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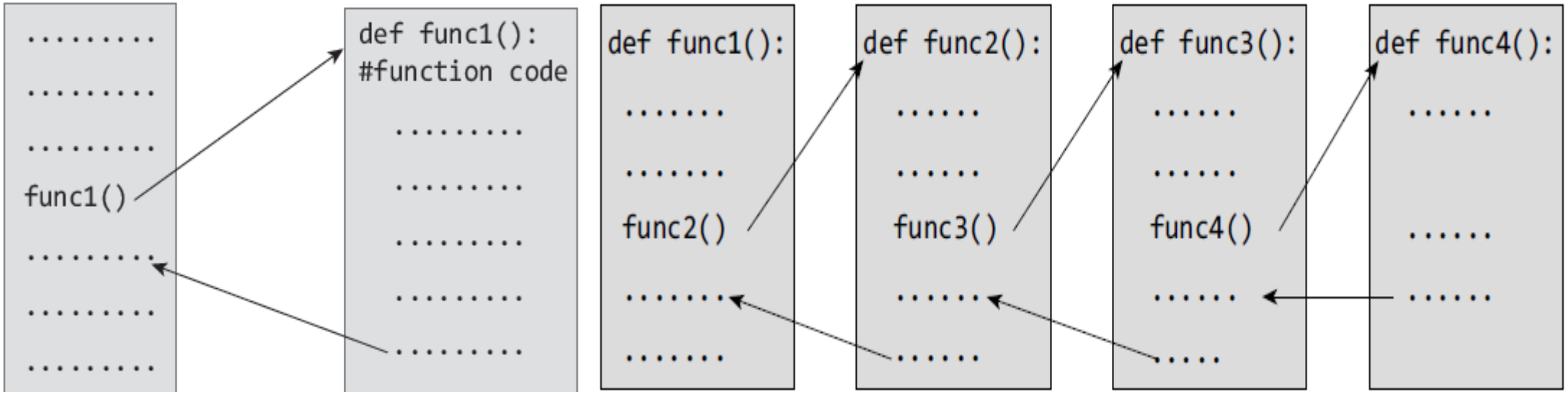
Unit III

Functions and Modules

Functions

Python enables its programmers to break up a program into segments commonly known as functions, each of which can be written more or less independently of the others. Every function in the program is supposed to perform a well-defined task.



Need for Functions

Each function to be written and tested separately.

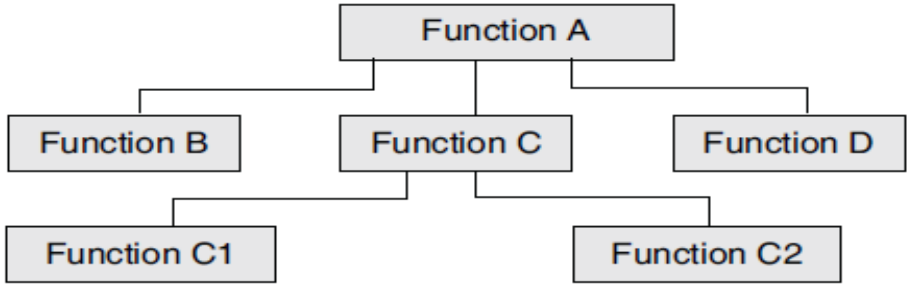
• Understanding, coding and testing multiple separate functions is far easier.

Without the use of any function, then there will be countless lines in the code and maintaining it will be a big mess.

• Programmers use functions without worrying about their code details. This speeds up program development, by allowing the programmer to concentrate only on the code that he has to write.

Different programmers working on that project can divide the workload by writing different functions.

• Like Python libraries, programmers can also make their functions and use them from different point in the main program or any other program that needs its functionalities.



