

Repetition

Michael C. Hackett
Assistant Professor, Computer Science

Community
College
of Philadelphia

Lecture Topics

- Repetitive Structures
 - Count-Controlled Loops
 - Sentinel-Controlled Loops
- Input Validation
- Branching Statements
- Infinite Loops
- Nested Loops

Colors/Fonts

• Variable Names	—	Brown
• Standard data types	—	Fuchsia
• Literals	—	Blue
• Keywords	—	Orange
• Operators/Punctuation	—	Black
• Function Names	—	Purple
• Comments	—	Gray
• Module Names	—	Pink

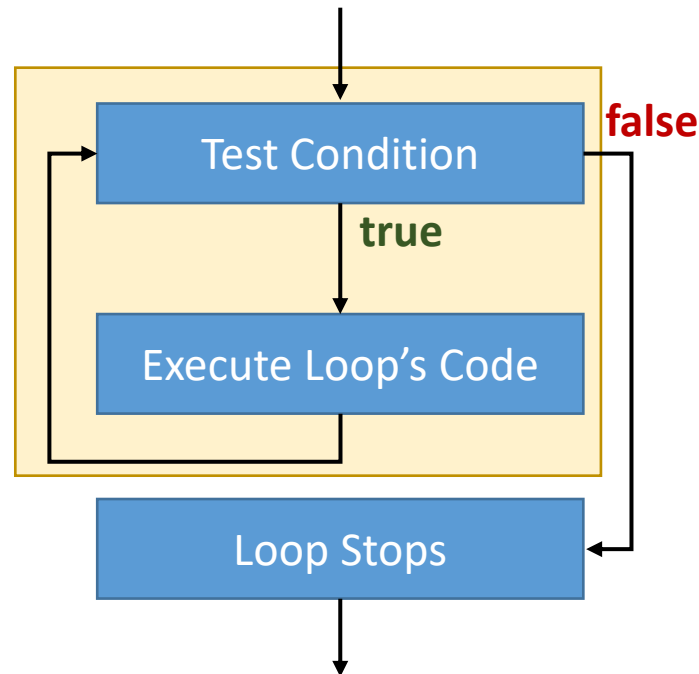
Source Code	— Consolas
Output	— Courier New

Loops

- A ***loop*** is a programming structure that allows code to be repeatedly executed, usually as long as some condition (Boolean expression) evaluates to true.
 - Each repetition of the loop's code is called an ***iteration***.
- Programming languages have a few types of loops.
 - Pre-test and Post-test Loops
 - Sentinel-Controlled and Count-Controlled.

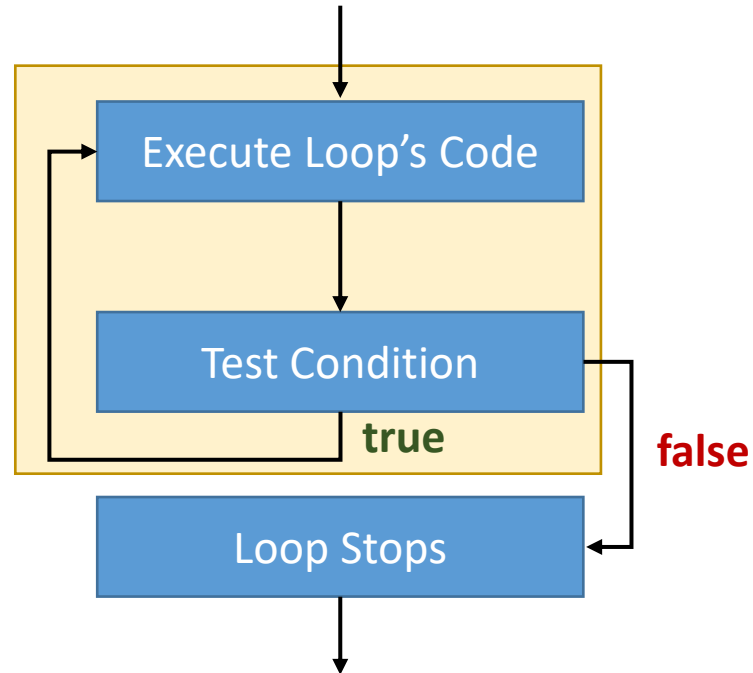
Types of Loops

- ***Pre-test loops*** test the condition *before* starting each iteration.



