

MATLAB Programming for Numerical Computation
Dr. Niket Kaisare
Department of Chemical Engineering
Indian Institute of Technology, Madras

Module No. #01

Lecture No. #1.3

Introduction to MATLAB programming –Loops and Execution Control

Hello and welcome to the MATLAB programming for computation course. We are in module 1 introduction to MATLAB programming. We are going to do lecture 1-3 over here, where we are going to cover loop and execution control. Specifically we are going to talk about for and while loops.

(Refer Slide Time: 00:31)

Various Loops in MATLAB

- For Loop (commands below will execute 10 times)

```
for i=1:10
    <statement 1>;
    :
    <statement n>;
```

end



- While Loop (commands below will execute if the condition is true)

```
while i<10
    <statement 1>;
    :
    <statement n>;
```

i=i+1;

end

Okay the loops, the 2 main loops in MATLABs are shown over here. The for loop and the while loop. The command for for loop is of the form for i =1:10, a bunch of statements followed by the command end okay. So, these number of these statements are going to be repeated 10 times. Let us say we wanted to repeated for values of i =1, 3, 5 so on and so forth until 10 okay. We will use the same column notations as before, we will say 1: 2:10 and that should work for i : 1 to 10 in steps of 2 okay.

So, this is something again what we have seen one of the earlier lectures we can use the same concepts in order to use it in the for loop the other loop is called the while loop. The while loop commands will be executed as long as the condition that we state over here is true. So, let say we

start with $i = 1$ and we keep repeating as long as the value of $i < 10$. So, we will repeat it for the value of $i = 1, i = 2, i = 3$ so on and so forth until $i = 9$.

When the value after executing this for the ninth time, when we come across this particular statement, value of i is going to be equal to 10. So, $i = i + 1$ will be 10. When we then go for this particular statement with the execution going back to the first line, right now $i = 10$ which violates the command, which violates the condition $i < 10$ because $i = 10$ is not less than 10 and it will exit this while loops. So if I write this particular loop with, starting with $i = 1$ this loop is going to be executed 9 times okay.

(Refer Slide Time: 02:31)

When to use For Loop

- For loop is used when a set of operations are to be repeated a specific number of times
- Examples
 - Find first 10 terms of Fibonacci series
 - Find factorial of a number n



So where to use for loops? For loop should be used when a set of operations are to be repeated a specific number of times. If we know approximately how many number of times the particular operation is going to repeat, we should use for loops. For example if we want to find the first 10 terms of Fibonacci series, we can use for loop for doing this. Find a factorial of a number n , we can use a for loop because we know that we need to use this, do this for a specific number of times.

(Refer Slide Time: 03:05)

When to use While Loop

- While loop is used when a set of operations is to be repeated if a certain condition is met
- Find all terms of Fibonacci series less than value 200
- Location of a ball thrown upwards is given by $y = v_0 t - \frac{1}{2}gt^2$. Calculate the location of the ball for every 0.1 seconds until it reaches the ground (i.e., $y > 0$)



Now when to use while loop? While loop is used when a set of operations is to be repeated until a certain condition is met. For example, if we want to find Fibonacci series not the first 10 terms of the series but the while find the values till the value of the last term becomes grey, until that value of the last term is less than 200. Then we will use a while loop because what we want to do is not repeat a particular statement for a specific number of times. But we want to repeat it until a condition is met.

(Video Starts: 03:40) So let us go to MATLAB and do this Fibonacci series example using a for loop. So let us say edit a fibo using for okay. And it is going to prompt me yes okay. I am going to write a comment over here. Fibonacci series using for loop, let say $n = 10$.

We wanted to repeated 10 times fibo = 1, 1 okay. why 1, 1 we need 2 elements in order to start the Fibonacci series. If you recall Fibonacci series is any nth element of the Fibonacci series is just the sum of $n - 1$ and $n - 2$ th element. So the first guy is 1, second guy is 1, the third 1 is $1 + 1$ that is 2, the fourth 1 is $2 + 1$ that is 3 the next guy is $3 + 2$ that is 5. The guy after that is $5 + 3 = 8$ so on and so forth okay.

So, now we will use for loop for $i = 3$ to n . Why 3 because we already have the first 2 guys okay. So we are not going from 1 to n , we are going from 3 to n and we will say fibo i that is the next

element is going to be equal to $\text{fibonacci}[i-1] + \text{fibonacci}[i-2]$ and end okay. Save this and run this fibo using for, fibo using for and press enter and I am going to get the Fibonacci series.

You can see this in the work space over here. I will type this out by typing fibo and pressing enter. So, we now have the first 10 terms of the Fibonacci series okay. So, let us say now we wanted to convert it into a Fibonacci series using a while loop and we wanted to do this until the element becomes equal to or greater than 200. The last element has to be less than 200 and that is the condition that we will use. So edit fibo using while okay.

Okay, so we have $\text{fibonacci} = 1, 1$ and let me put comment over here. Fibonacci series until 200 using while loop okay. So, $\text{fibonacci} 1, 1$ okay. While $\text{fibonacci}[\text{end}]$ which is the last element of fibo is less than 200, so as long as the last element of fibo is less than 200. I am going to repeat the steps. $\text{fibonacci}[\text{new}] = \text{fibonacci}[\text{end}]$. That is the last term from the previous series and $\text{fibonacci}[\text{end} - 1]$ okay. Now next what we are going to do is, we are going to expand the array fibo with the fibo new term.

And i will say this as fibonacci , $\text{fibonacci}[\text{new}]$ okay. Square brackets not circular brackets over here and end okay. And once I do this, I am going to be able to run this particular code until the value of the Fibonacci series reaches up to 200 or below 200 okay. So, this is the same thing that did earlier initializing fibo as 1, 1 until the last element of the vector $\text{fibonacci} < 200$ the while loop is going to be repeated the new element which has to be appended at the end of the fibo is going to be equal to the sum of the last 2 elements.

