Repetition: Loop Usage

CPSC 217: Introduction to Computer Science for Multidisciplinary Studies I
Winter 2023

Jonathan Hudson, Ph.D.
Instructor
Department of Computer Science
University of Calgary

January 9, 2023

UNIVERSITY OF CALGARY

Compare Loop Types

For vs While

Loops in Python – Developing for/while

The following are equivalent loops:

```
sum = 0

for i in range(0,10,1):
     sum = sum  + i

print(sum)
```

```
sum = 0
i = 0
while  i < 10:
    sum = sum + i
    i = i + 1
print(sum)
```

Loops in Python – Developing for/while

The following are equivalent loops:

```
sum = 0

for i in range(0,10,1):
     sum = sum  + i

print(sum)
```

```
sum = 0
i = 0
while  i < 10:
    sum = sum + i
    i = i + 1
print(sum)
```

Break/Continue

UNIVERSITY OF CALGARY

Break and Continue

- Allow a loop iteration to end prematurely
- `break`
  - Entire loop ends immediately
  - Execution continues at the first statement after the loop body
- `continue`
  - Current iteration ends immediately
  - Execution returns to the top of the loop
    - In a for loop, the next item in the list is used

Break and Continue

```
for i in range(1,12):
  if i == 5:
    break
  print(i)
```

```
for i in range(1, 12):
  if i == 5:
    continue
  print(i)
```

1, 2, 3, 4

ends loop at 5 before print

1, 2, 3, 4,   6, 7, 8, 9, 10, 11

skips rest of body before print at 5

Break and Continue

```
i = 0
while i <= 10:
  i += 1
  if i == 5:
    break
  print(i)
```

1, 2, 3, 4

ends loop at 5 before print

```
i = 0
while i <= 10:
  i += 1
  if i == 5:
    continue
  print(i)
```

1, 2, 3, 4,   6, 7, 8, 9, 10, 11

skips rest of body before print at 5

Nesting

Nested loops

- Loops are powerful components in programming
- A loop can be the body of another loop, and so on
- Different types of loops can be combined together

```
while (logical expression):
        first part of while loop body
        for <variable> in <something that can be iterated>:
                body of the for loop
        remainder of the while loop body
remainder of the program
```

```
while (logical expression):                         #outer loop
        first part of while loop body
        while (logical expression):                 #inner loop
                body of the inner while loop
        remainder of the outer while loop
remainder of the program
```

Nested loops

```
while (logical expression):                                   # outer while loop
    for <variable> in <something that can be iterated>:
        while (logical expression):                           # inner while loop
                body of the inner while loop
         reminder of the for loop
    remainder of the outer while loop
remainder of the program
```

Indentation is critical

```
while (logical expression):                                   # 1st while loop
    while (logical expression):                               # 2nd while loop
        while (logical expression):                           # 3nd while loop
                body of the 3rd while loop
        remainder of the 2nd while loop
    remainder of the 1st while loop
remainder of the program
```

you do need to make sure your program is still readable.

Example

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

Example

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

Outer loop → 2 iterations

Inner loop → 3 iterations

Runs 2 * 3 times

The remainder of the outer loop

Loop Errors

Infinite loop

- When the looping condition is always satisfied → Loop never ends
- Caused by logical error:
  - The loop control does not get updated **(update error)**
  - The update will always satisfy the loop condition **(update error)**

```
i = 1
while (i <= 10):
                print (i)
i = i + 1
```

```
i = 1
while (i <= 10):
        print (i)
        i = i - 1
```

- To stop an infinite loop use “Ctrl + C”
  - (CMD C on Apple)

Erroneous loops

- The looping condition is not met before entering the loop.
- **A type of initialization error**
- Example:

```
i = 10
while (i < 10):
        print (i)
        i = i + 1
```

```
for i in range (5, 0, 2):
            print (i)
```

range (1, 4, 1) $\rightarrow$ (1, 2, 3)
range (4, 1, -1) $\rightarrow$ (4, 3, 2)
range (1, 5, 2) $\rightarrow$ (1, 3)
range (5, 0, 2) $\rightarrow$???

