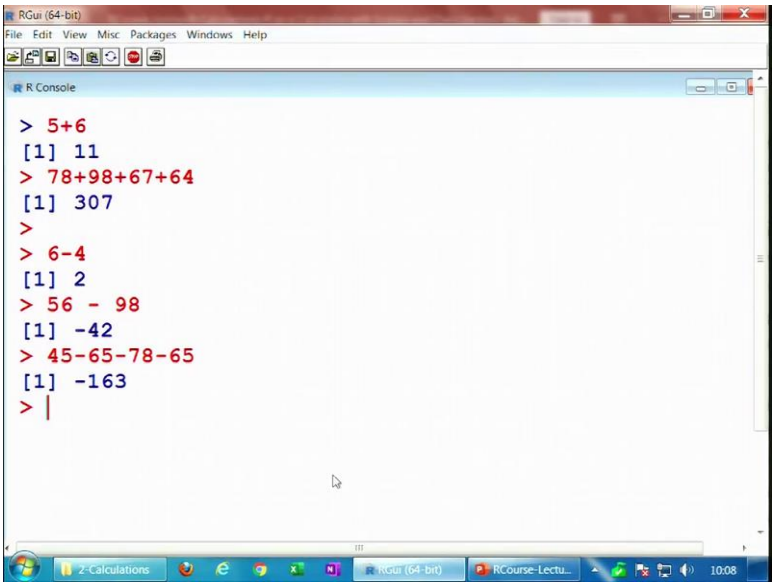

And, yeah before we move forward let me try to show you these computations on the R console. So, let me try to show you here suppose if you want to add here 5 and 6. So, you can see here that it is coming out to be here 11. Similarly, if you want to it add here 78 plus 98 plus 67 plus 64 means, it will give you the value of 307. And, similarly if you come on the aspect of subtraction, suppose if I say here 6 minus 4 you can see here this is 2. Suppose, if I take here 56 minus 98, this is going to be minus 42.

And similarly, if you try to take here 45 minus 65 minus 78 minus 65, you can see here the answer comes out to be here minus 163. So, you can see here whether I am involving 2 numbers or more than 2 numbers, R can handle it in the usual way as a calculator does it.

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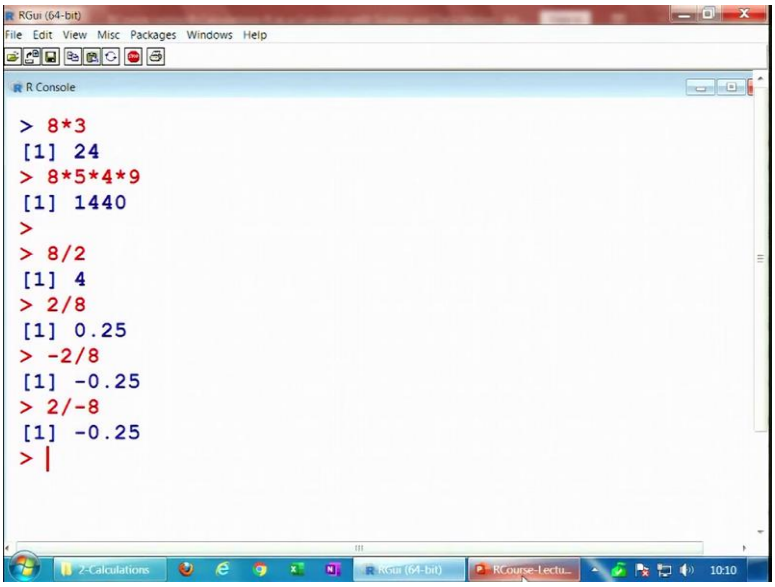

Similarly, now in case if I look on the multiplication part. So, this will be here 8 into say 3, 8 3's are 24. We can see here like this. And, similarly if you try to say here 8 into 5 into 4 into 9, this will give you the answer 1440. So, you can see here there is not much difference in the mathematical operations of the R software in comparison to any calculator, ok. So, after this I try to look on the division part also for example, if you want to divide 8 divided by 2, this is 4.

