Python Programming - IV

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Python Functions

- In Python, function is a named group of related statements that perform a specific task.
- Functions help break our program into smaller and modular chucks.
- As our program grows larger and larger, functions make it more organized and manageable.
- Furthermore, it avoids repetition and makes code reusable.

Syntax of Function

```
def function_name(parameters):
    """docstring"""
    statement(s)
```

Components of function definition:

- Keyword def marks the start of function header
- A function name to uniquely identify it.
- Parameters (arguments) through which we pass values to a function. They are optional.
- A colon (:) to mark the end of function header.
- Optional documentation string (docstring) to describe what the function does
- One or more valid python statements that make up the function body.
- An optional return statement to return a value from the function.

Example of a function

```
def greet(name):
    """This function greets to
    the person passed in as
    parameter"""
    print("Hello, " + name + ". Good morning!")
```

```
>>> greet('Paul')
Hello, Paul. Good morning!
```

Function Call

- Once we have defined a function, we can call it from another function, program or even the Python prompt.
- To call a function we simply type the function name with appropriate parameters.

```
>>> greet('Paul')
Hello, Paul. Good morning!
```

Docstring

- The first string after the function header is called the docstring and is short for documentation string.
- It is used to explain in brief, what a function does.
- Although optional, documentation is a good programming practice.
- In the previous example, we have a docstring immediately below the function header.
- We generally use triple quotes so that docstring can extend up to multiple lines.
- This string is available to us as ***__doc__*** attribute of the function.

Docstring

```
>>> print(greet.__doc__)
This function greets to
    the person passed into the
    name parameter
```

The return statement

- The return statement is used to exit a function and go back to the place from where it was called.

Syntax of return

```
return [expression_list]
```

- This statement can contain expression which gets evaluated and the value is returned.
- If there is no expression in the statement or the return statement itself is not present inside a function, then the function will return the None object.

Example of return

```
def absolute_value(num):
    """This function returns the absolute
        value of the entered number"""

    if num >= 0:
        return num
    else:
        return -num


print(absolute_value(2))
print(absolute_value(-4))
```

