

Introduction to Python

Definite Iteration: For Loops

Topics

I) For Loops

Iteration

Iteration is a repeating portion of an algorithm. Iteration repeats a specified number of times or until a given condition is met.

Iteration loops are frequently referred to as **for** loops because **for** is the keyword that is used to introduce them in nearly all programming languages, including Python.

Python's *for* loop iterates over items of a sequence(e.g. a list of numbers or a string(sequence of characters)) and process them with some code.

```
for x in sequence:  
    block
```

For Loops

Python's *for* loop iterates over items of a sequence(e.g. a list of numbers or a string(sequence of characters)) and process them with some code.

`for x in sequence:` This is a list. It is an example of a sequence.
 `block` More on lists in a later lecture.

`for x in [2,3,5,7]:`
 `print(x, end=" ")` *# ends each print with a space*
print all on same line



2 3 5 7

For Each Loops

```
for x in [2,3,5,7]:  
    print(x)
```

2

3

5

7

```
for x in "hello":  
    print(x)
```

h

e

l

l

o

Iterate through each number in the list.

"for each x in" list.

Iterate through each character in the string.

range(stop)

A simple use of a *for* loop runs some code a specified number of times using the *range()* function.

`range(stop)`: returns sequence of numbers from 0 (default) up to but not including stop. Increment by 1 (default).

```
for i in range(5):
```

```
    print(i, end=" ")
```



Think of `range(5)` as generating this list: `[0, 1, 2, 3, 4]`.

0 1 2 3 4

```
for i in range(10):
```

```
    print("hi", end=" ")
```

hi hi hi hi hi hi hi hi hi hi

range(start, stop)

range(start, stop): from start up to but not including stop. Increment by 1 (default).

```
for i in range(2, 8):  
    print(i, end=' ')
```

2 3 4 5 6 7

range(start, stop, step)

range(start, stop, step): from start up to but not including stop, increment by step.

```
for i in range(1, 10, 2):  
    print(i, end=' ')
```

1 3 5 7 9

If step is negative, a list can be traversed backwards.

```
for i in range(10, 2, -1):  
    print(i, end=' ')
```

10 9 8 7 6 5 4 3

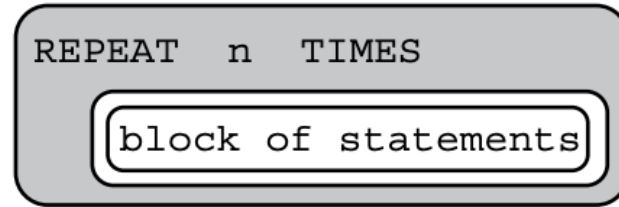
AP Exam

To perform a task n times, the AP exam use the following syntax.

Text:

```
REPEAT n TIMES  
{  
  <block of statements>  
}
```

Block:



Note: The above is equivalent to the following code in Python:

```
for i in range(n):  
    # block of statements  
...
```

Definite Iteration

The for loop is an example of a **definite iteration**. We can determine ahead of time the number of times the loop repeats. Later, we will talk about **indefinite iteration**, a loop where we cannot predict the number of times a loop repeats.

```
for i in range(5):  
    print("*", end="")  
  
*****
```

The loop above prints five '*'s. We can determine this ahead of time from the for loop statement.

Summing and Counting

There are two common tasks that uses for loops.

- 1) Summing
- 2) Counting

Summing Values

Write a segment of code that solve the problem

$$1 + 2 + 3 + \dots + 98 + 99 + 100.$$

We need a variable that accumulate the sum at each iteration of the loop. This variable should be initialized to 0.

```
sum = 0
for i in range(1, 101):
    sum += i
```

Writing a function to sum

Now write a function that accepts a non-negative integer parameter n and returns the sum of integers from 1 to n (including).

```
def sum(n):  
    sum = 0  
    for i in range(1, n+1):  
        sum += i  
    return sum
```

```
print(sum(5))    # 1+2+3+4+5=15  
a = sum(100)     # a = 5050  
print(a)         # 5050 is printed on console
```

Conditional Summing

Write a segment of code that compute the sum of all numbers from 1 to 100 that are multiples of 3.

```
sum = 0
for i in range(0, 101, 3):
    sum += i
```

Or equivalently, we can use a conditional to select the numbers to add:

```
sum = 0
for i in range(1, 101):
    if i % 3 == 0:
        sum += i
```

Better to use if conditional for filtering.
In general, using the step size above might not always work.

Conditional Summing Example

Write a segment of code that compute the sum of all numbers from 1 to 100.
However:

- 1) if a number is a multiple of 3, double it before adding,
- 2) if a number is a multiple of 5, triple it before adding,
- 3) If a number is a multiple of both, quadruple it before adding.
- 4) otherwise, just add the number.

Conditional Summing Solution?

Is the following a correct solution?

```
sum = 0
for i in range(1, 101):
    if i % 3 == 0:
        sum += 2 * i
    elif i % 5 == 0:
        sum += 3 * i
    elif i % 3 == 0 and i % 5 == 0:
        sum += 4 * i
    else:
        sum += i
```

No! Why not?