And, similarly if you divide it by here 2 divided by 8, this will be here -0.25, if you divided by here minus 2 by 8, the answer is -0.25 and so on. So, let us try to see what happens if you try to say this divided by -8, let us try to see what happens. So, you can see here that it can handle this thing also, yeah it can handle the brackets also. So, for handling the brackets in the mathematical operations, the rule is very simple.

Same rule which you have been taught in your elementary classes BODMAS; B O D M A S. The same rule is applicable here. What does this BODMAS mean? BODMAS is B for Bracket, O for Orders or say powers. Sometime, we write 2 raise to the power of 3

like this, then Division, then Multiplication, then Addition and then Subtraction. So, this is the order in which the mathematical operations are formed using the BODMAS rule right. And, the mathematical operations with multiple operators are solved from left to right in this order. So, that is the same thing which you have learnt in your elementary classes. So, there is nothing new for you to learn, the only thing is what you have to understand how are you going to execute it on the R console.

The only difference between the usual mathematical operations and in the R software is that here in only this parenthesis mean this type of brackets are only used in the mathematical operations in the R software including in BODMAS. This curly brackets like this one or the square bracket like this one, they are not used in doing calculation in the R software. You will see later on that these two symbols, this curly bracket and a square bracket they are used for some other job. So, that is the reason that we do not use them here in mathematics, right.

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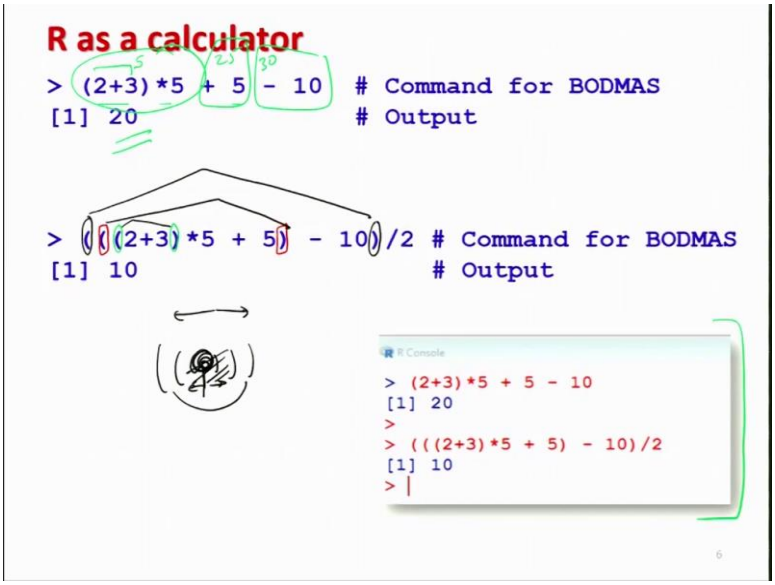

For example, if I try to write down here an application expression like 2 plus 3 inside the parenthesis into 5 plus 5 minus 10. So, you know first of all this expression inside the bracket that is going to be solved. So, this will become here 5 and then 5 into 5 is 5. So, this becomes here 25 and 25 and then addition. So, 25 plus 5, this become 30 and then 30 minus 10, this is here 20. So, you can see here that the same BODMAS rule is operated

here and yeah in case if you want to have more brackets, somehow if you have this type of operation.

So, you can see here that I have written here this expression, but you have to understand how these brackets are given. So, you have to always keep in mind that whenever you are trying to give an opening bracket, you also have to give the closing bracket; open parenthesis, closing parenthesis, right. So, if you try to see this is the parenthesis for 2 plus 3 and similarly if I try to see here, this is the parenthesis for this in red color and this is the parenthesis in black color like this.

So, these two are paired, these two are paired and these two are paired. And, we know that in mathematic that whenever we try to do the bracket operations, this start from the center means if you have like this thing, this type of brackets. So, operation will start from here first here inside this bracket and then it will go to the second bracket, it will compute whatever is in this bracket and then it will go to the third bracket and so on.

So, that is the usual way of doing calculations and the same thing is being followed in the R software also and you can see here that here we have the screenshot of the same operation. So, you can believe that if you try to do this you will get the same outcome and yeah means you have to verify also. So, please do it yourself and see whether you get the same thing or not.