Types of Loops

- ***Post-test loops*** test the condition *after* completing each iteration.
 - Python does not have a post-test loop.



Count-Controlled Loops

- A loop is ***count-controlled*** when it iterates through a range of values.
- Each iteration, the loop assigns the next value in the range to a variable that can be used in the loop's code.
- The loop stops when it has exhausted the list of values in the range.
- A “for loop” is a count-controlled loop.

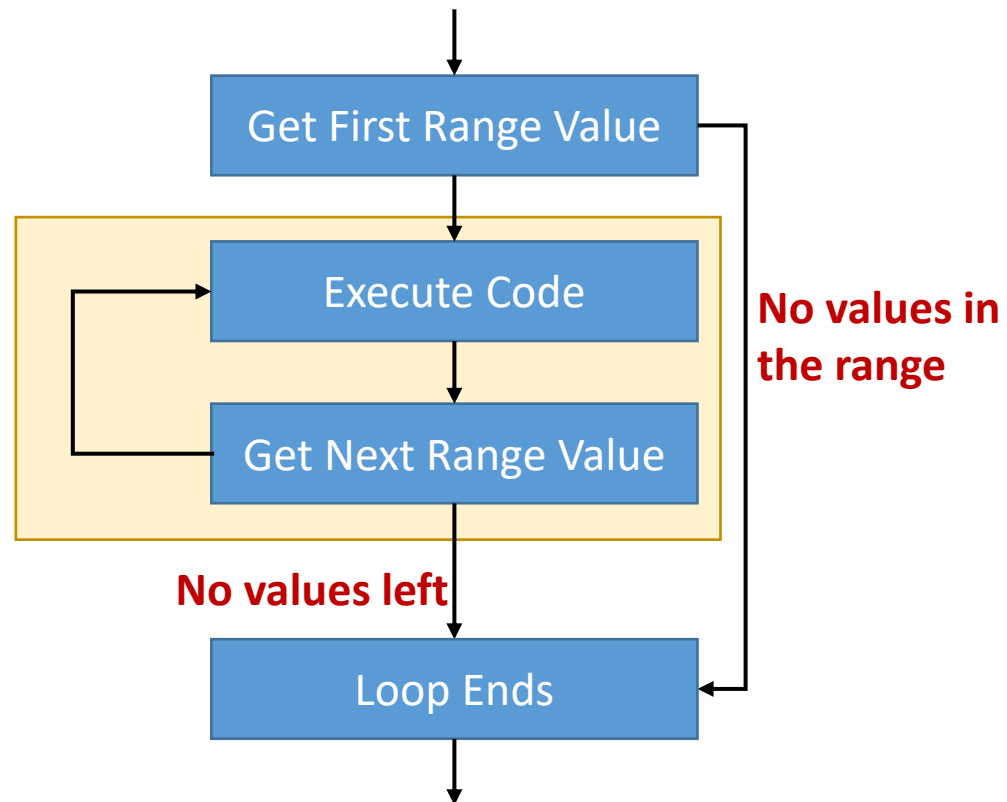
For Loops

- A ***for loop*** iterates over a range of values.
 - Often implemented using Python's built-in range function.

```
for variable in range :  
    #code that will be  
    #executed for every value  
    #in the range
```

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For Loop (Flow Chart)



Range Function

- Accepts one, two or three arguments.

range(5) —————> Values 0, 1, 2, 3, 4

range(2, 8) —————> Values 2, 3, 4, 5, 6, 7


range(3, 10, 2) —————> Values 3, 5, 7, 9

range(11, 7, -1) —————> Values 11, 10, 9, 8

For Loop

- A for loop that simulates making 5 laps around a race track.