Function Declaration and Definition

- A function, f that uses another function g, is known as the ***calling function*** and g is known as the ***called function***.
- The inputs that the function takes are known as ***arguments/parameters***.
- When a called function returns some result back to the calling function, it is said to return that result.
- The calling function may or may not pass parameters to the called function. If the called function accepts arguments, the calling function will pass parameters, else not.
- ***Function declaration*** is a declaration statement that identifies a function with its name, a list of arguments that it accepts and the type of data it returns.
- ***Function definition*** consists of a function header that identifies the function, followed by the body of the function containing the executable code for that function.

Function Definition

Function blocks starts with the keyword def.

- **The keyword is followed by the function name and parentheses (( )).**
- **After the parentheses a colon (:) is placed.**
- **Parameters or arguments that the function accept are placed within parentheses.**
- **The first statement of a function can be an optional statement - the *docstring* describe what the function does.**
- **The code block within the function is properly indented to form the block code.**
- **A function may have a return[expression] statement. That is, the return statement is optional.**
- **You can assign the function name to a variable. Doing this will allow you to call same function using the name of that variable.**

Example:

```
def diff(x,y):          # function to subtract two numbers
        return x-y
a = 20
b = 10
operation = diff        # function name assigned to a variable
print(operation(a,b))   # function called using variable name
```

OUTPUT

```
10
```

Function Call

The function call statement invokes the function. When a function is invoked the program control jumps to the called function to execute the statements that are a part of that function. Once the called function is executed, the program control passes back to the calling function.

Function Parameters

A function can take parameters which are nothing but some values that are passed to it so that the function can manipulate them to produce the desired result. These parameters are normal variables with a small difference that the values of these variables are defined (initialized) when we call the function and are then passed to the function.

Function name and the number and type of arguments in the function call must be same as that given in the function definition.

If the data type of the argument passed does not matches with that expected in function then an error is generated.

Example:

```
def function_name(variable1, variable2,..)
        documentation string
        statement block
        return [expression]
```

Function Header

Function Body

Examples

```
def func():
        for i in range(4):
                print("Hello World")
func()      #function call
```

OUTPUT

```
Hello World
Hello World
Hello World
Hello World
```

```
def func(i):
        print("Hello World", i)
func(5+2*3)
```

OUTPUT

```
Hello World 11
```

```
def total(a,b):    # function accepting parameters
   result = a+b
   print("Sum of ", a, " and ", b, " = ", result)

a = int(input("Enter the first number : "))
b = int(input("Enter the second number : "))
total(a,b) #function call with two arguments
```

OUTPUT

```
Enter the first number : 10
Enter the second number : 20
Sum of 10 and 20 = 30
```

```
def func(i):                # function definition header accepts a variable with name i
print("Hello World", i)
j = 10
func(j)                     # Function is called using variable j
```

OUTPUT

```
Hello World 10
```

Variable Scope and Lifetime

Local and Global Variables

A variable which is defined within a function is ***local*** to that function. A local variable can be accessed from the point of its definition until the end of the function in which it is defined. It exists as long as the function is executing. Function parameters behave like local variables in the function. Moreover, whenever we use the assignment operator (=) inside a function, a new local variable is created.

Global variables are those variables which are defined in the main body of the program file. They are visible throughout the program file. As a good programming habit, you must try to avoid the use of global variables because they may get altered by mistake and then result in erroneous output.

Local and Global Variables

Example:

```
num1 = 10    # global variable
print("Global variable num1 = ", num1)
def func(num2):           # num2 is function parameter
        print("In Function - Local Variable num2 = ",num2)
        num3 = 30         #num3 is a local variable
        print("In Function - Local Variable num3 = ",num3)
func(20)       #20 is passed as an argument to the function
print("num1 again = ", num1)        #global variable is being accessed
#Error- local variable can't be used outside the function in which it is defined
print("num3 outside function = ", num3)
```

OUTPUT

```
Global variable num1 = 10
In Function - Local Variable num2 = 20
In Function - Local Variable num3 = 30
num1 again =  10
num3 outside function =
Traceback (most recent call last):
  File "C:\Python34\Try.py", line 12, in <module>
    print("num3 outside function = ", num3)
NameError: name 'num3' is not defined
```

Programming Tip: Variables can only be used after the point of their declaration

Using the Global Statement

To define a variable defined inside a function as global, you must use the global statement. This declares the local or the inner variable of the function to have module scope.