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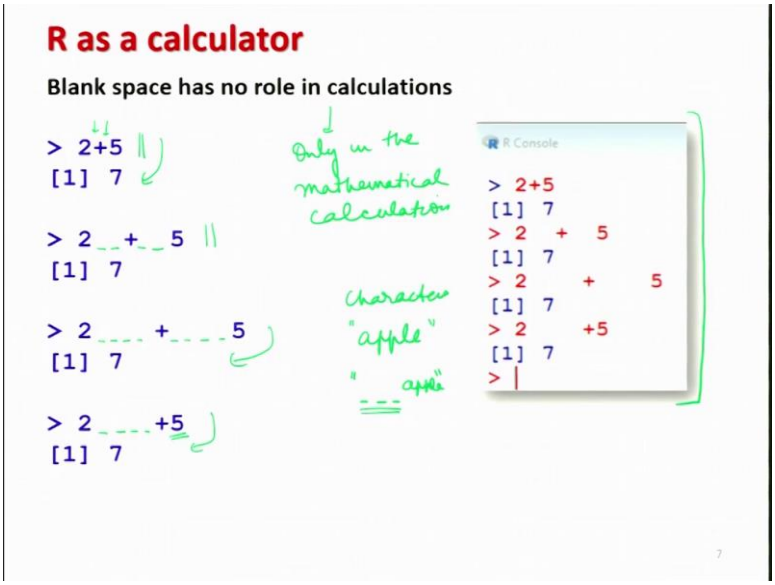

So, before I move forward, let me try to give you these examples on the R console also. So, that you can be confident that these things are working.

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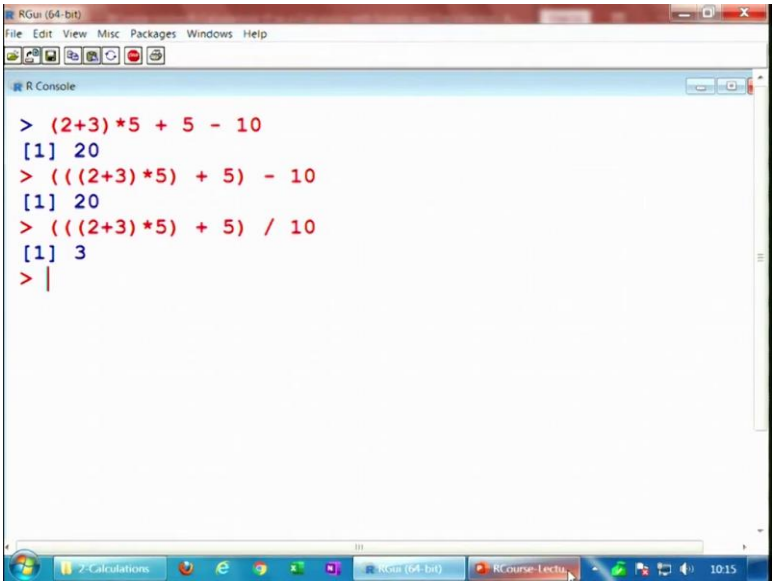

So, if you try to see here, this will give you the answer 20 and yeah in case if you try to make here more brackets here if I try to make it here more brackets. For example, if I try to say here like this and then if I try to make here like this one more bracket here, like this here you can see here the answer is 20.

So, that is how means you can do and if you want to make it here like here division also. So, you will see here that the things are changing; now it will be 30 divided by 10; so, you get here 3. So, that is the same way as you have learnt the arithmetic, the same rule is being followed here also. Now, after this a very basic fundamental thing that when you are trying to do mathematical calculations then in the R software blank space has no value.

For example: in case if you try to write down here 2 plus 5 like this. So, you can see here there is no blank space here, I am simply writing adjacent 2 plus 5 without any blank space, it will give us the value 7. And, in case if you try to give here this blank space here and here then the answer is going to be 2 plus 5 which is 7. Even if you try to increase the blank space here like this after and before the plus symbol, still the answer is going to be 7.

And, even if you have more space on left hand side of the operator and no space on the right hand side of the operator, still the answer is going to be the same 7 and this is here the screenshot. But, remember one thing this is true only in the mathematical calculations. What does this mean? Do you remember that earlier we had done two types of values, one are numerical values and another are characters.