Start (inclusive) Stop (exclusive)




```
for counter in range(1, 6) :  
    print("Lap #" + str(counter))  
  
print("Finished!")
```

```
Lap #1  
Lap #2  
Lap #3  
Lap #4  
Lap #5  
Finished!
```

For Loop

Start (inclusive) Stop (exclusive)

```
for i in range(3, 8) :  
    print("Number: " + str(i))
```

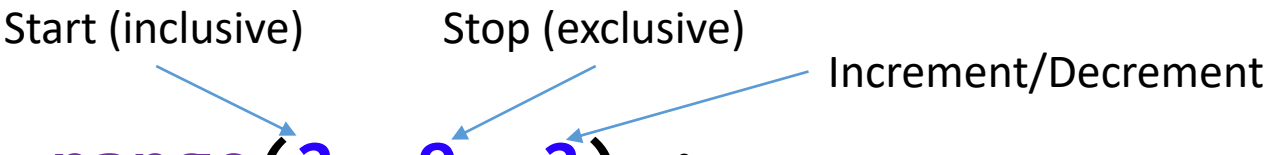


```
Number: 3  
Number: 4  
Number: 5  
Number: 6  
Number: 7
```

For Loop

Start (inclusive) Stop (exclusive) Increment/Decrement

```
for i in range(2, 9, 2) :  
    print("Number:", i)
```

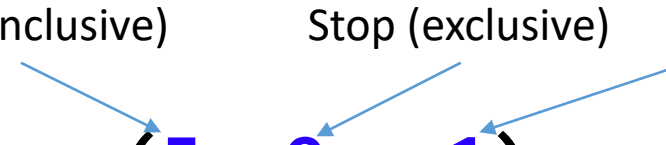


```
Number: 2  
Number: 4  
Number: 6  
Number: 8
```

For Loop

Start (inclusive) Stop (exclusive) Increment/Decrement

```
for i in range(5, 0, -1) :  
    print("Number:", i)
```



```
Number: 5  
Number: 4  
Number: 3  
Number: 2  
Number: 1
```

For Loops

- Python's for loop is referred to as an ***enhanced for loop*** in other languages.
 - Also called an *iterator-based*, *for-in*, or *for-each* loop.
 - It is capable of iterating through a list of items, not just numbers.
- Other languages have ***traditional*** ("C-style") ***for loops***.
 - Introduced in the C programming language.
 - Only iterates over a range of numbers.
 - Python does not have C-style for loops.
 - Java has both C-style for loops and enhanced for loops.
 - (We'll see how to use both when we move on to Java)

Sentinel-Controlled Loops

- A loop is ***sentinel-controlled*** when it uses a certain value or values to indicate that the loop should stop repeating.
 - This value is referred to as a ***sentinel value*** or ***flag value***.
- A “while loop” is a sentinel-controlled loop.

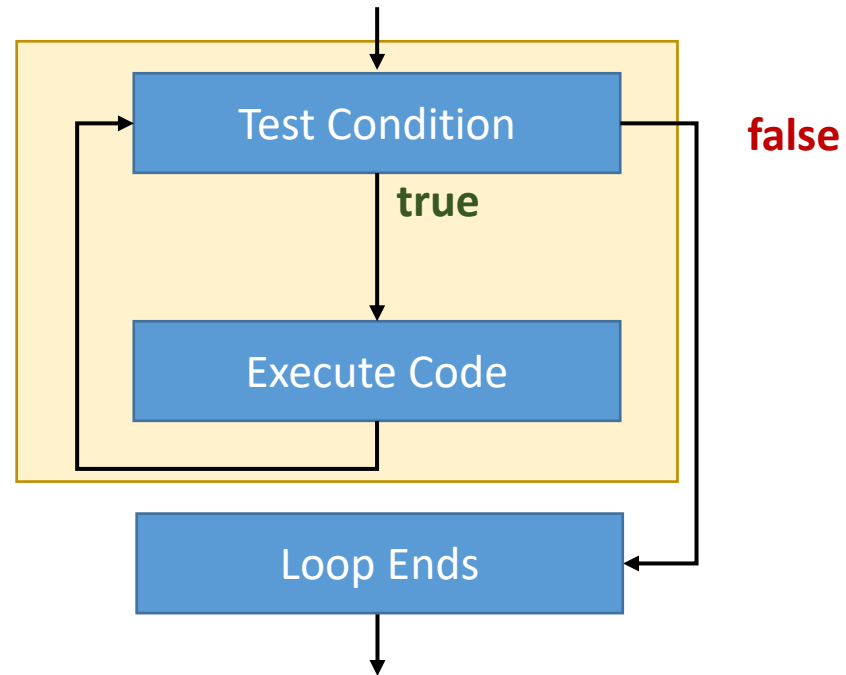
While Loop

- A ***while loop*** repeats as long as its Boolean expression is true.
 - “*While this condition is true, keep repeating...*”
 - When the condition is false, the loop stops.
- The syntax for a Python while loop is shown below.

```
while Boolean Expression :  
    #code that will be  
    #executed as long as the  
    #Boolean Expression is true
```