Example:

```
var = "Good"
def show():
        global var1
        var1 = "Morning"
        print("In Function var is - ", var)
show()
print("Outside function, var1 is - ", var1)      #accessible as it is global
variable
print("var is - ", var)
```

OUTPUT

```
In Function var is -  Good
Outside function, var1 is -  Morning
var is -  Good
```

Programming Tip: All variables have the scope of the block.

Resolution of names

Scope **defines the visibility of a name within a block. If a local variable is defined in a block, its scope is that particular block. If it is defined in a function, then its scope is all blocks within that function.**

When a variable name is used in a code block, it is resolved using the nearest enclosing scope. If no variable of that name is found, then a NameError is raised. In the code given below, str is a global string because it has been defined before calling the function.

Example:

```
def func():
        print(str)
str = "Hello World !!!"
func()
```

OUTPUT

```
Hello World !!!
```

The Return Statement

The syntax of return statement is,

return [expression]

The expression is written in brackets because it is optional. If the expression is present, it is evaluated and the resultant value is returned to the calling function. However, if no expression is specified then the function will return None.

The return statement is used for two things.

- **Return a value to the caller**
- **To end and exit a function and go back to its caller**

Example:

```
def cube(x):
   return (x*x*x)
num = 10
result = cube(num)
print('Cube of ', num, ' = ', result)
```

OUTPUT

```
Cube of 10 = 1000
```

Defining Function

Required Arguments

In the *required arguments*, the arguments are passed to a function in correct positional order. Also, the number of arguments in the function call should exactly match with the number of arguments specified in the function definition

Examples:

```
def display():
   print "Hello"
display("Hi")
```

OUTPUT

```
TypeError: display() takes
no arguments (1 given)
```

```
def display(str):
   print str
display()
```

OUTPUT

```
TypeError: display() takes
exactly 1 argument (0
given)
```

```
def display(str):
   print str
str ="Hello"
display(str)
```

OUTPUT

```
Hello
```

Keyword Arguments

When we call a function with some values, the values are assigned to the arguments based on their position. Python also allow functions to be called using keyword arguments in which the order (or position) of the arguments can be changed. The values are not assigned to arguments according to their position but based on their name (or keyword).

Keyword arguments are beneficial in two cases.

- **First, if you skip arguments.**
- **Second, if in the function call you change the order of parameters.**

Example:

```
def display(str, int_x, float_y):
   print("The string is : ",str)
   print("The integer value is : ", int_x)
   print("The floating point value is : ", float_y)
display(float_y = 56789.045, str = "Hello", int_x = 1234)
```

OUTPUT

```
The string is:  Hello
The integer value is:  1234
The floating point value is:  56789.045
```

Variable-length Arguments

In some situations, it is not known in advance how many arguments will be passed to a function. In such cases, Python allows programmers to make function calls with arbitrary (or any) number of arguments.

When we use arbitrary arguments or variable length arguments, then the function definition use an asterisk (*) before the parameter name.The syntax for a function using variable arguments can be given as,

```
def functionname([arg1, arg2,.... ] *var_args_tuple ):
    function statements
    return [expression]
```

Example:

```
def func(name, *fav_subjects):
    print("\n", name, " likes to read ")
    for subject in fav_subjects:
        print(subject)
func("Goransh", "Mathematics", "Android Programming")
func("Richa", "C", "Data Structures", "Design and Analysis of Algorithms")
func("Krish")
```

OUTPUT

```
Goransh  likes to read  Mathematics Android Programming
Richa likes to read  C Data Structures Design and Analysis of Algorithms
Krish  likes to read
```

Default Arguments

Python allows users to specify function arguments that can have default values. This means that a function can be called with fewer arguments than it is defined to have. That is, if the function accepts three parameters, but function call provides only two arguments, then the third parameter will be assigned the default (already specified) value. The default value to an argument is provided by using the assignment operator (=). Users can specify a default value for one or more arguments.