We had taken couple of example using the word apple, right. So, when you are trying to write something as character within the double quotes then this blank space will be printed as such, that will be treated as such. For example, if you try to write down here apple like this and if you leave some space and then you try to write down here apple, then these two will be shown on the screen and R will also consider these 3 additional blank space and the operations.

What type of operation this will involve? That we will try to see in the forthcoming lectures when we try to print the mathematical calculations and print the characters, at that time, you will see. So, the bottom line what you have to understand here is that the blank space has no role, when we are trying to do mathematical calculations.

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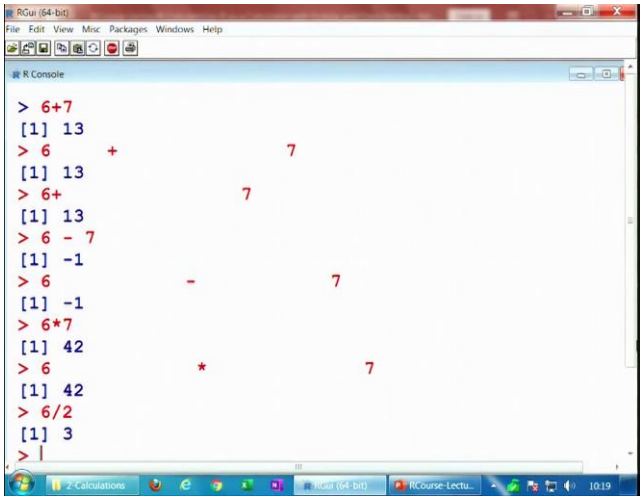

And, if you want to see it on the R console also I can show you here; that if you try to see here 6 + 7, you can see here I have not given here any space. But, if I try to give here these many space here 6 + 7, you can see here this is again 13 or even if I try to give here no space in the first shot and then so much space on the right hand side of the operator, that is again going to be 13 and yeah this is true with all the operators.

For example: if I try to take here 6 - 7, this is here minus 1 and even if I write try to write 6 blank space minus say here 7, still you can see here this is -1. And, similarly for the multiplication also like a 6 into 7 without leaving any blank space, this is 42. And, if you try to take it here 6 and some blank space and then some blank space with here 7, this is here 42. And, the same thing is with here division also 6 divided by 2 is 3 and if you try to take here this 6 and say divided by here 2, this is again 3.

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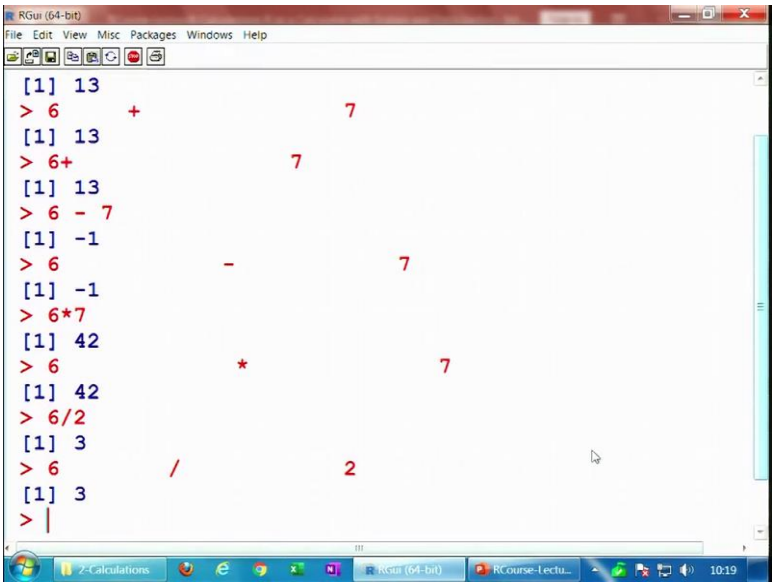