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Indent one tab


While Loop (Flow Chart)



While Loop

```
i = 3
while i < 8 :
    print("Number: " + str(i))
    i += 1

print("Program Complete.")
```



A black arrow points from the text "Sentinel Value" to the number 8 in the while loop condition.

```
Number: 3
Number: 4
Number: 5
Number: 6
Number: 7
Program Complete.
```

While Loop

- A while loop may not iterate at all, if the condition is false from the start.

```
i = 12
```


```
while i < 8 :  
    print("Number: " + str(i))  
    i += 1
```

```
print("Program Complete.")
```

Program Complete.

While Loop

```
input = input("Enter word: ")  
  
while input != "exit":  
    #Print the input  
    print("You entered: " + input)  
    #Prompt for input again  
    input = input("Enter word: ")  
  
print("Goodbye!")
```



Sentinel Value

```
Enter word: cat  
You entered: cat  
Enter word: dog  
You entered : dog  
Enter word: llama  
You entered : llama  
Enter word: exit  
Goodbye!
```

While Loop

- In the while loop below, the sentinel value that will trigger the loop to terminate is when *any number* less than one is entered.

```
done = False #Controls the loop
```

```
while not done :  
    number_to_square = int(input("Enter a number: "))  
    if number_to_square < 1 :  
        done = True  
    else :  
        print("Your number squared is: " +  
              str(number_to_square ** 2))  
  
print("Goodbye!")
```

```
Enter a number: 3  
Your number squared is: 9  
Enter a number: 4  
Your number squared is: 16  
Enter a number: 0  
Goodbye!
```

For vs While Loops

- While loop
 - Use when you need to iterate as long as a condition is and remains true.
 - Sentinel-controlled.
- For loop
 - Use when you need to iterate over a range of values.
 - Count-controlled.
- Both are pre-test loops.

Input Validation

- While loops are useful when validating a user's input.
- It can continue to prompt a user for input in the event the user enters invalid values.

```
Enter a positive number: -4
Error. Entered number is not positive.
Re-enter a positive number: 0
Error. Entered number is not positive.
Re-enter a positive number: 5
Thank you!
```


Input Validation

```
input = int(input("Enter a positive number: "))

while input < 1 :
    #Print error message
    print("Error. Entered number is not positive.")
    #Prompt for input again
    input = int(input("Re-enter a positive number: "))

print("Thank you!")
```

```
Enter a positive number: -4
Error. Entered number is not positive.
Re-enter a positive number: 0
Error. Entered number is not positive.
Re-enter a positive number: 5
Thank you!
```

Input Validation

```
input = int(input("Enter a number between 1 and 10: "))

while input < 1 or input > 10 :
    #Print error message
    print("Error. Entered number is outside of specified range.")
    #Prompt for input again
    input = int(input("Re-enter a number between 1 and 10: "))

print("Thank you!")
```

```
Enter a number between 1 and 10: -4
Error. Entered number is outside of specified range.
Re-enter a number between 1 and 10 : 20
Error. Entered number is outside of specified range.
Re-enter a number between 1 and 10 : 5
Thank you!
```

Branching Statements

- There are two branching statements that allow us to either:
 - Immediately exit a loop.
 - Immediately begin the next iteration.

break

- Once encountered, the loop will immediately stop where it is. Any code outside/after of the loop will begin to be executed.

continue

- Once encountered, the loop will immediately stop where it is and begin the next iteration.

break statement

```
for i in range(1, 10) :  
    if i > 5 :  
        break  
    print("Number:", i)  
  
print("All done!")
```

```
Number: 1  
Number: 2  
Number: 3  
Number: 4  
Number: 5  
All done!
```

- This loop normally would have printed “Number: 1” through “Number: 9”
- However, once the value of i is greater than 5, the break statement will be encountered.
- The loop will exit immediately and resume the code outside of the loop.

