Leiden University
Medical Center

Python Programming

Functions

Outline

Introduction

User Defined Functions

Arguments

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

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functions.py

```python
def greeting():
    print('Hello!')
```

User Defined Functions

Calling a function

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

```
name ( arguments )
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greeting()
```

User Defined Functions

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

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functions.py

```python
def greeting():
    print('Hello!')

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

```python
def greeting(name):
    print('Hello {}!'.format(name))

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

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

User Defined Functions

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functions.py

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

print(add_two(5))
```

User Defined Functions

The `return` statement

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

functions.py

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

print(add_two(5))
```

terminal

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

User Defined Functions

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

functions.py

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

for i in range(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

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

for i in range(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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negative.py

```python
def first_negative(numbers):
  for n in numbers:
     if n < 0:
       print(n)
       return
  print("No negative number found!")

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

User Defined Functions

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

terminal

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

User Defined Functions

The `return` statement

- Something is always returned.

negative.py

```python
def first_negative(numbers):
  for n in numbers:
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  print("No negative number found!")

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

terminal

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

User Defined Functions

The `return` statement

- Something is always returned.

negative.py

```python
def first_negative(numbers):
  for n in numbers:
     if n < 0:
       print(n)
       return
  print("No negative number found!")

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

User Defined Functions

The `return` statement

- Something is always returned.

negative.py

```python
def first_negative(numbers):
  for n in numbers:
     if n < 0:
       print(n)
       return
  print("No negative number found!")

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

```python
def first_negative(numbers):
  for n in numbers:
     if n < 0:
       print(n)
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print(first_negative([]))
```

User Defined Functions

The `return` statement

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

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```

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

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

print(add_two())
```

Arguments

Required

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

functions.py

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

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

```python
def add_value(number, default=2):
    return number + default

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

```python
def add_value(number, default=2):
    return number + default

print(add_value(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

```python
def add_value(number, default=2):
    return number + default

print(add_value(5, default=2))
print(add_value(number=5, default=2))
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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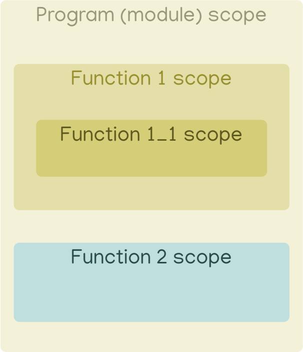
Roughly speaking:

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



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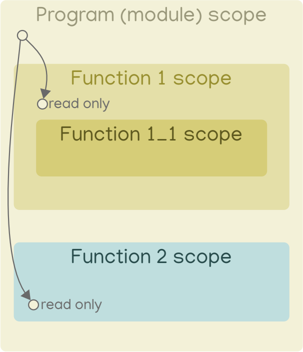

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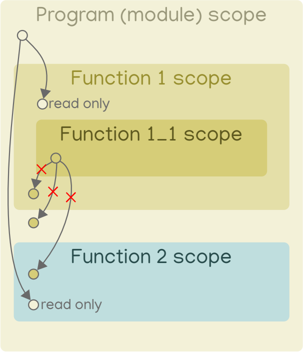
- Variables from an outside scope are visible in the inner nested scope, but you cannot (re)-assign a value to them (read only) unless they are declared global.
- Variables inside a nested scope are not visible in the outer scope.



Variables Scope

scope.py

```python
g1 = 0
if g1 == 0:
    g2 = 1

def some_function(p):
    l = 3
    print(p)
    print(l)

# Calling the function
some_function(23)

print(p, l)

print(g1, g2)
```

Variables Scope

scope.py

Module scope

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Variables Scope

scope.py

Module scope

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g1 = 0          # A global variable
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Variables Scope