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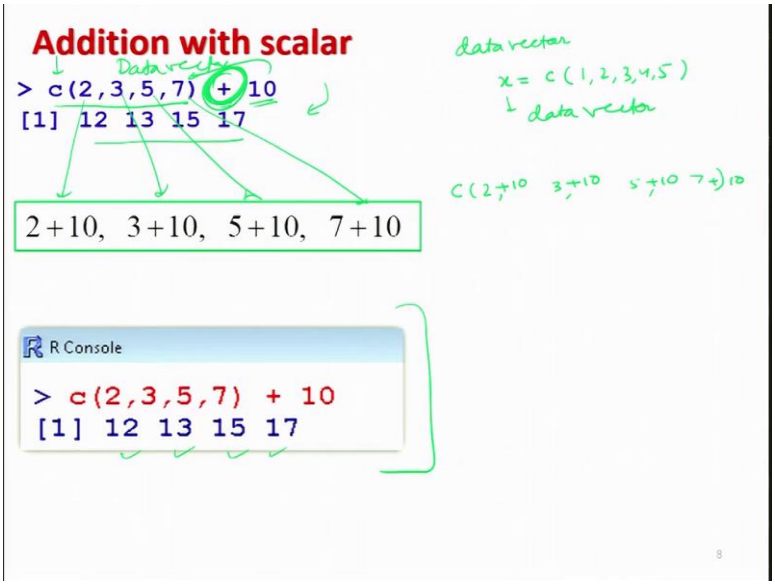

So, that makes the things more simple to understand that how the things are happening in the R software. And, once now you have understood that how the operations between two scalars are being performed, now we can extend this concept when you have a scalar and a data vector. Do you remember what was data vector? We had discussed it in the earlier lecture, that if you want to create any data vector you have to use the c operator, lowercase c.

And, within the parenthesis you have to give the values like 1, 2, 3, 4, 5 etc. and if you try to store it in a variable say x, then now this x is going to be the data vector. So, now I am going to make such operations, when there is an involvement of scalar and a data vector. And, after that I will explain you when there a is an involvement of data vectors only and once you understand these operations, then you can conduct any type of operation involving scalars, data vectors, one data vector, two data vectors and so on, right.

So, and then R has got a little bit different approach of computation when data vectors are used. So, my objective in this lecture is that I want to explain you that how R functions. Once you understand that thing then using that logic you can write your own programs and then you can write your own functions without any problem. So, in order to explain it, once again I will try to take some examples and through those examples I will try to show you. And, I promise you if you understand only the first example, after that understanding all other example will become very simple and straight forward for you.

So, now let me take here the first example. So, if you try to take here, I have taken here a data vector which contains four values 2, 3, 5 and 7 and they have been combined using the operator c and now I try to add here a scalar 10. So, if you enter here, you will get here an outcome like 12, 13, 15, 17. So, now, you have to understand what R is trying to do. Actually, what is happening that when you try to write down here 2, 3, 5 and 7 and as soon as you say here plus 10, this 10 is added to all the numbers.

So, this operation is like this here 2 + 10, 3 + 10, 5 + 10 and 7 + 10. So, what you have to see what is happening? The scalar is entering into this data vector inside this parenthesis and it is operating with the operator which is given here on each of the element inside the

data vector and that is why it is becoming here the outcome comes out to be here 12, 13, 15, 17.

Now, in case if I ask you at this stage, if you have understood the basic fundamental that whenever there is an operation between a data vector and a scalar, then the scalar is entering inside the data vector and it is trying to make the same operation on each of the element. What is this mean? This means that either I am trying to use here addition, subtraction, division, multiplication; don't you think that same logic will hold true? Yes, and that is why I am trying to spend time on the first calculation, after that you will see this will become very simple and very straight forward, right.

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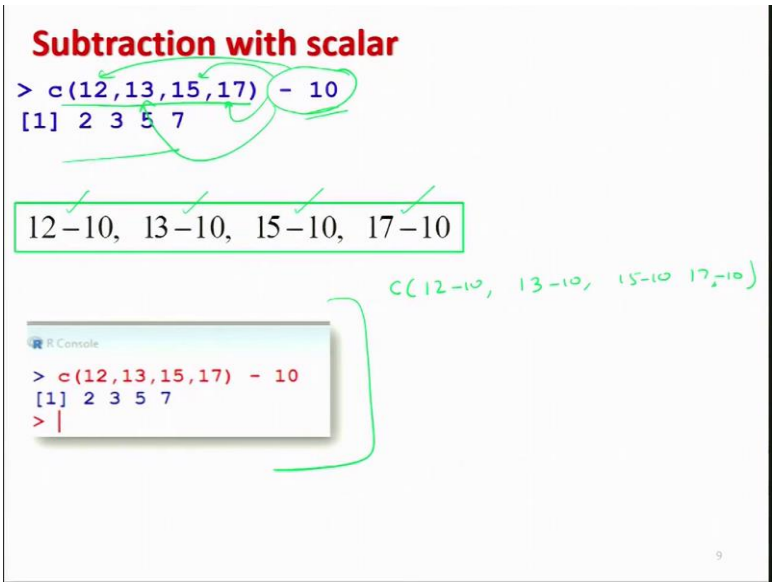