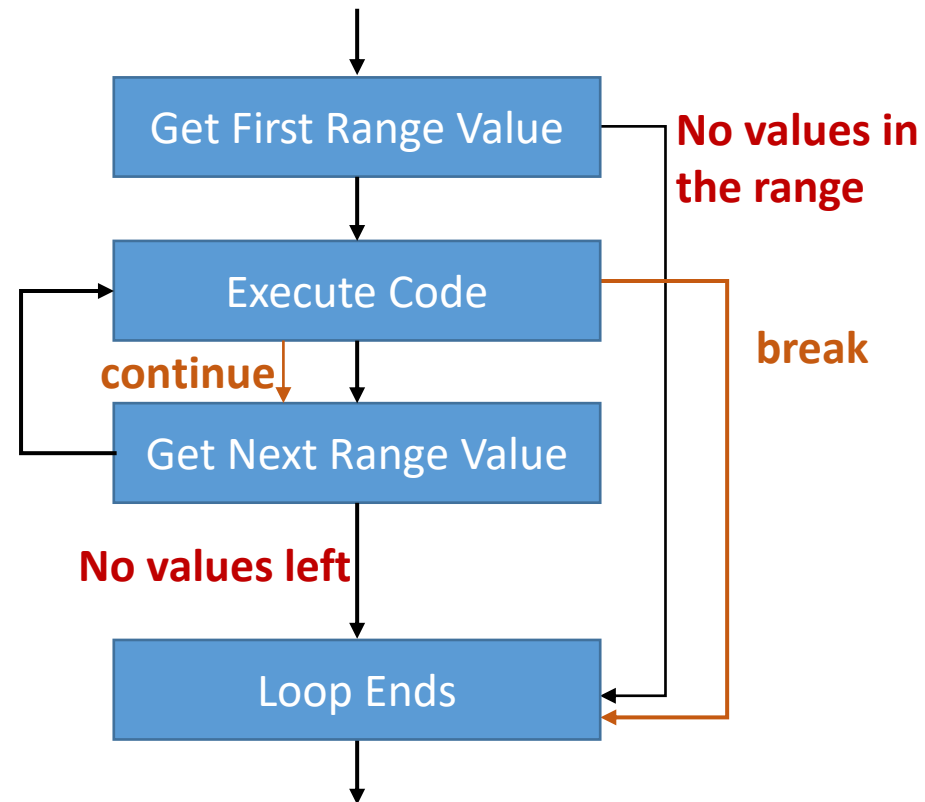
continue statement – for loop

```
for i in range(1, 11) :  
    if i % 2 == 1 :  
        continue  
    print("Number:", i)  
  
print("All done!")
```

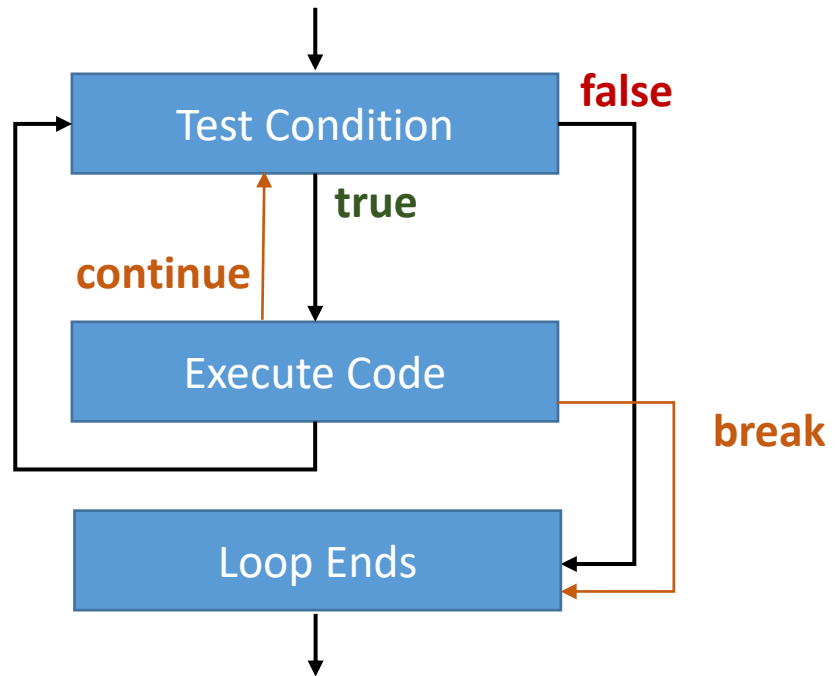
```
Number: 2  
Number: 4  
Number: 6  
Number: 8  
Number: 10  
All done!
```