Example:

```
def display(name, course = "BTech"):
    print("Name : " + name)
    print("Course : ", course)
display(course = "BCA", name = "Arav") # Keyword Arguments
display(name = "Reyansh")              # Default Argument for course
```

OUTPUT

```
Name : Arav
Course :  BCA
Name : Reyansh
Course :  BTech
```

Lambda Functions Or Anonymous Functions

Lambda or anonymous **functions are so called because they are not declared as other functions using the def keyword. Rather, they are created using the lambda keyword. Lambda functions are throw-away functions, i.e. they are just needed where they have been created and can be used anywhere a function is required. The lambda feature was added to Python due to the demand from LISP programmers.**

Lambda functions contain only a single line. Its syntax can be given as,

```
lambda arguments: expression
```

Example:

```
sum = lambda x, y: x + y
print("Sum = ", sum(3, 5))
```

OUTPUT

```
Sum = 8
```

Documentation Strings

Docstrings (documentation strings) serve the same purpose as that of comments, as they are designed to explain code. However, they are more specific and have a proper syntax.

```
def functionname(parameters):
   "function_docstring"
   function statements
   return [expression]
```

Example:

```
def func():
    """The program just prints a message.
    It will display Hello World !!!   """
    print("Hello World !!!")
print(func.__doc__)
```

OUTPUT

```
The program just prints a message.
    It will display Hello World !!!
```

Recursive Functions

A recursive function is defined as a function that calls itself to solve a smaller version of its task until a final call is made which does not require a call to itself. Every recursive solution has two major cases, which are as follows:

- ***base case*, in which the problem is simple enough to be solved directly without making any further calls to the same function.**
- ***recursive case*, in which first the problem at hand is divided into simpler sub parts.**

Recursion utilized divide and conquer technique of problem solving.

Example:

```
def fact(n):
      if(n==1 or n==0):
            return 1
      else:
            return n*fact(n-1)
n = int(input("Enter the value of n : "))
print("The factorial of",n,"is",fact(n))
```

OUTPUT

```
Enter the value of n : 6
The factorial of 6 is 720
```

Modules

The from…import Statement

A module may contain definition for many variables and functions. When you import a module, you can use any variable or function defined in that module. But if you want to use only selected variables or functions, then you can use the from...import statement. For example, in the aforementioned program you are using only the path variable in the sys module, so you could have better written from sys import path.

Example:

```
from math import pi
print("PI = ", + pi)
```

OUTPUT

```
3.141592653589793
```

To import more than one item from a module, use a comma separated list. For example, to import the value of pi and sqrt() from the math module you can write,

```
from math import pi, sqrt
```

Making your own Modules

Every Python program is a module, that is, every file that you save as .py extension is a module.

Examples:

First write these lines in a file and save the file as MyModule.py

```
def display():      #function definition
   print("Hello")
   print("Name of called module is : ", __name__)

str = "Welcome to the world of Python !!!     #variable definition
```

Then, open another file (main.py) and write the lines of code given below.

```
import MyModule
print("MyModule str = ", MyModule.str)      #using variable defined in MyModule
MyModule.display()                          #using function defined in MyModule
print("Name of calling module is : ", __name__)
```

When you run this code, you will get the following output.

```
MyModule str =  Welcome to the world of Python !!!
Hello
Name of called module is :  MyModule
Name of calling module is :  __main__
```

The dir() function

dir() is a built-in function that lists the identifiers defined in a module. These identifiers may include functions, classes and variables. If no name is specified, the dir() will return the list of names defined in the current module.

