Leiden University
Medical Center

Python Programming

Functions

Mihai Lefter

Outline

User Defined Functions

- A function is a named sequence of statements that performs some piece of work.
- Later on that function can be called multiple times by using its name.

Defining a function

A function definition includes its `name`, `parameters` (optional), and `body`:

```
def␣name(parameters):
␣␣␣␣body
```

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```

functions.py

```
1 def greeting():
2     print('Hello!')
```

Calling a function

A function is called by using its `name` and by providing the required `arguments`:

```
name ( arguments )
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functions.py

```
1 def greeting():
2     print('Hello!')
3
4 greeting()
```

Calling a function

A function is called by using its `name` and by providing the required `arguments`:

```
name ( arguments )
```

functions.py

```
1  def greeting():
2      print('Hello!')
3
4  greeting()
```

terminal

```
$ python functions.py
Hello!
```

Calling a function

A function is called by using its `name` and by providing the required `arguments`:

```
name ( arguments )
```

Now let's add some `parameters`:

functions.py

```
1  def greeting(name):
2      print('Hello {}!'.format(name))
3
4  greeting('students')
```

terminal

```
$ python functions.py
Hello students !
```

The `return` statement

Used mainly to `return` a certain result value back to the caller.

functions.py

```
1 def add_two(number):
2     return number + 2
```

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```
1 def add_two(number):
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3
4 print(add_two(5))
```

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functions.py

```
1 def add_two(number):
2     return number + 2
3
4 print(add_two(5))
```

terminal

```
$ python functions.py
7
```

The `return` statement

Used mainly to `return` a certain result value back to the caller.

functions.py

```
1  def add_two(number):
2      return number + 2
3
4  for i in range(5):
5      print('{} -> {}'.format(i, add_two(i)))
```

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Used mainly to `return` a certain result value back to the caller.

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```
1  def add_two(number):
2      return number + 2
3
4  for i in range(5):
5      print('{} -> {}'.format(i, add_two(i)))
```

terminal

```
$ python functions.py
0 -> 2
1 -> 3
2 -> 4
3 -> 5
4 -> 6
```

The `return` statement

- Functions immediately `exit` when a `return` statement is encountered.
- No explicit value needs to be mentioned in the `return` statement.

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negative.py

```
1  def first_negative(numbers):
2    for n in numbers:
3       if n < 0:
4         print(n)
5         return
6    print("No negative number found!")
7
8  first_negative([3, -5, 10, -2])
```

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6    print("No negative number found!")
7
8  first_negative([3, -5, 10, -2])
```

terminal

```
$ python negative.py
-5
```

The `return` statement

- Something is always returned.

negative.py

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1  def first_negative(numbers):
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```

terminal

```
$ python negative.py
-5
```

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negative.py

```
1  def first_negative(numbers):
2    for n in numbers:
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5         return
6    print("No negative number found!")
7
8  print(first_negative([3, -5, 10, -2]))
```

The `return` statement

- Something is always returned.

negative.py

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1  def first_negative(numbers):
2    for n in numbers:
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6    print("No negative number found!")
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8  print(first_negative([3, -5, 10, -2]))
```

terminal

```
$ python negative.py
-5
None
```

The `return` statement

- Something is always returned, even if no `return` statement is reached.

negative.py

```
1  def first_negative(numbers):
2    for n in numbers:
3       if n < 0:
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The `return` statement

- Something is always returned, even if no `return` statement is reached.

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5         return
6    print("No negative number found!")
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8  print(first_negative([]))
```

terminal

```
$ python negative.py
No negative number found!
None
```

Required

Have to be passed during the function call (precisely in the right order).

functions.py

```
1 def add_two(number):
2     return number + 2
3
4 print(add_two())
```

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Have to be passed during the function call (precisely in the right order).

functions.py

```
1 def add_two(number):
2     return number + 2
3
4 print(add_two())
```

terminal

```
$ python functions.py
File "functions.py", line 4, in <module>
add_two()
TypeError:  add_two() missing 1 required positional argument:  'number'
```

Default

Have a default value if no argument value is passed during the function call.

functions.py

```
1  def add_value(number, default=2):
2      return number + default
3
4  print(add_value(5))
```

terminal

```
$ python functions.py
7
```

Default

Have a default value if no argument value is passed during the function call.

functions.py

```
1  def add_value(number, default=2):
2      return number + default
3
4  print(add_value(5))
5  print(add_value(5, 5))
```

terminal

```
$ python functions.py
7
10
```

Explicit parameter mentioning

When you want to make sure that the mapping is correct.

functions.py

```
1  def add_value(number, default=2):
2      return number + default
3
4  print(add_value(5, default=2))
5  print(add_value(number=5, default=2))
6  print(add_value(default=2, number=5))
```

terminal