Output

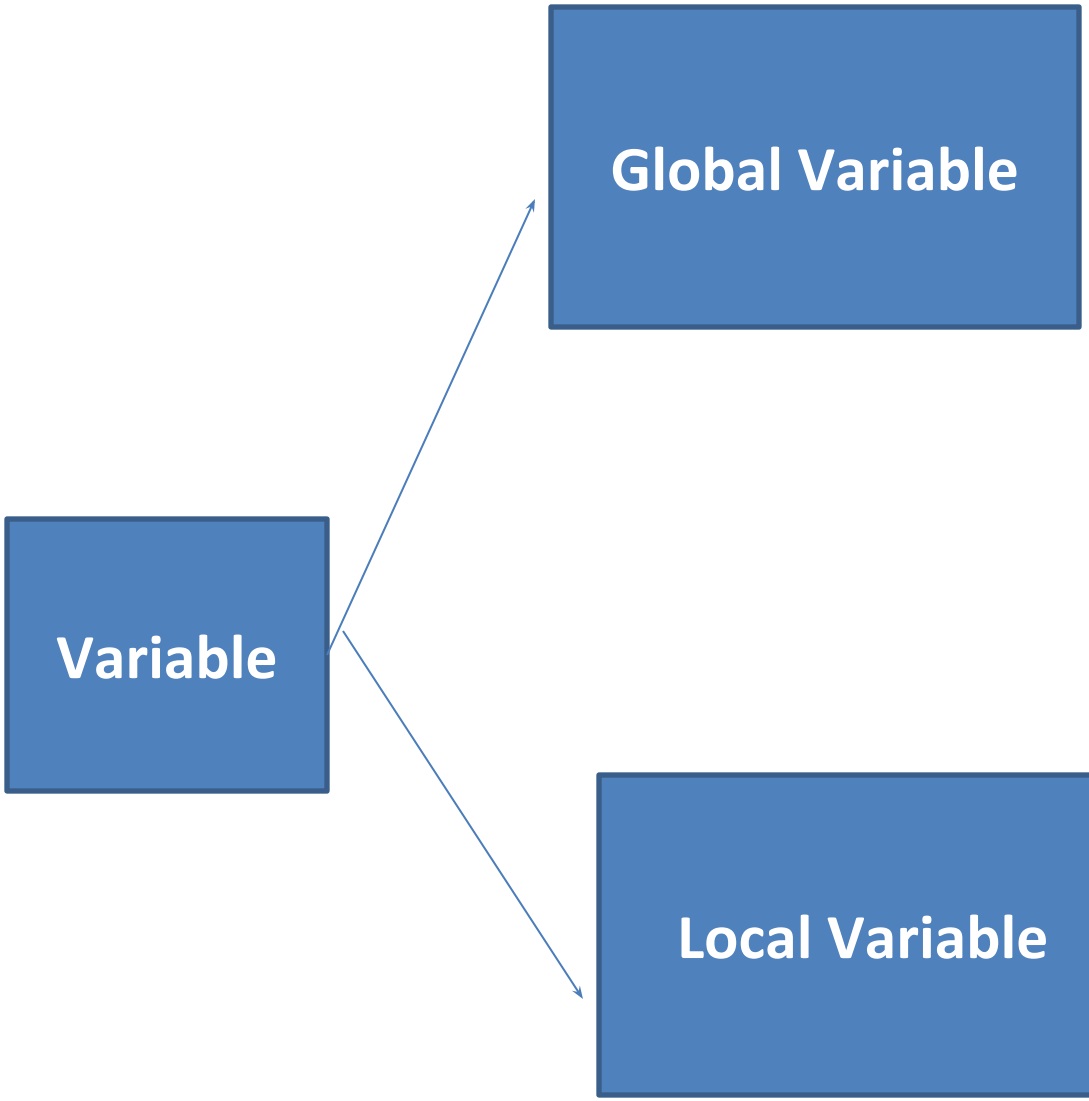
```
2
4
```

Example of return None

```
>>> print(greet("May"))
Hello, May. Good morning!
None
```

Scope and Lifetime of variables

- Scope of a variable is the portion of a program where the variable is recognized.
- Parameters and variables defined inside a function is not visible from outside. Hence, they have a local scope.
- Lifetime of a variable is the period throughout which the variable exits in the memory.
- The lifetime of variables inside a function is as long as the function executes.
- They are destroyed once we return from the function.
- Hence, a function does not remember the value of a variable from its previous calls.



Declared outside the Function and it will be Accessible everywhere

Declared within the function and it will be accessible Within the function only.

Example

Scope of a variable inside a function

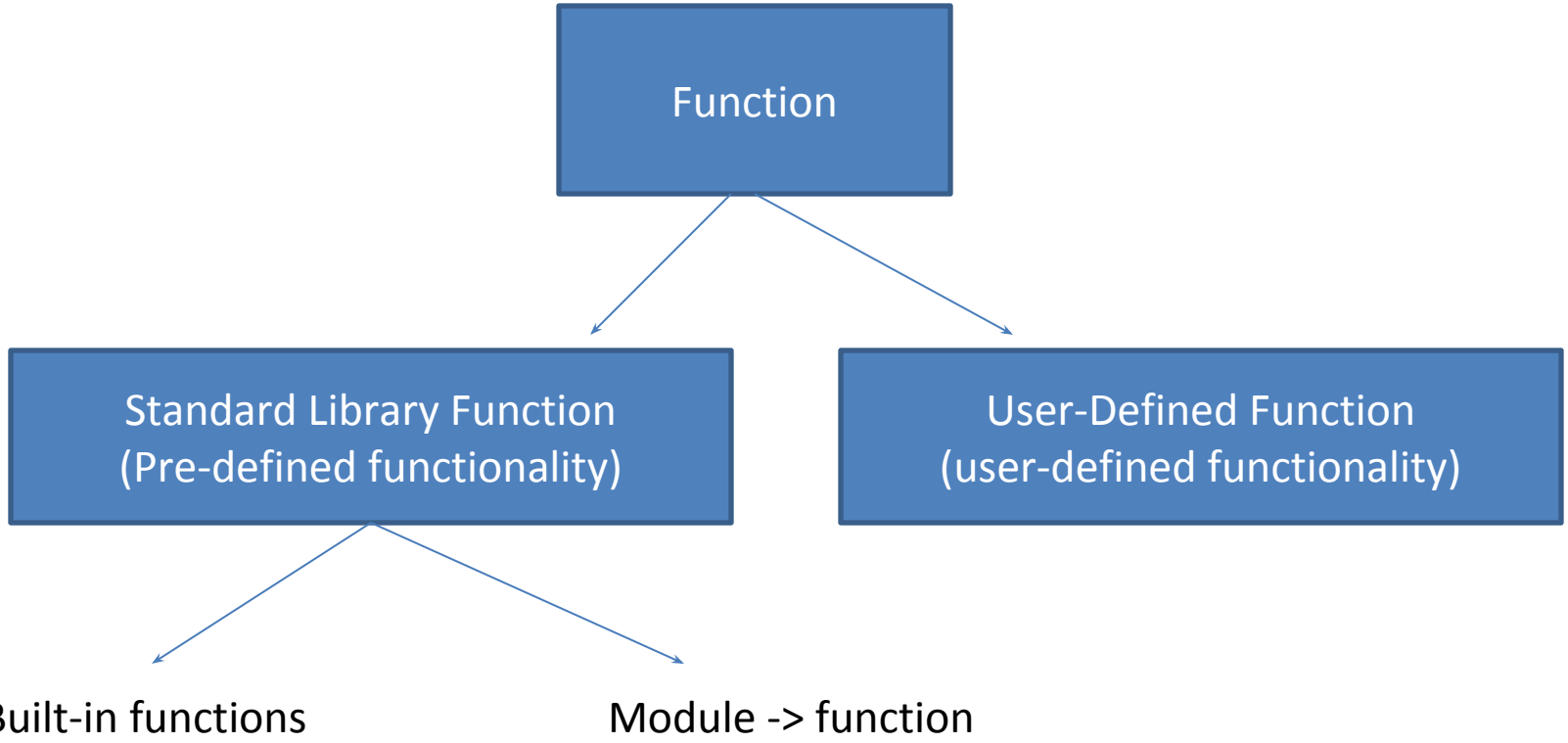
```
def my_func():
    x = 10
    print("Value inside function:",x)

x = 20
my_func()
print("Value outside function:",x)
```