The last element is extracted using the code word called end. End extracts the last element of any vector or an array, so, $\text{fibonacci}[\text{end}]$ is going to extract the last element of a fibo and $\text{fibonacci}[\text{end} - 1]$ is going to extract the second last element. So, I am sorry it should be + and not - over here okay. And then fibo is going to be fibonacci and the last element that has been extracted. And I save this and run this fibo using while and press enter get my fibo, I type fibo and this is what I get.

So 1, 1, 2, 3, 5 and so on up to 233. And the reason why I actually got that element 233 is because this loop was repeated. When the element 233 was already present in the fibo loop and if I did not want that particular element in the fibo array I just need to do $\text{fibonacci}[\text{end}] = \text{blank}$. What

this is going to do is, it is going to replace the last element with null which basically means that is nothing but killing the last element. And I can do that and let me now try that over here using fibo using while okay. And now when I type fibo I am going to get 1 to 144. The 233 which is $89 + 144$ is no longer present the other way to do this instead of using `fibo end = blank`.

The other way to do this is, to do type `fibo = fibo 1 : end - 1` okay. That is the other way to type this. This is the type of format that will have been using so far. Is this is the standard colon notations and colons notations is going not from 1 to end but not 1 to end - 1. So, all the elements except the last element is going to be extracted out of the array fibo and reassigned with the same array fibo.

Okay let us try this out again. I will give the command `clear all` to clear all the works space arrays okay. And type fibo using while. Note that I am not typing the command; I know that I have recently used that command. So, I am just going to use up array in order to select the previous command and type enter and type fibo and I am going to get the Fibonacci series okay.

What we have get computed in Fibonacci series until 233 and when it comes across this particular command it going to extract the first 12 elements not the last element from that particular array. So we will have the array up to 233 and then the last element is going to be removed and the first 12 elements are going to be reassigned to the array fibo okay. (Video ends: 11:20)

(Refer Slide Time: 11:21)

When to use While Loop

- While loop is used when a set of operations is to be repeated if a certain condition is met
- Find all terms of Fibonacci series less than value 200
- Location of a ball thrown upwards is given by $y = v_0t - \frac{1}{2}gt^2$. Calculate the location of the ball for every 0.1 seconds until it reaches the ground (i.e., $y > 0$)

(Refer slide 11:27)

When to use For Loop

- For loop is used when a set of operations are to be repeated a specific number of times
- Examples
 - Find first 10 terms of Fibonacci series,
 - Find factorial of a number n
 - ...

So that is how we have calculated first 10 terms of an fibonacci series or all the terms of fibonacci series less than 200 okay. Now let us where think about the example that we saw in the first lecture that was of Dhoni hitting a 6. In that example what we did was Dhoni has hit the ball and we were trying to compute how the ball trajectory is going to be until the ball reaches the ground. Let us create another example, where the ball is hit vertically instead of at an angle.

Let us say that the ball is hit vertically with a velocity of v_0 okay. So, when it hit vertically with a velocity of v_0 the gravity that is acting against it in the downward direction. So, the ball is going to go vertically upwards, going to reach a certain height which velocity is going to 0 and

then it is going to fall downwards under gravity. So let us say we wanted to find location of the trajectory, of the ball that is thrown upwards at the end of every 0.1 seconds. We are going to use this particular calculation in order to get y at every 0.1 seconds.

(Video Starts: 12:40) So let us do that using a while loop okay. So, we will say edit ball vertical okay and I will say display location of ball hit vertically every at every 0.1 seconds okay. So let say $v_0 = 20$ meters per second, gravity was equal to 9.8 meter square per second okay. So we will do while $y \geq 0$.

We are going to repeat this => sorry ≥ 0.1 because we want to compute at the end of every 0.1 seconds. y is going to be equal to a v_0 multiplied by t - g multiplied by t square divided by 2 okay.

And we want to display this at $t = \text{num2str } t$, location = y okay. We have not yet covered how to work with a string this is something that we are going to cover in next lecture okay. How so just bare with me I will take this particular example again in the fifth lecture 1 -5 lecture and we will go over it. And we will say end okay. What I am doing over here is, I am at each step. Whenever we are repeating this particular array okay.

I am calculating the new time, I am calculating the location y at that particular time and I am displaying the time and location y okay. I am going to repeat that so long as $y \geq 0$ that means the ball is in the air and has not reached the ground okay. So let me do that I will say ball vertical and press enter and this is what I am going to get okay. So, I started at 0.1 at time 0.1, we have reached 1.9 meters at 0.2 seconds, we have reached 3.8 meters so on and so forth.

And at time 4.1, we have reached below the surface okay. The equation is valid only until the ball reaches the surface is no longer valid beyond that so we are getting an incorrect result over here. Just as before what has happened over here is that particular loop was executed until the value reached a value before a negative value. If we do not want that to happen what simply we should we should be doing is we should be displaying before and not after computation of that value.

And if we do that and we execute I will just clear the screen and I will execute the ball vertical. What is going to happen is, the location will be displayed until the ball is in the air, not when the ball has reached the surface and again you will see that it is starting at $t = 0$ location in is equal to 0 instead of starting at $t = 0.1$ okay. (Video Ends: 17:01)

So this is the thing that I wanted to cover with respect to for loops and while loops. So just to recap, when to use for loops is, for loops is to be used when a set of operations is to be repeated a specific number of times. Whereas the while loops is to be used when a set of operations is to be repeated until a certain as long as sorry, certain condition is met okay. Okay so, with this we come to an end of this lecture. In this lecture we have covered how to use for and while loop in MATLAB. Thank you and see you in the next lecture.