scope.py

Module scope

```python
g1 = 0          # A global variable
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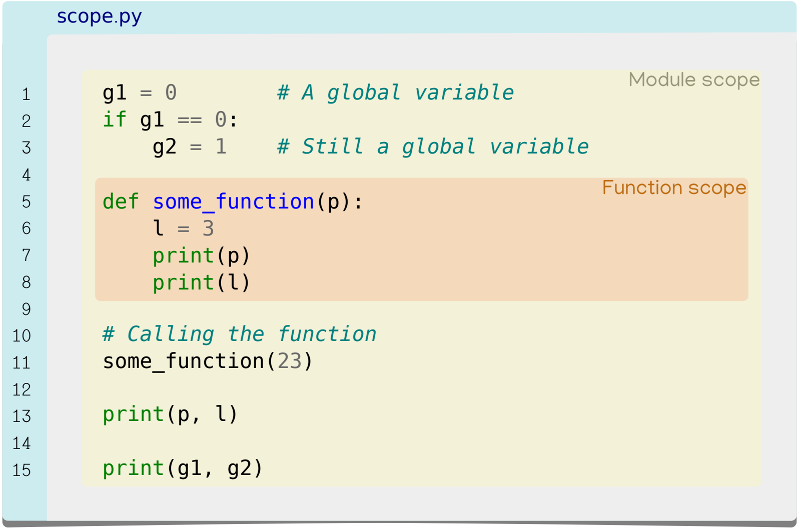
Variables Scope



scope.py

Module scope

Function scope

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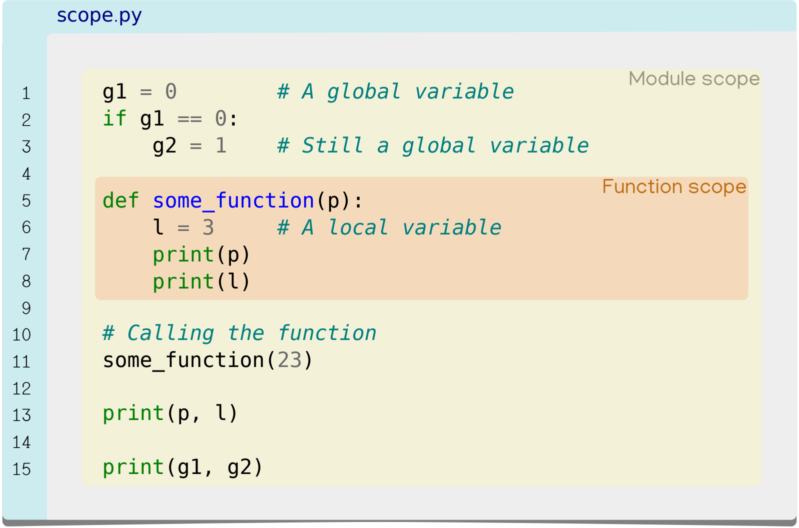
Variables Scope



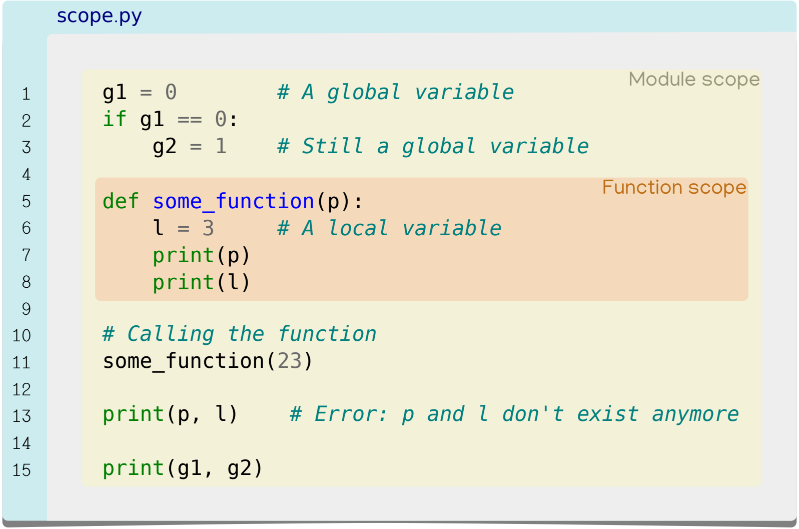
scope.py

Module scope

```python
g1 = 0          # A global variable
if g1 == 0:
    g2 = 1      # Still a global variable

def some_function(p):
    l = 3       # A local variable
    print(p)
    print(l)

# Calling the function
some_function(23)

print(p, l)

print(g1, g2)
```

Function scope

Variables Scope



scope.py

Module scope

Function scope

```python
g1 = 0        # A global variable
if g1 == 0:
    g2 = 1    # Still a global variable

def some_function(p):
    l = 3     # A local variable
    print(p)
    print(l)