Types of Functions

- Basically, we can divide functions into the following two types:

1. **Built-in functions** - Functions that are built into Python.
2. **User-defined functions** - Functions defined by the users themselves.


Function
Standard Library Function
(Pre-defined functionality)
User-Defined Function
(user-defined functionality)
Built-in functions
Module -> function

Python Programming User-defined Functions

- Functions that we define ourselves to do certain specific task are referred as user-defined functions.
- Functions that readily come with Python are called built-in functions.
- If we use functions written by others in the form of library, it can be termed as library functions.
- All the other functions that we write on our own fall under user-defined functions.
- So, our user-defined function could be a library function to someone else.

Advantages of user-defined functions

- User-defined functions help to decompose a large program into small segments which makes program easy to understand, maintain and debug.
- If repeated code occurs in a program. Function can be used to include those codes and execute when needed by calling that function.
- Programmers working on large project can divide the workload by making different functions.

Example of a user-defined function

```
def my_addition(x,y):
    """This function adds two
    numbers and return the result"""
    sum = x + y
    return sum

num1 = float(input("Enter a number: "))
num2 = float(input("Enter another number: "))
print("The sum is", my_addition(num1,num2))
```

```
Enter a number: 2.4
Enter another number: 6.5
The sum is 8.9
```

Python Function Arguments

```
def greet(name,msg):
    """This function greets to
    the person with the provided message"""
    print("Hello",name + ', ' + msg)


greet("Monica","Good morning!")
```

Output

```
Hello Monica, Good morning!
```

Python Function Arguments

- if we call **greet** function with different number of arguments, the interpreter will complain.
- Below is a call to this function with one and no arguments along with their respective error messages.

```
>>> greet("Monica")     # only one argument
TypeError: greet() missing 1 required positional argument: 'msg'
```

```
>>> greet()     # no arguments
TypeError: greet() missing 2 required positional arguments: 'name' and 'msg'
```

Variable Function Arguments

- In previous example, function had fixed number of arguments.
- In Python there are other ways to define a function which can take variable number of arguments.
- Three different forms of this type are:
  1. **Default Arguments**
  2. **Keyword Arguments**
  3. **Arbitrary Arguments or Variable-length arguments**

Default Arguments

- Function arguments can have default values in Python.
- We can provide a default value to an argument by using the assignment operator (=).

```
def greet(name, msg = "Good morning!"):
    """This function greets to
    the person with the provided message.
    If message is not provided, it defaults
    to "Good morning!" """

    print("Hello",name + ', ' + msg)
```

Default Arguments

```
>>> greet("Kate")
Hello Kate, Good morning!

>>> greet("Bruce","How do you do?")
Hello Bruce, How do you do?
```

Default Arguments

- Any number of arguments in a function can have a default value.
- But once we have a default argument, all the arguments to its right must also have default values.
- This means to say, non-default arguments cannot follow default arguments.

```
def greet(msg = "Good morning!", name):
```

We would get an error as:

```
SyntaxError: non-default argument follows default argument
```

Keyword Arguments

- When we call a function with some values, these values get assigned to the arguments according to their position.
- For example, in the above function greet(), when we called it as greet("Bruce","How do you do?"), the value "Bruce" gets assigned to the argument *name* and similarly "How do you do?" to *msg*.
- Python allows functions to be called using keyword arguments.
- When we call functions in this way, the order (position) of the arguments can be changed.

