**While Loops**

[00:00:00.48] [MUSIC PLAYING]

[00:00:08.11] RYAN AHMED: Hello, everyone. And welcome to this lesson on while loops. While loops continuously repeat a block of code as long as a given condition is held true. When the condition in the while becomes false, the program control passes to the code line immediately following the loop.

[00:00:27.56] Here are the key learning objectives of this lesson-- understand the syntax and use case of while loops, learn how to use the break keyword to exit while loops, learn how to generate an infinite while loop.

[00:00:42.39] So let's head over to our Jupyter Notebook and get started.

[00:00:45.20] [MUSIC PLAYING]

[00:00:52.61] All right. So right now we are in the Jupyter Notebook titled while loops. So while loops continuously repeat a block of code as long as a given condition is held true. Let me show you an example. Let's assume that I would like to print out these numbers to the screen. I would like to print out 0, 1, 2, and 3 as an example.

[00:01:17.13] And I'm going to use while loop to do that. Let me walk you through the syntax and what is actually happening behind the scenes as well. So what I'm going to do here is first, I'm going to define a counter. I'm going to call it i. And I'm going to put 0 in it. This is simply the initialization for my counter i.

[00:01:39.08] Next, I'm going to say while i is less than or equal to 3. And then I'm going to add colon at the end. This is simply the syntax for the while loop. And while loop works by saying while. This is the key word that I would like to use. And then I specify a condition afterwards.

[00:02:01.43] As long as that condition is held true, I'm going to simply repeat all the block of code coming up after the indentation or the white space. So I'm going to repeat that multiple times as long as this condition is held true.

[00:02:19.52] So what I'm going to do here, is going to say, OK. Is i less than or equal to 3. Well, i initially was 0. So 0, yes, was actually less than or equal to 3. So this condition was true.

[00:02:34.47] So if that satisfied, that's great. I'm going to go ahead and execute the body of the while loop. I'm going to print i. So I'm going to print 0. And that's the output that I see here on the right hand side. And then I'm going to increment the counter by 1. So I'm just going to increment the value of i by 1.

[00:02:54.65] So now I'm going to get 0 plus 1. Now, the new value of i is equals to 1. Please note that I'm not going to exit. I need to go up again to the while loop and ask the question again. Make sure that the condition is still hold and true. I'm going to say, OK, is 1 less than or equal to 3. Well, the answer is yes. That's true.

[00:03:19.49] And I'll go ahead and execute the body of the while loop. So I'm going to print 1. And this is simply the output that I'm going to see here. And then I'm going to increment 1 by 1. So 1 plus 1 becomes 2. So the new value of i right now is 1.

[00:03:36.95] I'm going to go up again. And then I'm going to ask the question. Is 2 less than or equal to 3. Well, the answer is yes. The condition is satisfied. I'm going to go ahead and print i. So I'm going to print 2.

[00:03:48.98] And then I'm going to increment it again. So 2 plus 1 becomes 3. And I'm going to go up again and check the condition. Is 3 less than or equal to 3. Well, the answer is true. Yes. Because 3 is equal to 3.

[00:04:04.46] So I'm going to print i. So I'm going to print 3. And then I'm going to increment 3 by 1. I'm going to say 3 plus 1 becomes 4. So I'm going to go up. And then I'm going to ask the question. Is 4 less than or equal to 3. Well, the answer is no. That's not true anymore. Please note that I'm not going to execute the body of the while loop. We're just going to exit the while loop.

[00:04:29.91] So I'm just going to leave and then execute whatever code that comes up after the while is over. And this is simply why you generate the outputs here starting from 0, 1, 2, and 3. Please note that were going to use while loop quite extensively, actually in the final project as well. But this is simply the syntax of while loop.

[00:04:50.88] Let me go ahead and walk you through the code. All right. So let's go ahead and cover our first code cell. So what I have here is I defined a value of i, and I put 0 in it. This is simply the initialization for the counter i. And then I'm going to say while. Is i less than or equal to 3. Well, the answer is right. That's true. So 0 is in fact less than 3.

[00:05:15.39] I'm going to go ahead and print i. So I'm going to print 0. And then I'm going to increment i by 1. So it becomes 1. Go up again. Check the condition. I'm going to print 1. And then I'm going to print 2. And then finally I'm going to print 3.

[00:05:30.84] So if you press Shift and Enter in your keyboard, here we go. Now, we have been able to generate the exact same output that we covered here before in the slide. OK. And this is exactly the same syntax that I showed you here.

[00:05:43.83] All right. So let me show you another example. Let's assume that I would like to calculate the future value of a lump sum of money. So assume, for example, that I have $1,000 today in my bank account, and the interest rate is 10% annually. So what I'm going to do is I'm going to leave that money to grow for one year.

[00:06:07.69] So what I'm going to do is first, I'm going to define a variable. I'm going to call it PV, which stands for present value. And then I'm going to put $1,000 in it. Next, I'm going to define another variable for the interest rate. I'm going to say interest rate's going to be equal to 0.1, which simply our 10%.

[00:06:26.76] In order for me to calculate the future value after one year, this is simply the equation that I'm going to use. I'm going to say FV or future value is equal to my current present value plus whatever interest that I accumulated in one year. So present value is $1,000. The interest that I'm going to accumulate in one year is 1,000 times 0.1, which is times 10%, which is $100.

[00:06:56.52] So I'm going to get 1,000 plus $100. Then I'm going to get $1100. OK. Press Shift Enter. This is going to be the future value of my investment after exactly one year.

[00:07:10.14] Well, what if I wanted to see the investment, my amount, that my dollar amount, after two years or maybe after three years or four. Well, let me show you how we can print out the accumulated value at the end of every year using while loops.

