

Python Programming

Functions

Mihai Lefter



Introduction

	Tuesday 26/11 J-1-83	Wednesday 27/11 P-5-34	Thursday 28/11 P-5-34	Friday 29/11 J-1-83
9:00 - 10:00	Welcome, introduction to Python <small>Mihai</small>	Assignments review <small>Mihai/Mark</small>	Assignments review <small>Mihai/Jonathan</small>	Assignments review <small>Mihai/Ruben</small>
10:00 - 11:00	Data types <small>Mark</small>	Functions <small>Mihai</small>	String methods, errors, and exceptions <small>Ruben</small>	Jupyter Notebook <small>Ruben</small>
11:00 - 12:00	Flow control <small>Mihai</small>	Object-oriented programming <small>Jonathan</small>	Standard library, reading, and writing files <small>Mihai</small>	Data mangling with pandas <small>Mihai</small>
12:00 - 13:00	Lunch break			
13:00 - 14:00	Practical session			
14:00 - 17:00				

Introduction

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9:00 - 10:00	Welcome, introduction to Python <small>Mihai</small>	Assignments review <small>Mihai/Mark</small>	Assignments review <small>Mihai/Jonathan</small>	Assignments review <small>Mihai/Ruben</small>
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Introduction

Outline

Introduction

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Variables Scope

Function as Values

Docstrings

Higher Order Functions

Anonymous Functions

Hands On!

Introduction

- 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.

User Defined Functions

Defining a function

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

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

User Defined Functions

Defining a function

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

```
def _name ( parameters ):  
    _body
```

functions.py

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

User Defined Functions

Calling a function

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

```
name ( arguments )
```


User Defined Functions

Calling a function

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

```
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```

functions.py

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

User Defined Functions

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!
```

User Defined Functions

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 !
```

User Defined Functions

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
```

User Defined Functions

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 print(add_two(5))
```

User Defined Functions

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 print(add_two(5))
```

terminal

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

User Defined Functions

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)))
```

User Defined Functions

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)))
```

terminal

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


User Defined Functions

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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- No explicit value needs to be mentioned in the `return` statement.

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])
```

User Defined Functions

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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```
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])
```

terminal

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

User Defined Functions

The `return` statement

- Something is always returned.

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])
```

terminal

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

User Defined Functions

The `return` statement

- Something is always returned.

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 print(first_negative([3, -5, 10, -2]))
```

User Defined Functions

The `return` statement

- Something is always returned.

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 print(first_negative([3, -5, 10, -2]))
```

terminal

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

User Defined Functions

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:
4             print(n)
5             return
6     print("No negative number found!")
7
8 print(first_negative([]))
```

User Defined Functions

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:
4             print(n)
5             return
6     print("No negative number found!")
7
8 print(first_negative([]))
```

terminal

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


Arguments

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())
```

Arguments

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())
```

terminal

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

Arguments

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
```

Arguments

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
```

Arguments

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

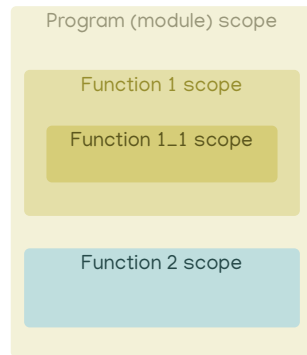
Scope refers to the variables visibility, i.e., in which program parts can be seen and used.

Variables Scope

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Roughly speaking:

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

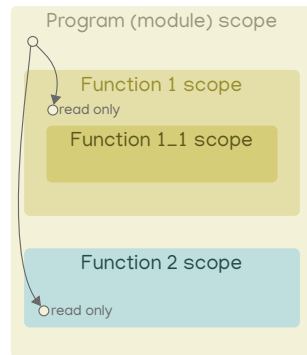


Variables Scope

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Roughly speaking:

- 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.

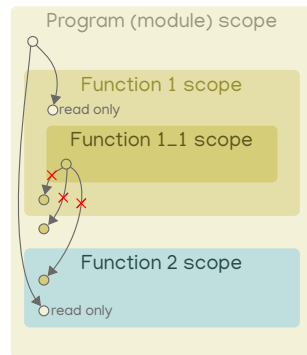


Variables Scope

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

Roughly speaking:

- 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

```
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

```
1      g1 = 0          # A global variable          Module scope
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

```
1      g1 = 0          # A global variable          Module scope
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)
9
10     # Calling the function
11     some_function(23)
12
13     print(p, l)
14
15     print(g1, g2)
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Variables Scope

scope.py

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

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

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


Variables Scope

scope.py

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

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

Variables 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.

Variables 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.

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)
```

Variables 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.

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)
```

terminal

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

Variables 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.

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)
```

terminal

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

This applies to function parameters as well.

Variables Scope

The `global` keyword

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

Variables Scope

The `global` keyword

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

```
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)
```


Variables Scope

The `global` keyword

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

```
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)
```

terminal

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

Variables Scope

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)
```

Variables Scope

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
```

Variables Scope

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)
```

Variables Scope

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]
```

Variables Scope

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)
11
12 print('a after the call:', a)
```

Variables Scope

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

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 obvious way."""
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 obvious way.
```

Higher Order Functions

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:

```
lambda parameters : expression
```

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
```


Wrap up

You are now able to:

- Create your own user defined functions.
- Call your defined functions with the right arguments.
- Understand variables scope.
- Write docstrings for your functions.
- Use higher order functions.
- Employ anonymous functions.

Wrap up

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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.

Acknowledgements

Martijn Vermaat
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