- If i's value is odd, the continue statement will be encountered.
- Instead of finishing the iteration and printing out the number, the loop stops there and begins the next iteration.

For Loop



While Loop



Infinite Loops

- An *infinite loop* is a loop that never stops.
 - In the example below, the loop's condition will never be false.

```
done = False
my_number = 0
while not done :
    my_number += 1
    print("Number: " + str(my_number))
```

```
Number: 1
Number: 2
Number: 3
Number: 4
Number: 5
...
```

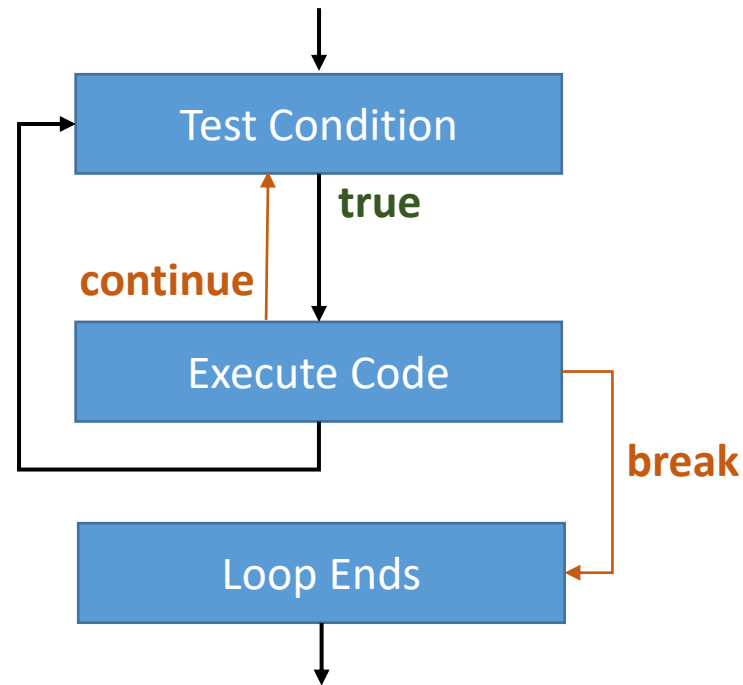
- Enhanced for loops will never be infinite, because the range of values is always finite.
- We'll look more closely at infinite loops when we move on to looping in Java.

Infinite Loops

```
while True :  
    number_to_square = int(input("Enter a number (0 to exit): "))  
    if number_to_square == 0 :  
        break  
    else :  
        print("Your number squared is:", number_to_square ** 2)  
  
print("Goodbye!")
```

```
Enter a number (0 to exit): 3  
Your number squared is: 9  
Enter a number (0 to exit): 4  
Your number squared is: 16  
Enter a number (0 to exit): 0  
Goodbye!
```

Infinite While Loop



Nested For Loops

- A nested loop is a loop within a loop.
- For every iteration of the outer loop, the inner loop will be iterated to completion.

```
for i in range(1, 4) :  
    print("Number:", i)  
    for j in range(1, 3) :  
        print("Number:", j)
```

Be sure to use different names for your counters. Any variables declared in outer loops will be accessible by inner loops, including the counter.

Nested For Loops

```
for i in range(1, 4) :  
    print("Outer Number:", i)  
    for j in range(1, 3) :  
        print("Inner Number:", j)
```

Outer Number: 1			
Inner Number: 1	}	Inner Loop	}
Inner Number: 2			
Outer Number: 2			
Inner Number: 1	}	Inner Loop	}
Inner Number: 2			
Outer Number: 3			
Inner Number: 1	}	Inner Loop	}
Inner Number: 2			