```
$ python functions.py
7
7
7
```

Variables Scope

Scope refers to the variables visibility, i.e., in which program parts can be seen and used.

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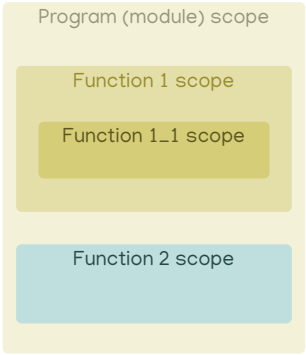
Roughly speaking:

- The whole program (module) forms one scope.
- A function definition creates a new (nested) scope.



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- The whole program (module) forms one scope.
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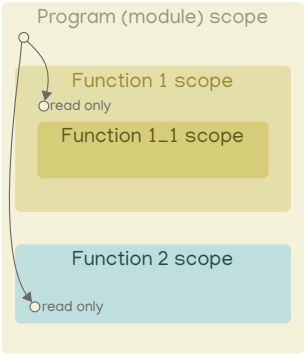
- Variables from an outside scope are visible in the inner nested scope, but you cannot (re)-assign a value to them (read only) unless they are declared global.



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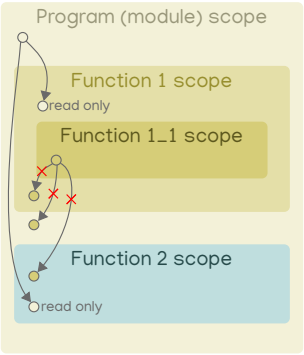
- The whole program (module) forms one scope.
- A function definition creates a new (nested) scope.
- Variables from an outside scope are visible in the inner nested scope, but you cannot (re)-assign a value to them (read only) unless they are declared global.
- Variables inside a nested scope are not visible in the outer scope.



Variables Scope

scope.py

```
1   g1 = 0
2   if g1 == 0:
3       g2 = 1
4
5   def some_function(p):
6       l = 3
7       print(p)
8       print(l)
9
10  # Calling the function
11  some_function(23)
12
13  print(p, l)
14
15  print(g1, g2)
```

Variables Scope

scope.py

Module scope

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1  g1 = 0
2  if g1 == 0:
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Variables Scope

scope.py

Module scope

```
1   g1 = 0          # A global variable
2   if g1 == 0:
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5   def some_function(p):
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Variables Scope

scope.py

Module scope

```
1   g1 = 0          # A global variable
2   if g1 == 0:
3       g2 = 1      # Still a global variable
4
5   def some_function(p):
6       l = 3
7       print(p)
8       print(l)
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Module scope

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Function scope

```
5  def some_function(p):
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Variables Scope

scope.py

Module scope

```
1  g1 = 0          # A global variable
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3      g2 = 1      # Still a global variable
4
```

Function scope

```
5  def some_function(p):
6      l = 3       # A local variable
7      print(p)
8      print(l)
9
10 # Calling the function
11 some_function(23)
12
13 print(p, l)
14
15 print(g1, g2)
```

Variables Scope

scope.py

Module scope

```
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```
5  def some_function(p):
6      l = 3       # A local variable
7      print(p)
8      print(l)
9
10 # Calling the function
11 some_function(23)
12
13 print(p, l)    # Error: p and l don't exist anymore
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15 print(g1, g2)
```

Variables Scope

scope.py

Module scope

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1  g1 = 0          # A global variable
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5  def some_function(p):
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8      print(l)
9
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12
13 print(p, l)    # Error: p and l don't exist anymore
14
15 print(g1, g2)  # g1 and g2 still exist
```

Variables Scope

scope.py

Built-in scope

Module scope

```
1  g1 = 0          # A global variable
2  if g1 == 0:
3      g2 = 1      # Still a global variable
4
5  def some_function(p):
6      l = 3       # A local variable
7      print(p)
8      print(l)
9
10 # Calling the function
11 some_function(23)
12
13 print(p, l)     # Error: p and l don't exist anymore
14
15 print(g1, g2)   # g1 and g2 still exist
```

Function scope

Hiding variables

If in a new scope a variable is created that already exists in an outer scope, the new variable will hide the outer variable.

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If in a new scope a variable is created that already exists in an outer scope, the new variable will hide the outer variable.

scope_hiding.py

```
1  a = 1
2
3  def some_function():
4      a = 2 # Hides the global a variable
5      print(a)
6
7  # Calling the function
8  some_function()
9  print(a)
```

Hiding variables

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scope_hiding.py

```
1  a = 1
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```

terminal

```
$ python scope_hiding.py
2
1
```

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scope_hiding.py

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2
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4      a = 2 # Hides the global a variable
5      print(a)
6
7  # Calling the function
8  some_function()
9  print(a)
```

terminal

```
$ python scope_hiding.py
2
1
```

This applies to function parameters as well.

The `global` keyword

Allows a variable to be changed outside of the current scope.

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global.py

```
1  a = 1
2
3  def some_function():
4      global a  # a is the global one
5      a = 2
6      print(a)
7
8  # Calling the function
9  some_function()
10 print(a)
```

The `global` keyword

Allows a variable to be changed outside of the current scope.

global.py

```
1  a = 1
2
3  def some_function():
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5      a = 2
6      print(a)
7
8  # Calling the function
9  some_function()
10 print(a)
```

terminal

