PYTHON BASICS

Python is most widely used **general purpose high level programming language** like Java, C, C++ etc. Python was developed by **Guido van Rossum** in the late eighties and early nineties at the National Research Institute for Mathematics and Computer Science in the Netherlands. Python is derived from many other languages, including **ABC, Modula-3, C, C++, Algol-68, SmallTalk, and Unix shell** and other scripting languages. Rossum was a fan of a comedy series from late seventies. Python is named after a TV Comedy Show called '**Monty Python's Flying Circus'** and not after Python-the snake**. Python 3.11.4** is the latest version of Python.

FEATURES OF PYTHON

- **General purpose programming language** - As a general-purpose programming language python is designed to be used for widest variety of application domains (a general-purpose language). ...It can be used for developing both desktop and web applications, complex scientific and numeric applications, data analysis and visualization. Conversely, a domain-specific programming language is one designed to be used within a specific application domain. For eg: COBOL (Business applications), FORTRAN(Complex mathematical computations).

- **High level language** - High-level language is any programming language that enables development of a program in a much more user-friendly programming context and is generally independent of the computer's hardware architecture. Like JAVA, C ,C++ Python is a Highlevel programming language.

- **Interpreted** - Python runs on an interpreter system, meaning that code can be executed as soon as it is written. You do not need to compile your program before executing it.

- **Interactive** - We can actually sit at a Python prompt and interact with the interpreter directly to write your programs and It allows interactive testing and debugging of snippets of code.
- **Portable** - Python can run on a wide variety of hardware platforms like Windows, Linux, MAC OS and has the same interface on all platforms. You can move Python programs from one platform to another, and run it without any changes.
- **Multiple Programming Paradigms**- Python also supports several programming paradigms. It supports object oriented and Functional programming. Python can be treated in a procedural way, an object-oriented way or a functional way.
- **Easy to Learn** - Python has a simple syntax similar to the English language. This makes python easier to learn. Python has syntax that allows developers to write programs with fewer lines than some other programming languages. Most of other high level languages like JAVA, C, C++ has so many syntactical constructs like Punctuation marks, semicolon, braces etc to indicate the ending of a statement or to identify block of code. But in Python, It has fewer syntactical constructions than other languages.

For eg:

In **JAVA**

Suppose we need to assign a name **"BOB"** to a variable **name** .In JAVA we have to first specify the type of the variable as **String**. After that we assign value **BOB** to variable **name** and put a semicolon at the end to indicate ending of a line.

String name="BOB";

In order to print it out we use **System.Out.Println("name");** and put a semi colon at the end.

But

In **Python**

We write **name=”BOB”**

In order to print it out we use simply **print(name**)

We do not need to specify the type and put semicolon to indicate the ending of a line. This syntax makes Python code more easier to read and Learn.

- **Dynamic Typed Language** – As specified above, in python we don’t have to specify the type when declaring a variable. It skip the headache of type casting and declaring types when declaring a variable.

  In JAVA,

  int x=1;

  x=(int)x/2;

  In order to store integer values to a variable **x** first we have to declare its type as **int**. it means that x always store integer values .In the first line we assign value 1 to integer variable x.

  If we take **x=x/2**; the value of x becomes ½. x can never equal 0.5. So first we have to cast the result into type integer using (int) function. Now the result becomes 0.

  In python,

  x=1

  x=x/2

  In this case, Python itself take care of type management we don’t need to worry about it.

If we write x=1 at this point type of x is int because we assign integer value to x. if we write x=x/2 now x equals 0.5 and the type of x at this point is float. We don't need to explicitly type cast the result into float. According to the type of values we store to a variable its type is decided by the interpreter at runtime. We don't need to worry about it.

- **Databases** - Python provides interfaces to all major commercial databases like POSTGRES, MY SQL, SQLITE.
- **GUI Programming**- Python supports GUI applications. Python provides Tk GUI library to develop user interface in python based application.
- **Free and Open-Source**-Python is developed under an OSI-approved open source license. Hence, it is completely free to use, even for commercial purposes. It doesn't cost anything to download Python or to include it in your application. It can also be freely modified and re-distributed. Python can be downloaded from the official Python website.
- **Robust Standard Library**-Python has an extensive standard library available for anyone to use. This means that programmers don't have to write their code for every single thing unlike other programming languages. There are libraries for image manipulation, databases, unit-testing, expressions and a lot of other functionalities.
- **Large Community Support-**Python was founded around 30 years ago and so it has a vast community of efficient developers. These developers are constantly helping out the beginners through their constant support and in-depth journals. There is plenty of documentation and guides that the newbie programmers could learn and enhance their Python.

Setting up of Environment

In order to use python first it must be installed on our computer, Follow these steps

1).Go to the Python website www.python.org and click the Download menu choice.

2). Next , Download the Python 3.10 or Python 3.9 installer.

3).When the download is completed, double-click the file and follow the instructions to install it.

First Python Program

Let us execute the programs in different modes of programming.

- **Interactive Mode Programming**.

  Python provides Interactive Shell to execute code immediately and produce output instantly. To test a short amount of code in python sometimes it is quickest and easiest not to write the code in a file. This is made possible because Python can be run as a command line itself.

  Type the following text at the Python prompt and press Enter –

  ```
  >>> print ("Hello, Python!")
  ```

  This produces the following result –

  ```
  >>>Hello, Python!
  ```

- **Script Mode Programming**

  Using **Script Mode**, we can write our Python code in a separate file of any editor in our Operating System. Let us write a simple Python program in a script. Python files have the extension .**py**. Type the following source code in **a test.py** file –

  ```
  print ("Hello, Python!")
  ```

  Now open Command prompt and execute it by :

  ```
  >>> python test.py
  ```

  This produces the following result –

```
>>>Hello, Python!
```

- **USING IDLE**

  When Python is installed, a program called **IDLE** is also installed along with it. It provides graphical user interface to work with Python.