[00:07:30.81] So now let's assume that again, I'm going to put my $1,000 in my account. The interest rate is 10% annually. And then I'm going to leave it here three years, as an example. And what I wanted to do is I would like to see what would be the future value after each year.

[00:07:48.73] So what I'm going to do is I'm going to use while loops to simply print out the future value at the end of every year. So I'm going to define years. And then I'm going to put 1 in it. That is going to be my initial value. I'm going to define an amount, and that would be $1,000. I'm going to also define the interest rate. And that is going to be 0.1.

[00:08:14.48] And then I'm going to write a while loop that simply print out the amount at the end of every year. So I'm going to say while as long as this condition is true. So as long as years, which is initialized here to 1 initially, is less than or equal to 3, please go ahead and execute the following.

[00:08:34.61] Grab the amount. Add to it whatever interest that has been accumulated within that year. And then sum these two together. And then put that in the new amount. Just update the amount again. Print out for me the future value in specific year. This could be year one, two, or three, is equal to the amount.

[00:08:58.44] So in year one, I'm going to print the amount. Year two, I'm going to print the updated amount. Year three, I'm going to print the third or the most up to date amount. And of course, every time I'm going to grab the years variable. I'm going to add the 1 to it. So initially it's going to be year one. And then year two.

[00:09:16.32] Long as years is less than or equal to 3, I'm going to execute this while loop. Once I go to four, I'm just going to exit. I'm just going to leave the while loop.

[00:09:27.34] Let me run the sum and show you the output. So if you press Shift and Enter. Here we go. Simply what you get right now, is you get the future value in year one is equal to 1100. And then the future value in year two is going to be 1210. And then the future value in year three is going to be 1331.

[00:09:48.76] Let me show you again what's going to happen behind the scenes. So first, I'm going to initialize years equals to 1. And then I'm going to ask a question. Is 1 less than or equal to 3. Well, the answer is right. The answer is true. So I'm going to go ahead here. I'm going to grab the amount, which is a $1,000 plus 0.1 times 1,000. So that's 100.

[00:10:11.47] So 1,000 plus 100. The amount is going to be 1,100. So I'm going to print the following, the future value in year one, because years has one in it. It's going to be equal to 1,100. And this is simply the output that I'm going to generate here in the first iteration.

[00:10:30.31] Next, I'm going to grab the 1 plus 1 becomes 2. So years right now is equal to 2. I'm going to go up again. And then I'm going to ask a question. Is 2 less than or equal to 3. Well, the answer is true. The answer is right. So I'm still in the while loop. I'm going to execute the body of the while loop.

[00:10:50.38] And then I'm going to do the following. I'm going to grab the new amount, which is my 1,100. Plus I'm going to get a new interest value. And then I'm going to sum them together to generate a new amount in the second iteration. And that will be my 1,200. So I'm going to say the future value in year two, that's where I got here. It's equals to 1210.

[00:11:14.85] And then I'm going to increment years by 1. So I'm going to grab 2 plus 1 becomes 3. I'm going to go up, ask a question. Is 3 less than or equal to three. Still true. So I'm going to grab the amount right now, which is my 1210 plus whatever interests that I'm going to accumulate. This is simply 0.1 times 1210. And then I'm going to sum them together. I will end up with 331.

[00:11:43.91] Print them out. So I'm going to print the future value in year 3 equals to 1331. And then I'm going to increment years by 1. So now it becomes 4. Go up again. Ask a question. Is 4 less than or equal to 3. The answer is no. That's not true anymore. It's just going to exit the white loop. And this is simply the output that I'm going to generate. And that's it.

[00:12:05.83] OK. What I wanted to show you finally is I wanted to show you two key points. First, I could actually define a white loop that can go on forever by setting the condition to be always true. So if I say while true and add colon, basically what I'm saying is, go ahead, repeat that block of code forever, as long as possible essentially. Because I'm not going to exit in here.

[00:12:32.48] But if you plan to do that, and if you leave it running, of course that could cause memory overflow. And that could crash the Jupyter Notebook at some point. And that's why if you decide to do that, I'm going to kind of manufacture within the while loop to add a condition to break the loop inside. And that's what I'm doing here.

[00:12:53.27] So as an example, let's assume that I would like to keep doubling a variable with every iteration until the total value reaches $1,000. And then I would like to exit, as an example. To do that, I'm going to define a variable. I'm going to call it x. I'm going to put 1 in it. I'm going to say while true, please go ahead repeat that block of code forever. OK.

[00:13:16.34] And then I'm going to say grab the x, multiply times 2, and update the value of x. And print for me please the value of x. We learned how to do that before. And then I'm going to add an if condition. I'm going to say, OK, if you find the value of x at any time within the while loop is greater than 1,000, please go ahead, break the loop.

[00:13:39.51] So this keyword simply is going to exit the while loop right away. So if you run it right now, if you press Shift Enter, simply what you get here is you get value equals 2 and then value equals to 4, value equals to 8. So you are doubling every time. Once you reach 1,024, this condition has been satisfied.

[00:14:01.68] So you will see this is going to break the while loop. And that's simply how you can leverage the while true, and you can also leverage the break keyword as well to break while loops. OK.

[00:14:12.23] All right. So that's it. That's simply all I have for this lesson. I hope you enjoyed it.

[00:14:17.18] In the next lesson, we're going to have our practice opportunity/ coding lab. So please go ahead, give it a shot. Give it a try. Write your code in here. And then I'm going to show you a detailed video explanation of my solution.

[00:14:29.00] Please stay tuned. Best of luck. And I'll see you in the next lesson.

[00:14:32.24] [MUSIC PLAYING]