Other Errors

- Off-by-one errors (the loop runs the wrong amount of times)
- Initialization Errors: Incorrect first value for loop control (either doesn’t enter [erroneous] or enters with wrong value)

Testing Loops

Testing loops

- Make sure the loop executes the proper number of times.
- Test conditions:
  - Loop does not run
  - Loop runs exactly once
  - Loop runs exactly N times

Tracing

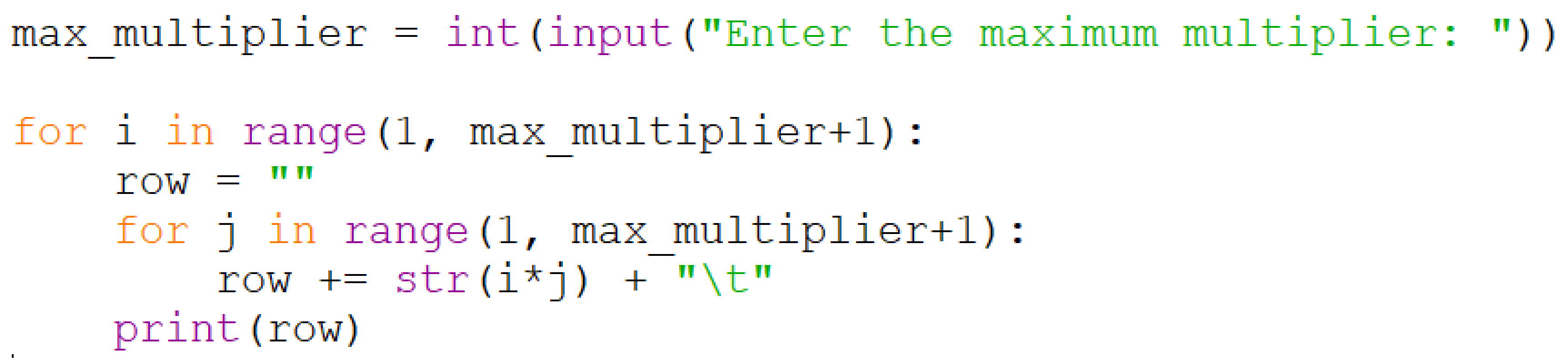
- Tracing code:
  - Examine each statement in sequence
  - Perform whatever tasks the statement requires, recording values of interest
    - Usually requires that the value of each variable is recorded
  - Result of tracing could be the value of one or more variables, or the output generated

  - **Very** important skill for debugging!
  - Can be done by hand, or by using print statements to display intermediate values during the execution of the loop

Loop Practice

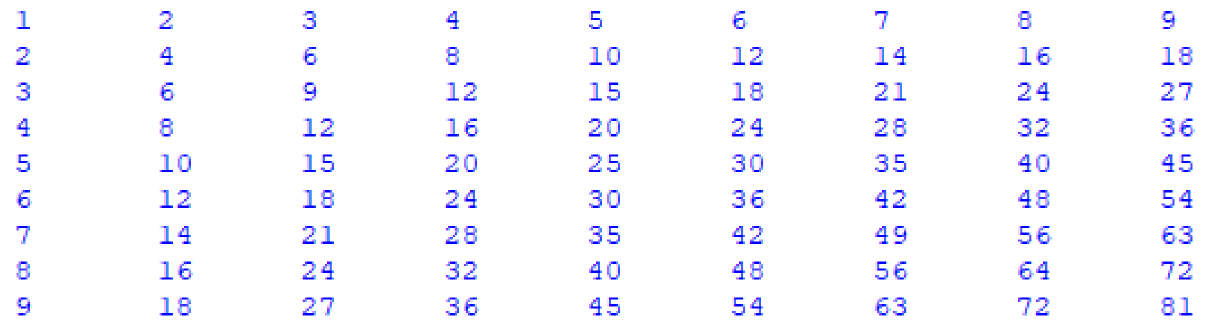
Practice - Multiplication Table

Produce a multiplication table from **1** to some **value** inputted by user:



```
max_multiplier = int(input("Enter the maximum multiplier: "))

for i in range(1, max_multiplier+1):
    row = ""
    for j in range(1, max_multiplier+1):
        row += str(i*j) + "\t"
    print(row)
```



```
1       2       3       4       5       6       7       8       9
2       4       6       8       10      12      14      16      18
3       6       9       12      15      18      21      24      27
4       8       12      16      20      24      28      32      36
5       10      15      20      25      30      35      40      45
6       12      18      24      30      36      42      48      54
7       14      21      28      35      42      49      56      63
8       16      24      32      40      48      56      64      72
9       18      27      36      45      54      63      72      81
```