```
$ python global.py
2
2
```

What about parameters and arguments?

parameters.py

```
1  def some_function(b):
2      b = 2
3      print(b)
4
5  a = 1
6
7  print(a)
8
9  # Calling the function
10 some_function(a)
11
12 print(a)
```

What about parameters and arguments?

parameters.py

```
1  def some_function(b):
2      b = 2
3      print(b)
4
5  a = 1
6
7  print(a)
8
9  # Calling the function
10 some_function(a)
11
12 print(a)
```

terminal

```
$ python parameters.py
1
2
1
```

Mutable arguments

mutable_params.py

```
1  def some_function(a_list):
2      a_list = 13
3      print('a_list:', a_list)
4
5  a = [7, 5]
6
7  print('a before the call:', a)
8
9  # Calling the function
10 some_function(a)
11
12 print('a after the call:', a)
```

Mutable arguments

mutable_params.py

```
1  def some_function(a_list):
2      a_list = 13
3      print('a_list:', a_list)
4
5  a = [7, 5]
6
7  print('a before the call:', a)
8
9  # Calling the function
10 some_function(a)
11
12 print('a after the call:', a)
```

terminal

```
$ python mutable_params.py
a before the call:  [7, 5]
a_list:  13
a after the call:  [7, 5]
```

Mutable arguments

However, element changes to update the argument.

mutable_params.py

```
1  def some_function(a_list):
2      a_list[1] = 13
3      print('a_list:', a_list)
4
5  a = [7, 5]
6
7  print('a before the call:', a)
8
9  # Calling the function
10 some_function(a)
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12 print('a after the call:', a)
```

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However, element changes to update the argument.

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3      print('a_list:', a_list)
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5  a = [7, 5]
6
7  print('a before the call:', a)
8
9  # Calling the function
10 some_function(a)
11
12 print('a after the call:', a)
```

terminal

```
$ python mutable_params.py
a before the call:  [7, 5]
a_list:  [7, 13]
a after the call:  [7, 13]
```

Function as Values

We can pass functions around just like other values, and call them.

function_values.py

```
1  def add_two(number):
2      return number + 2
3
4  def add_some_other_number(number, other_number=12):
5      return number + other_number
6
7  functions = [add_two, add_some_other_number]
8  for function in functions:
9      print(function(7))
```

Function as Values

We can pass functions around just like other values, and call them.

function_values.py

```
1  def add_two(number):
2      return number + 2
3
4  def add_some_other_number(number, other_number=12):
5      return number + other_number
6
7  functions = [add_two, add_some_other_number]
8  for function in functions:
9      print(function(7))
```

terminal

```
$ python function_values.py
9
19
```

Docstrings

- Regular string values which you start the function definition body with.
- You can access a docstring using the `help()` built-in.

docstrings.py

```
1  def factorial(n):
2      """Compute factorial of n in the obious way."""
3      if n == 0:
4          return 1
5      else:
6          return factorial(n - 1) * n
7
8  help(factorial)
```

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docstrings.py

```
1  def factorial(n):
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3      if n == 0:
4          return 1
5      else:
6          return factorial(n - 1) * n
7
8  help(factorial)
```

terminal

```
$ python docstrings.py
Help on function factorial in module __main__:
factorial(n)
Compute factorial of n in the obious way.
```

Take a function as an argument.

IPython

```
In [1]: help(map)
        Help on class map in module builtins:
        class map(object)
         |  map(func, *iterables) --> map object
         |
         |  Make an iterator that computes the function using arguments from
         |  each of the iterables.  Stops when the shortest iterable is
         |  exhausted.

In [2]: list(map(add_two, [1, 2, 3, 4]))
Out[2]: [3, 4, 5, 6]
```

Anonymous Functions

Can be created with the `lambda` keyword:

```
lambda parameters : expression
```

anonymous.py

```
1 x_times_7 = lambda x: x * 7
2 print(x_times_7(4))
```

Anonymous Functions

Can be created with the `lambda` keyword:

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lambda parameters : expression
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anonymous.py

```
1 x_times_7 = lambda x: x * 7
2 print(x_times_7(4))
```

terminal

```
$ python anonymous.py
28
```

Anonymous Functions

Can be created with the `lambda` keyword:

```
lambda parameters : expression
```

anonymous.py

```
1  x_times_7 = lambda x: x * 7
2  print(x_times_7(4))
3
4  for i in list(map(lambda x: x+2, range(4))):
5      print(i)
```

Anonymous Functions

Can be created with the `lambda` keyword:

```
lambda parameters : expression
```

anonymous.py

```
1  x_times_7 = lambda x: x * 7
2  print(x_times_7(4))
3
4  for i in list(map(lambda x: x+2, range(4))):
5      print(i)
```

terminal

```
$ python anonymous.py
28
2
3
4
5
```

Hands On!

1. Write a Python function that returns the maximum of two numbers.
2. Write a Python function that returns the maximum of three numbers. Try to reuse the first maximum of two numbers function.
3. Write a Python function that accepts a list as a parameter. Next, it determines and prints the number of positive and negative numbers.

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