Keyword Arguments

Following calls to the above function are all valid and produce the same result

```
def greet(name, msg = "Good morning!"):
    """This function greets to
    the person with the provided message.
    If message is not provided, it defaults
    to "Good morning!" """

    print("Hello",name + ', ' + msg)
```

```
greet(name = "Bruce",msg = "How do you do?")      # 2 keyword arguments
greet( msg = "How do you do?",name = "Bruce")     # 2 keyword arguments (out of order)
greet("Bruce",msg = "How do you do?")             # 1 positional, 1 keyword argument
```

Keyword Arguments

- we can mix positional arguments with keyword arguments during a function call.
- But we must keep in mind that keyword arguments must follow positional arguments.
- Having a positional argument after keyword arguments will result into errors.
- Example:

```
greet(name="Bruce","How do you do?")
```

Will result into error as:

```
SyntaxError: non-keyword arg after keyword arg
```

Arbitrary Arguments or Variable-length arguments

- Sometimes, we do not know in advance the number of arguments that will be passed into a function.
- Python allows us to handle this kind of situation through function calls with arbitrary number of arguments.
- In the function definition we use an asterisk (*) before the parameter name to denote this kind of argument.

Example.

```
def greet(*names):
    """This function greets all
    the person in the names tuple."""

    # names is a tuple with arguments
    for name in names:
        print("Hello",name)


greet("Monica","Luke","Steve","John")
```

```
Hello Monica
Hello Luke
Hello Steve
Hello John
```

Python Recursion

- Recursion is the process of defining something in terms of itself.
- A physical world example would be to place two parallel mirrors facing each other.
- Any object in between them would be reflected recursively.

Python Recursive Function

- In Python, a function can call other functions.
- It is even possible for the function to call itself.
- These type of construct are termed as recursive functions.

```
5*4*3*2*rec(1)
5*4*3*rec(2)
5*4*rec(3)
5*rec(4)
rec(5)=> stack will create
```

Example of recursive function:

To find the factorial of an integer:

```
def recur_fact(x):
    """This is a recursive function
    to find the factorial of an integer"""

    if x == 1:
        return 1
    else:
        return (x * recur_fact(x-1))


num = int(input("Enter a number: "))
if num >= 1:
    print("The factorial of", num, "is", recur_fact(num))
```

```
Enter a number: 4
The factorial of 4 is 24
```

Advantages of recursion

- Recursive functions make the code look clean and elegant.
- A complex task can be broken down into simpler sub-problems using recursion.
- Sequence generation is easier with recursion than using some nested iteration.

Disadvantages of recursion

- Sometimes the logic behind recursion is hard to follow through.
- Recursive calls are expensive (inefficient) as they take up a lot of memory and time.
- Recursive functions are hard to debug.

Python Anonymous/Lambda Function

- In Python, anonymous function is a function that is defined without a name.
- While normal functions are defined using the def keyword, in Python anonymous functions are defined using the lambda keyword.
- Hence, anonymous functions are also called lambda functions.

Syntax of Lambda Function

```
lambda arguments: expression
```

- Lambda functions can have any number of arguments but only one expression.
- The expression is evaluated and returned.
- Lambda functions can be used wherever function objects are required.

Example of Lambda Function

Here is an example of lambda function that doubles the input value.

```
double = lambda x: x * 2

print(double(5))
```

Example of Lambda Function

- A lambda can take multiple arguments and can return (like a function) multiple values.

```
>>> fn = lambda x, y, z: (x ** 2) + (y * 2) + z
>>> fn(4, 5, 6)
32
```

```
>>> a = lambda x, y: (x * 3, y * 4, (x, y))
>>> a(3, 4)
(9, 16, (3, 4))
```

Use of Lambda Function

- We use lambda functions when we require a nameless function for a short period of time.
- In Python, we generally use it as an argument to a higher-order function (a function that takes in other functions as arguments).
- Lambda functions are used along with built-in functions like filter(), map() etc.

Example use with map()

- The map() function in Python takes in a function and a list.
- The function is called with all the items in the list and a new list is returned which contains items returned by that function for each item.

use of map() function to double all the items in a list.

```
my_list = [1, 5, 4, 6, 8, 11, 3, 12]

new_list = list(map(lambda x: x * 2 , my_list))
print(new_list)
```

```
[2, 10, 8, 12, 16, 22, 6, 24]
```

Example use with filter()

- The filter() function in Python takes in a function and a list as arguments.
- The function is called with all the items in the list and a new list is returned which contains items for which the function evaluats to True.

use of filter() function to filter out only even numbers from a list:

```
my_list = [1, 5, 4, 6, 8, 11, 3, 12]

new_list = list(filter(lambda x: (x%2 == 0) , my_list))
print(new_list)
```

```
[4, 6, 8, 12]
```