COMPSCI 101

Principles of Programming

Lecture 13 – range function,
for…in range() loops

Learning outcomes

At the end of this lecture, students should:

- understand the Python range() function and be able to use it to define a series of values
- understand the for…in loop structure used with the range() function
- be able to define a for…in range() loop to implement counter-controlled repetition
- be able to convert a for…in range() loop into an equivalent while loop and vice versa

Recap

`while` loops

- a loop is used for implementing repeated tasks
- be able to design and write Python `while` loops

```
def get_sum_of_divisors(number):
    divisor = 1
    div_sum = 0
    while divisor <= number // 2:
        if number % divisor == 0:
            div_sum = div_sum + divisor
        divisor = divisor + 1

    return div_sum

def main():
    print(get_sum_of_divisors(6))
    print(get_sum_of_divisors(36))
    print(get_sum_of_divisors(25))
    print(get_sum_of_divisors(9604))
main()
```

```
get_sum_of_divisors(6) 6
get_sum_of_divisors(24) 36
get_sum_of_divisors(25) 6
get_sum_of_divisors(5628) 9604
```


The Python range() function

The Python range() function defines a sequence of integer values within boundaries.

The range() function has the following syntax: **range(start, stop, step)**

where the three arguments are:

start - the lower bound (included) of the sequence defined,

stop - the upper bound (excluded) of the sequence defined,

step - the increment between each number in the sequence defined.

Some examples:

- range(1, 10, 2) defines the sequence 1, 3, 5, 7, 9
- range(5, 20, 6) defines the sequence 5, 11, 17
- range(14, 4, -3) defines the sequence 14, 11, 8, 5
- range(0, 7, 1) defines the sequence 0, 1, 2, 3, 4, 5, 6

The Python range() function continued

range(start, stop, **step**)

If the step is omitted, the default step is 1.

- range(0, 7) defines the sequence 0, 1, 2, 3, 4, 5, 6
- range(6, 10) defines the sequence 6, 7, 8, 9

If both the start and the step are omitted, the sequence starts from 0 with a step increment of 1.

- range(5) defines the sequence 0, 1, 2, 3, 4,
- range(7) defines the sequence 0, 1, 2, 3, 4, 5, 6

Note that printing a range object does NOT print the defined sequence of integers, i.e., print(range(6)) does NOT print the numbers 0 1 2 3 4 5

The Python range() function continued

range(start, stop, step)

The step cannot be 0:

- range(0, 7, **0**) gives an error

ValueError: range() arg 3 must not be zero

If the step is negative then the start value should be greater than the stop value.

- range(14, 4, -3) defines the sequence 14, 11, 8, 5
- range(4, 14, -3) defines an **empty range of numbers**

If the step is positive then the start value should be smaller than the stop value.

- range(14, 4, 3) defines an **empty range of numbers**
- range(4, 14, 3) defines the sequence 4, 7, 10, 13

Iteration – `for…in` loops

The following **`while`** loop executes exactly 100 times (for count = 0 to count = 99). The variable, `count`, controls the number of times the loop body is executed.

```
count = 0
while count < 100:
   print("Programming is fun!")
   count = count + 1
print("Done!")
```

The **for…in range(…)** loop provides a compact structure for counter-controlled loops.

```
for count in range(…):
    statement1
    statement2
    statement3
    …
```

```
for count in range(0, 100):
   print("Programming is fun!")

print("Done!")
```

```
Programming is fun!
Programming is fun!
Programming is fun!
…
Done!
```


Iteration – for…in loops

Note that in the `for…in` loop on the previous slide the name used as the loop variable can be **any identifier**. The following two sections of code behave in exactly the same way.

```
for value in range(0, 100):
   print("Programming is fun!")
```

```
for number in range(0, 100):
   print("Programming is fun!")
```

```
Programming is fun!
Programming is fun!
Programming is fun!
…
```

Note that in the `for…in` loops above, the loop body is executed for each value in the numbers defined by the `range()` function. In the body of the loop, the loop variable takes on each value of the numbers defined by the `range()` function, e.g.,

```
for number in range(3, 7):
   print(number * 5)
```

```
15
20
25
30
```

```
for value in range(0, 5):
   print(value)
```

```
0
1
2
3
4
```

Give the output

```
def print_output():
  total = 0
  for number in range(9, 20):
    if number % 2 == 0 or number % 3 == 0:
       total = total + 1

  print(total)

def main():
  print_output()

main()
```


Complete the loops

Complete the `for…in range()` loop so that the output is:

```
7 10 13 16 19 22
```

```
for                in                    :
  print(number, end = " ")

print()
```

Complete the `for…in range()` loop so that the output is:

```
30 25 20 15 10 5 0 -5 -10
```

```
for                in                    :
  print(value, end = " ")

print()
```


Complete the function

An amount doubles each year. Using a `for…in range()` loop complete the `double_each_year()` function which prints the growth of the parameter, (`start_amt`) for the given number of years (`num_years`).