Similarly, if I now ask you that what will happen with the subtraction? You try to take here a data vector which has 4 values 12, 13, 15, 17 and you try to subtract it by a scalar 10. Now, I do not need to explain you, now you can understand it very easily that now this -10 is going to be operated on each of this element, right.

So, this will become here 12 - 10, 13 - 10, 15 - 10, 17 - 10 and the answer will come here, this you can see here 2, 3, 5, 7, right. So, once again I can explain you, if you try to see here this is here 12, 13, 15 and 17. And, now this -10 is jumping inside the data vector and it is trying to operate on each of the element that is all. So, the answer comes out to be here like this.

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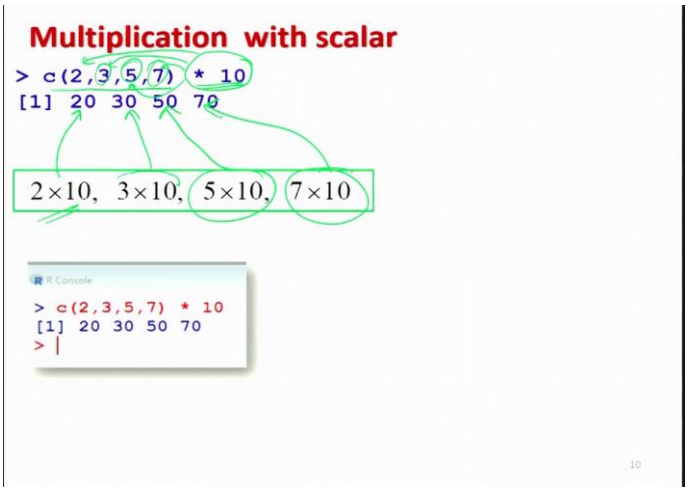

And, similarly if I ask you for the multiplication, do you really think that do I need to explain you? The same logic is going to work here and in case if I try to take here the data vector of 4 values 2, 3, 5, 7 and I try to multiply it with the number 10 then; obviously, this operation multiplication by 10, that is going to be operated on each of this element.

So, what will happen when 2 is multiplied by 10, this gives you an answer 10, when 3 is multiplied by 10, this gives you an answer 30, when 5 is being multiplied by 10, this gives you here the answer 50. And, when 7 is being multiplied by 10, it will give you the answer 70 and this is the same thing which happens here.

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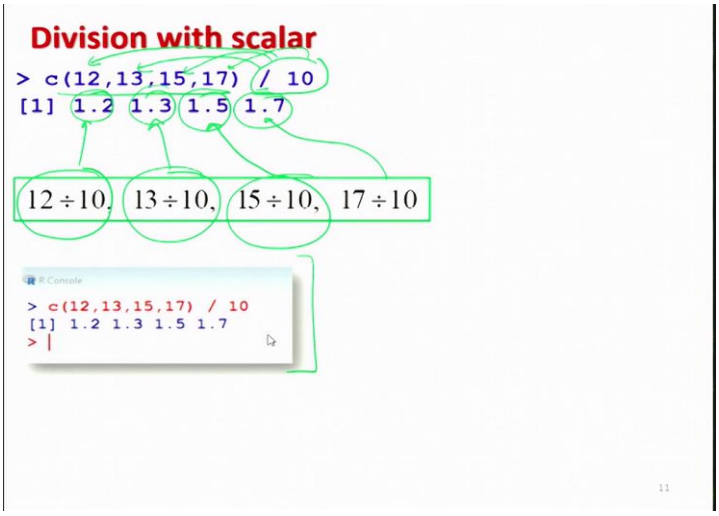

And, in case if you try to think about the division, do I need to explain you? Actually, I do not because, in case if I try to take here one data vector consisting of four values 12, 13, 15, 17 and if I try to divide it by here 10, then this operation that division by 10 that is going to be operated on 12. When operated by 12, this will become like this 12 divided by 10 and the answer will come out to be 1.2.