Conditional Summing Solution

The following is correct.

```
sum = 0
for i in range(1, 101):
    if i % 3 == 0 and i % 5 == 0:
        sum += 4 * i
    elif i % 3 == 0:
        sum += 2 * i
    elif i % 5 == 0 :
        sum += 3 * i
    else:
        sum += i
```

Counting

Write a function that accepts an integer parameter n and returns the number of factors of n .

```
def count_factors(n):  
    count = 0  
    for i in range(1, n+1):  
        if n % i == 0:           # i is a factor of n  
            count += 1  
    return count  
  
print(count_factors(10))  # 4 (factors of 10 = {1,2,5,10})  
print(count_factors(7))  # 2 (factors of 7 = {1,7})
```

String Indexing

Python allows you to retrieve individual members of a string by specifying the *index* of that member, which is the integer that uniquely identifies that member's position in the string. The built-in `len()` function returns the number of characters in a string.

```
message = "hello"
```

```
length = len(message)
```

```
print(length)           # 5
```

```
print(message[0])       # h
```

```
print(message[1])       # e
```

```
print(message[4])       # o
```

```
print(message[5])       # error! out of range!
```

Note: On the AP exam,
The first index of the first
character of a string is 1 not 0.

Strings are **immutable**: once it is created, it cannot be changed!

```
message[0] = "H"         # ERROR! A string is immutable!
```

Looping Through Each Character

Since each character of a string has index, we can use a loop to traverse a string.

```
message = "hello"  
for i in range(len(message)):  
    print(message[i])
```

Output:

h
e
l
l
o

Slicing

We can also “slice” a string, specifying a start-index and stop-index, and return a subsequence of the items contained within the slice.

Slicing is a very important indexing scheme that we will see many times in other data structures(lists, tuples, strings, Numpy's arrays, Panda's data frames, etc..). Slicing can be done using the syntax:

`some_string[start:stop:step]`

where

start: index of beginning of the slice(included), default is 0

stop: index of the end of the slice(excluded), default is length of string

step: increment size at each step, default is 1.

Slicing

```
language = "python"
```

```
print(language[0:4])
```

pyth

0 up to but not including index 4

```
print(language[:4])
```

pyth, default start index at 0

```
print(language[4:])
```

on, default end index is length of string

```
print(language[:])
```

python, 0 to end of string

```
print(language[0:5:2])
```

pto, step size of 2

```
print(language[::-1])
```

negative step size traverses backwards

nohtyp

AP Exam

There will be questions on the AP exam which requires students to manipulate strings. The exam will provide an API(application programming interface) for string manipulation. A sample API below was given in previous exams.

Procedure Call	Explanation
<u>concat</u> (str1, str2)	Returns a single string consisting of str1 followed by str2. For example, <u>concat</u> ("key", "board") returns "keyboard".
<u>reverse</u> (str)	Returns the reverse of the string str. For example, <u>reverse</u> ("abcd") returns "dcba".
<u>substring</u> (str, start, length)	Returns a substring of consecutive characters from str, starting with the character at position start and containing length characters. The first character of str is located at position 1. For example, <u>substring</u> ("delivery", 3, 4) returns "live".
<u>substring</u> (str, start, end)	Returns a substring of consecutive characters of str starting with the character at position start and ending with the character at position end. The first character of str is considered position 1. For example, <u>substring</u> ("delivery", 3, 6) returns "live".
<u>len</u> (str)	Returns the number of characters in str. For example, <u>len</u> ("pizza") returns 5.

The substring function may take on different arguments on the exam. Read the API carefully as this may vary year to year.

For Loop in Movies and TV-Shows

Movies:

Groundhog Day(1993); Bill Murray.

Looper(2010); Bruce Willis and Joseph Gordon-Levitt, Emily Blunt.

Edge of Tomorrow(2014); Tom Cruise, Emily Blunt.

Happy Death Day(2017).

TV-Show:

Russian Doll(Netflix, Emmy-Nominated)

Lab I

Create a new repl on repl.it.

Write a **for loop** to do each of the following:

- 1) Print out "Hello!" 10 times, each on a different line.
- 2) Alternate between printing "Hello" and "Hi" for a total of 20 times, each on a separate line. Use only one for loop. (Hint: Use a conditional)
- 3) Print 1 4 9 16 25 ... 100
- 4) Print 10 8 6 4 2 0 -2
- 5) Compute the sum: $1^2 + 2^2 + 3^2 + 4^2 + \dots + 19^2 + 20^2$

Lab 2: Counting Primes

Create a new repl.

1) Rewrite the function `count_factors` as explained in a previous slide.

2) A number n is prime if its only factors are 1 and n . Write the function `is_prime` which accepts an integer n and returns whether it is prime. Note that 1 is not prime. **You must call the function `count_factors` in your implementation of `is_prime`.**

`is_prime(13)` returns `True`

`is_prime(1245)` returns `False`

3) Write the function `num_primes` which accepts an integer n and returns the number of primes up to and including n . **You must call the function `is_prime` in your implementation.**

`num_prime(11)` returns 5 since 2, 3, 5, 7, 11 are the 5 prime numbers less than or equal to 11.

Call the three above functions with different inputs and make sure that your functions work as expected.

References

- I) Vanderplas, Jake, A Whirlwind Tour of Python, O'reilly Media.