Christmas tree

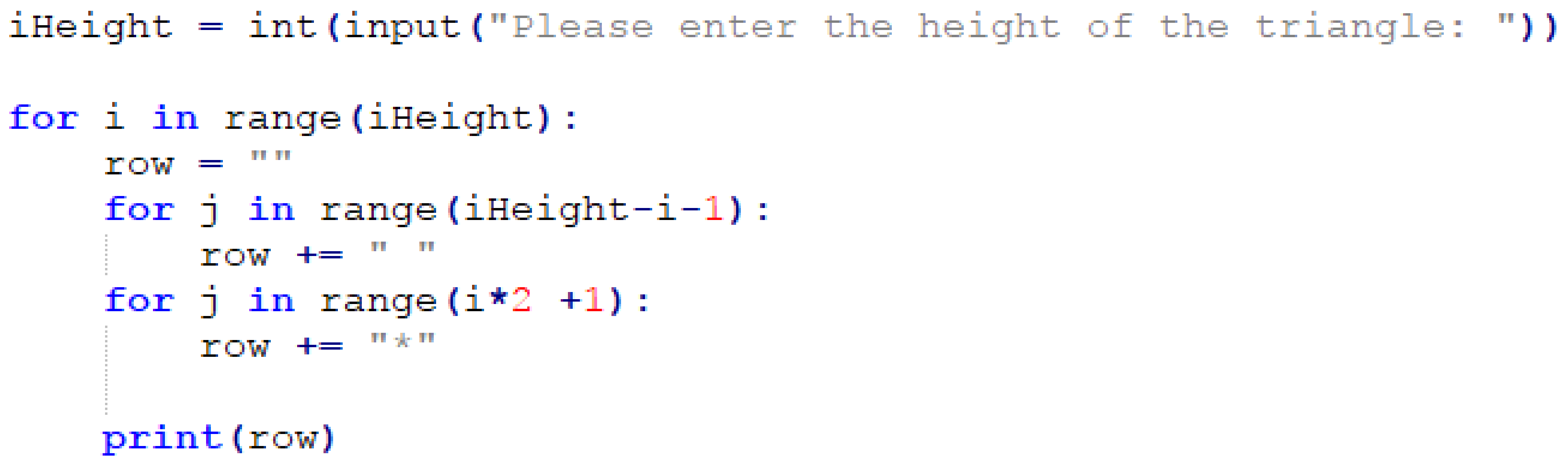
- Write a program that will print a triangle of a height provided by the user. For example:
  - If the height is 3, the triangle will look like:

```
  *
 ***
*****
```

  - If the height is 10, the triangle will look like:

```
         *
        ***
       *****
      *******
     *********
    ***********
   *************
  ***************
 *****************
*******************
```

Practice - Christmas Tree Solution 1

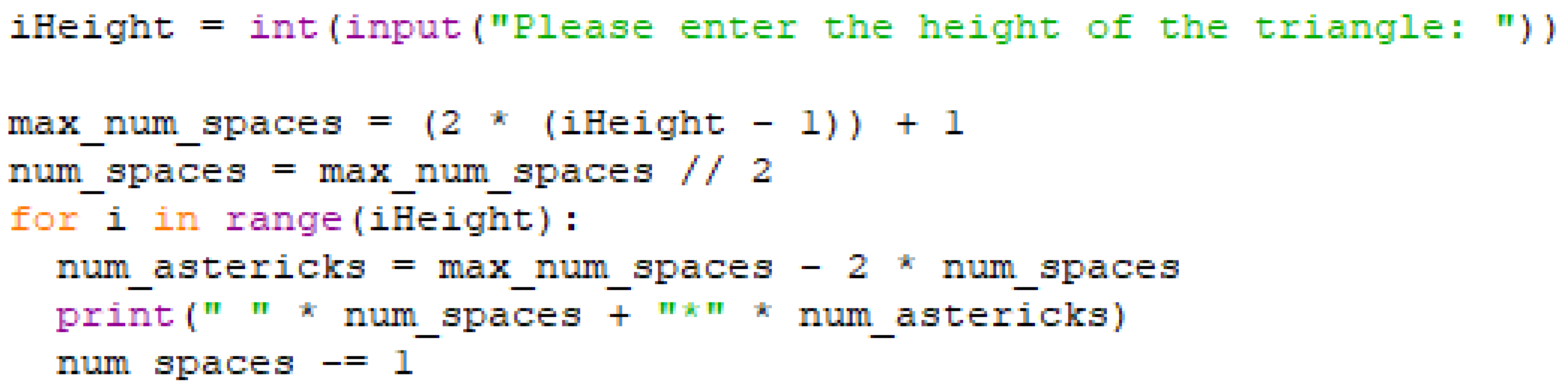


```python
iHeight = int(input("Please enter the height of the triangle: "))

for i in range(iHeight):
    row = ""
    for j in range(iHeight-i-1):
        row += " "
    for j in range(i*2 +1):
        row += "*"

    print(row)
```

Practice - Christmas Tree Solution 2



```python
iHeight = int(input("Please enter the height of the triangle: "))

max_num_spaces = (2 * (iHeight - 1)) + 1
num_spaces = max_num_spaces // 2
for i in range(iHeight):
  num_astericks = max_num_spaces - 2 * num_spaces
  print(" " * num_spaces + "*" * num_astericks)
  num spaces -= 1
```

Onward to … functions.

Jonathan Hudson
jwhudson@ucalgary.ca
https://pages.cpsc.ucalgary.ca/~jwhudson/

UNIVERSITY OF CALGARY