When it comes to 13, this is 13 divided by 10 and the answer comes out to be 1.3, then it is operated on the 15, then 15 divided by 10 and the answer comes out to be 1.5 and then 17 divided by 10, this comes out to be 1.7 and this is the screenshot here. So, you can see here it is not a very difficult operation which is happening. But, as I said I am not interested in doing this operation. My objective is that you try to understand what is happening with these operations.

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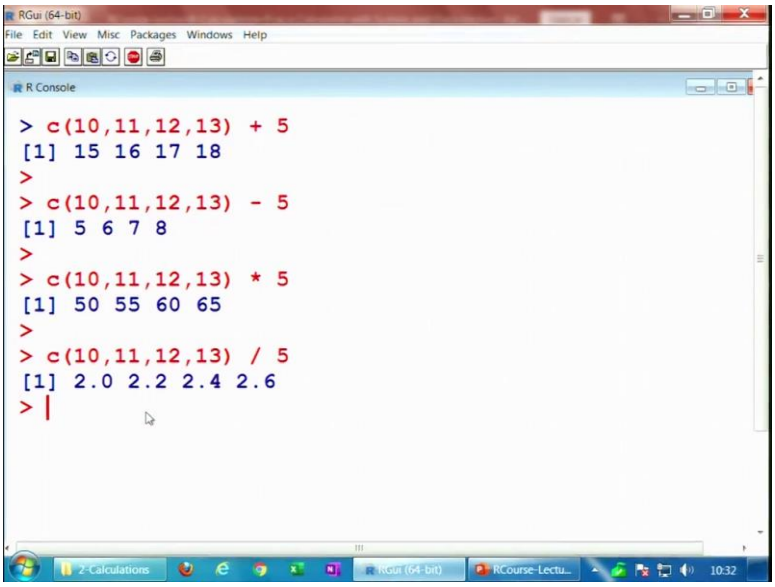

And, now let me try to show you these operations on the R console also. So, if I try to take here some numbers say 10, 11, 12, 13 and if I try to add here with some number here 5. So, you can see here means this 5 is going to be added in each and every element of this data vector and you have this answer 15, 16, 17, 18.

And, similarly if I try to subtract 5 from the same data vector then once again this operation of subtracting by 5 will be operated on each of the element 10, 11, 12, 13. So,

what do you expect? That every element will be subtracted by 5 and your answer will be 5, 6, 7, 8 and similarly if you try to do here with the multiplication; what will happen?

That this multiplication will be happening on each of this element 10, 11, 12, 13 and if you enter here, you get the answer here 50, 55, 60, 65. And, similarly if I try to take here the division so, I can take the same data vector and I try to divide every element by 5. So, you know that when this 5 is going to be operated over 10, 10 divided by 5 is 2.

And, similarly if you try to enter here, you will get here the answer 2.0, 2.2, 2.4 and 2.6. So, now, you can see here that doing operations between the data vector and scalar is not so difficult and it is not even division, addition, division, multiplication, subtraction; they all are pretty simple. Yeah, there are some more operations like as power operation and some other type of arithmetic operation, that I will try to show you in the forthcoming lectures also.

So, now here I stop in this lecture, that you try to take some arbitrary data vectors yourself and try to repeat these operations. Now, when you are trying to repeat these operations you know what is the outcome; for example, you know that what will be the multiplication of 2 into 10. So, try to see the same thing in the R software and try to see are you getting the same thing.

Remember one thing, the human being is the supreme and R is simply following the rules of the human being, the rules which are created by the human beings. So, the rules of mathematics are not created by R software, but the rules of mathematics are created by human beings and R is following them. So, before doing any computation, before doing any mathematical calculations, you have to make sure that R is doing the same thing what you want.

And, that is always a good practice in the programming that whenever you write the program, you are essentially doing some computation. So, before executing it on the final data, try to take couple of values and try to do the calculations manually and try to see that whatever you are doing it manually is R giving you the same outcome and if not, then you have to check where is the problem in the programming. So, you try to practice it and I will see you in the next lecture. Till then good bye.