Example:

```
def print_var(x):
    print(x)
x = 10
print_var(x)
print(dir())
```

OUTPUT

```
10
['__builtins__', '__doc__', '__file__', '__name__', '__package__', 'print_var', 'x']
```

Modules and Namespaces

A namespace is a container that provides a named context for identifiers. Two identifiers with the same name in the same scope will lead to a name clash. In simple terms, Python does not allow programmers to have two different identifiers with the same name. However, in some situations we need to have same name identifiers. To cater to such situations, namespaces is the keyword. Namespaces enable programs to avoid potential name clashes by associating each identifier with the namespace from which it originates.

Example:

```
# module1
def repeat_x(x):
    return x*2

# module2
def repeat_x(x):
    return x**2

import module1
import module2
result = repeat_x(10)     # ambiguous reference for identifier repeat_x
```

Local, Global, and Built-in Namespaces

During a program's execution, there are three main namespaces that are referenced- the built-in namespace, the global namespace, and the local namespace. The built-in namespace, as the name suggests contains names of all the built-in functions, constants, etc that are already defined in Python. The global namespace contains identifiers of the currently executing module and the local namespace has identifiers defined in the currently executing function (if any).

When the Python interpreter sees an identifier, it first searches the local namespace, then the global namespace, and finally the built-in namespace. Therefore, if two identifiers with same name are defined in more than one of these namespaces, it becomes masked.

Local, Global, and Built-in Namespaces

Example:

```
def max(numbers):      # global namespace
    print("USER DEFINED FUNCTION MAX.....")
    large = -1       # local namespace
    for i in numbers:
        if i>large:
            large = i
    return large
numbers = [9,-1,4,2,7]
print(max(numbers))
print("Sum of these numbers = ", sum(numbers))  #built in namespace
```

OUTPUT

```
USER DEFINED FUNCTION MAX.....
9
Sum of these numbers =  21
```

Module Private Variables

In Python, all identifiers defined in a module are public by default. This means that all identifiers are accessible by any other module that imports it. But, if you want some variables or functions in a module to be privately used within the module, but not to be accessed from outside it, then you need to declare those identifiers as private.

In Python identifiers whose name starts with two underscores (__) are known as private identifiers. These identifiers can be used only within the module. In no way, they can be accessed from outside the module. Therefore, when the module is imported using the import * form modulename, *all the identifiers of a module's namespace is imported except the private ones (ones beginning with double underscores). Thus, private identifiers become inaccessible from within the importing module.*

Packages in Python

A package is a hierarchical file directory structure that has modules and other packages within it. Like modules, you can very easily create packages in Python.

Every package in Python is a directory which must have a special file called __init__.py. This file may not even have a single line of code. It is simply added to indicate that this directory is not an ordinary directory and contains a Python package. In your programs, you can import a package in the same way as you import any module.

For example, to create a package called MyPackage, create a directory called MyPackage having the module MyModule and the __init__.py file. Now, to use MyModule in a program, you must first import it. This can be done in two ways.

```
import MyPackage.MyModule
```

or

```
from MyPackage import MyModule
```

Standard Library Module

Pre-installed Library
string, re, datetime, math, random, os, multiprocessing, subprocessing, socket, email, json,doctest,unitest,pdb,argparse and sys

Globals(), Locals(), And Reload()

The **globals()** and **locals()** functions are used to return the names in the global and local namespaces (In Python, each function, module, class, package, etc owns a "namespace" in which variable names are identified and resolved). The result of these functions is of course, dependent on the location from where they are called. For example,

If **locals()** is called from within a function, names that can be accessed locally from that function will be returned.

If **globals()** is called from within a function, all the names that can be accessed globally from that function is returned.

Reload()- When a module is imported into a program, the code in the module is executed only once. If you want to re-execute the top-level code in a module, you must use the reload() function. This function again imports a module that was previously imported.