The first line printed by the function is the starting amount. Each line of the output is numbered starting from the number 1. The function returns the final amount.

```
def double_each_year(start_amt, num_years):



def main():
   print("After 4 years:", double_each_year(24, 4))
   print("After 3 years:", double_each_year(235, 3))
   print("After 5 years:", double_each_year(15, 5))

main()
```

```
Starting with: 24
1: 48
2: 96
3: 192
4: 384
After 4 years: 384

Starting with: 235
1: 470
2: 940
3: 1880
After 3 years: 1880

Starting with: 15
1: 30
2: 60
3: 120
4: 240
5: 480
After 5 years: 480
```


Complete the function

Using a `for…in range()` loop complete the `print_series()` function which prints a series of numbers starting from the parameter value, `start_num`. The second number printed is the first number plus 1, the third number is the second number plus 2, the fourth number is the third number plus 3, and so on, e.g., a series of 8 numbers starting from the number 2 is:

```
2   3   5   8   12   17   23   30
    +1  +2  +3  +4   +5   +6   +7
```

```
def print_series(start_num, how_many):



def main():
   print_series(2, 8)
   print_series(5, 12)
   print_series(16, 9)

main()
```

```
2 3 5 8 12 17 23 30
5 6 8 11 15 20 26 33 41 50 60 71
16 17 19 22 26 31 37 44 52
```

while loop vs for…in loops

Counter-controlled while loops can be converted into for…in range() loops and vice versa.

```
count = 0
while count < 100:
   print("Programming is fun!")
   count = count + 1
```

```
for count in range(0, 100):
   print("Programming is fun!")
```

Not all `while` loops can be expressed using a `for…in range(…)` loop (only the ones for which we know exactly how many times the loop body is to be executed).

All `for…in range()` loops can be expressed as `while` loops.

Convert - while loop for…in loop

Convert the following `while` loop into a `for…in range()` loop:

```
counter = 12
while counter < 260:
   print(counter)
   counter = counter + 10
```

Convert the following `for…in range()` loop into a `while` loop:

```
for num in range(45, 3, -5):
   print(num * 2)
```


Same output?

Do the following two loops give the same output? If not, what is the difference in output and what change needs to be made in order to make the outputs of the two loops the same?

```
top = 6
count = 0
total = 0

for bottom in range(0, top , 2):
   count = count + 1
   total = total + top + bottom

print("count:",count,"sum:",total)
```

```
top = 6
bottom = 0
count = 0
total = 0

while bottom <= top:
   count = count + 1
   total = total + top + bottom
   bottom = bottom + 2

print("count:", count,"sum:",total)
```


Which to use, while loop or for…in loop?

Which type of loop should you use?

A **while** loop is more general. It can be used to handle repetition of a block of code a given number of times and also to handle user controlled repetitions, e.g., when the number of times the loop is executed depends on the user input (or on a condition which depends on a random number).

A **for…in range()** loop is more compact and it is used for repeating a block of code a given number of times. It is useful for processing a block of code for a sequence of values.

Summary

In a Python program:

- the Python range() function is used to define a sequence of values
- a for…in range() loop can be used to implement counter-controlled repetition
- a for…in range() loop can be converted into a while loop
- a for…in range() loop has the following syntax:

```
for a_variable in range(      ):
   statement1
   statement2
   …
```


Examples of Python features used in this lecture

```
def get_divisor_sum(number):
   div_sum = 1
   middle_num = number // 2
   for num_to_check in range(2, middle_num + 1):
      if number % num_to_check == 0:
         div_sum = div_sum + num_to_check

   return div_sum

def fun_stuff():
   total = 0
   for number in range(9, 20):
      if number % 2 == 0 or number % 3 == 0:
         total += 1

   print(total)
```