# Calling the function
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print(p, l)    # Error: p and l don't exist anymore

print(g1, g2)
```

Variables Scope

scope.py

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g1 = 0          # A global variable
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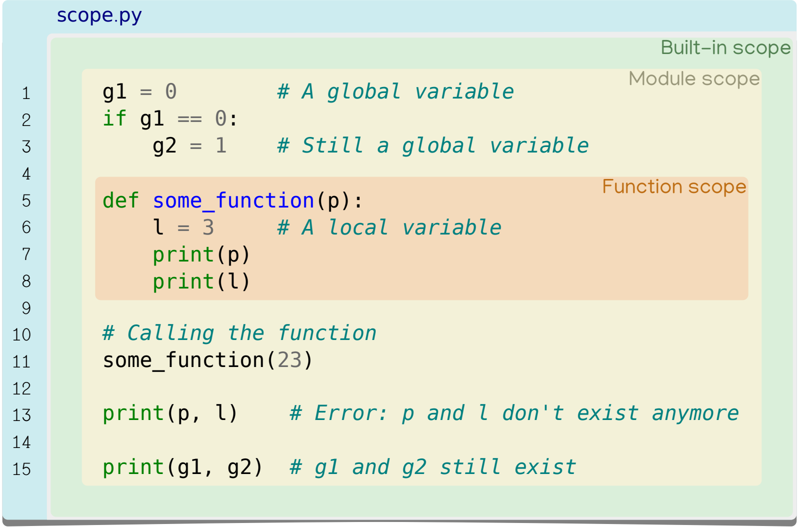
Function scope

Variables Scope



scope.py

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    l = 3       # A local variable
    print(p)
    print(l)

# Calling the function
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print(p, l)     # Error: p and l don't exist anymore

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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.

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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

```python
a = 1

def some_function():
    a = 2 # Hides the global a variable
    print(a)

# Calling the function
some_function()
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

```python
a = 1

def some_function():
    a = 2 # Hides the global a variable
    print(a)

# Calling the function
some_function()
print(a)
```

terminal

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

Variables Scope

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scope_hiding.py

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    a = 2 # Hides the global a variable
    print(a)

# Calling the function
some_function()
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.

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

global.py

```python
a = 1

def some_function():
    global a  # a is the global one
    a = 2
    print(a)

# Calling the function
some_function()
print(a)
```

Variables Scope

The `global` keyword

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

global.py

```python
a = 1

def some_function():
    global a  # a is the global one
    a = 2
    print(a)

# Calling the function
some_function()
print(a)
```

terminal

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

Variables Scope

What about parameters and arguments?

parameters.py

```python
def some_function(b):
    b = 2
    print(b)

a = 1

print(a)

# Calling the function
some_function(a)

print(a)
```

Variables Scope

What about parameters and arguments?

parameters.py

```python
def some_function(b):
    b = 2
    print(b)

a = 1

print(a)

# Calling the function
some_function(a)

print(a)
```

terminal

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

Variables Scope

Mutable arguments

mutable_params.py

```python
def some_function(a_list):
    a_list = 13
    print('a_list:', a_list)

a = [7, 5]

print('a before the call:', a)

# Calling the function
some_function(a)

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

Variables Scope

Mutable arguments

mutable_params.py

```python
def some_function(a_list):
    a_list = 13
    print('a_list:', a_list)

a = [7, 5]

print('a before the call:', a)

# Calling the function
some_function(a)

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

```python
def some_function(a_list):
    a_list[1] = 13
    print('a_list:', a_list)

a = [7, 5]

print('a before the call:', a)

# Calling the function
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```

Variables Scope

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However, element changes to update the argument.

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print('a before the call:', a)

# Calling the function
some_function(a)

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

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

def add_some_other_number(number, other_number=12):
    return number + other_number

functions = [add_two, add_some_other_number]
for function in functions:
    print(function(7))
```

Function as Values

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

function_values.py

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

def add_some_other_number(number, other_number=12):
    return number + other_number

functions = [add_two, add_some_other_number]
for function in functions:
    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

```python
def factorial(n):
    """Compute factorial of n in the obvious way."""
    if n == 0:
        return 1
    else:
        return factorial(n - 1) * n

help(factorial)
```

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```python
def factorial(n):
    """Compute factorial of n in the obvious way."""
    if n == 0:
        return 1
    else:
        return factorial(n - 1) * n

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

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

Anonymous Functions

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lambda ␣parameters : ␣expression
```

anonymous.py

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

terminal

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

Anonymous Functions

Can be created with the `lambda` keyword:

```
lambda ␣parameters : ␣expression
```

anonymous.py

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

for i in list(map(lambda x: x+2, range(4))):
    print(i)
```

Anonymous Functions

Can be created with the `lambda` keyword:

```
lambda ␣parameters : ␣expression
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anonymous.py

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

for i in list(map(lambda x: x+2, range(4))):
    print(i)
```

terminal

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

Wrap up

You are now able to:

- Create yout 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.

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
Jeroen Laros
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