  Open IDLE, copy the following code below and press enter.

  ```
  >>>print("Hello, World!")
  ```

  Or

  To create a file in IDLE, go to **File > New Window (Shortcut: Ctrl+N).**

  Write Python code (you can copy the code below for now) and save (Shortcut: Ctrl+S) with .py file extension like: hello.py or your-first-program.py

  ```
  print("Hello, World!")
  ```

  Go to Run > Run module (Shortcut: F5) and we can see the output.

IDENTIFIERS

- Identifier is the name given to entities like class, functions, variables etc. in Python. It helps differentiating one entity from another.

Rules for writing identifiers Identifiers can be a combination of letters in lowercase (a to z) or uppercase (A to Z) or digits (0 to 9) or an underscore (_). Names like myClass, var_1 and print_this_to_screen, all are valid example.

- An identifier cannot start with a digit. 1variable is invalid, but variable1 is perfectly fine.
- Keywords cannot be used as identifiers.

  ```
  >>> global = 1
  ```

```
  File "<interactive input>", line 1

    global = 1

          ^

SyntaxError: invalid syntax
```

- We cannot use special symbols like !, @, #, $, % etc. in our identifier.

```
>>> a@ = 0

  File "<interactive input>", line 1

    a@ = 0

     ^

SyntaxError: invalid syntax
```

- Identifier can be of any length.
- Python is a case-sensitive language. This means, Variable and variable are not the same. Always name identifiers that make sense.

Python Keywords

Keywords are the reserved words in Python. We cannot use a keyword as variable name, function name or any other identifier. They are used to define the syntax and structure of the Python language. In Python, keywords are case sensitive. All the keywords except True, False and None are in lowercase and they must be written as it is. The list of all the keywords are given below.

True	False	None	and	as
Asset	Def	Class	continue	break
Else	Finally	Elif	del	except
Global	For	If	from	import

Raise	Try	or	return	pass
nonlocal	In	not	is	lambda

Lines and Indentation

Python does not use braces ({}) to indicate blocks of code for class and function definitions or flow control. Blocks of code are denoted by line indentation, which is rigidly enforced. The number of spaces in the indentation is variable, but all statements within the block must be indented the same amount. For example —

```
if (True):
        print ("True")
else:
        print ("False")
```

Multi-Line Statements

Statements in Python typically end with a new line. Python, however, allows the use of the **line continuation character (\)** to denote that the line should continue. For example —

```
total = item_one + \
     item_two + \
     item_three
```

The statements contained within the [], {}, or () brackets do not need to use the line continuation character. For example —

```
days = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday']
```

Quotation in Python

Python accepts single ('), double (") and triple (''' or """) quotes to denote string literals, as long as the same type of quote starts and ends the string. The triple quotes are used to span the string across multiple lines. For example, all the following are legal —

word = 'word'

sentence = "This is a sentence."

paragraph = """This is a paragraph. It is

made up of multiple lines and sentences."""

Comments in Python

Python supports two types of comments:

1) **Single lined comment**:

In case user wants to specify a single line comment, then comment must start with **#**

eg: **# This is single line comment**.

2) **Multi lined Comment**:

Multi lined comment can be given inside triple quotes.

eg: **''' This**

Is

Multipline comment'''

Multiple Statements on a Single Line

The semicolon (;) allows multiple statements on a single line given that no statement starts a new code block

For eg:

If(a>b);print("a is greater than b")

Variables

Variables are nothing but reserved memory locations to store values. It means that when you create a variable, you reserve some space in the memory. Based on the data type of a variable, the interpreter allocates memory and decides what can be stored in the reserved memory. Therefore, by assigning different data types to the variables, you can store integers, decimals or characters in these variables.

Assigning Values to Variables

Python variables do not need explicit declaration to reserve memory space. The declaration happens automatically when you assign a value to a variable. The equal sign (=) is used to assign values to variables.

```
c = 100                 # An integer assignment

m  = 1000.0             # A floating point

name   = "John"         # A string

print (c)

print (m)

print (name)                                Output: 100

                                                    1000.0

                                                    John
```

Multiple Assignment

Python allows us to assign a single value to several variables simultaneously.

For example —

a = b = c = 1

Here, an integer object is created with the value 1, and all the three variables are assigned to the same memory location. We can also assign multiple objects to multiple variables.

For example –

```
a, b, c = 1, 2, "john"
```

Here, two integer objects with values 1 and 2 are assigned to the variables a and b respectively, and one string object with the value "john" is assigned to the variable c.

Standard Data Types

The data stored in memory can be of many types.

Python provides following data types –

Numeric Types:	**int, float, complex**
Text Type:	**str**
Sequence Types:	**list, tuple**
Mapping Type:	**dict**
Set Type:	**set**
Boolean Type:	**bool**
None Type:	**NoneType**

Python Numbers

Number data types store numeric values. Number objects are created when you assign a value to them. For example –

```
var1 = 1
```

We can also delete the reference to a number object by using the **del** statement. The syntax of the **del** statement is –

```
del var1[,var2[,var3[....,varN]]]]
```

You can delete a single object or multiple objects by using the **del** statement.

For example –

```
del var
```

Python supports three different numerical types −

- **int (signed integers)**
- **float (floating point real values)**
- **complex (complex numbers**)

A complex number consists of an ordered pair of real floating-point numbers denoted by **x + yj,** where x and y are real numbers and j is the imaginary unit.

Python Strings

Strings in Python are identified as **a contiguous set of characters** represented in the quotation marks. Python allows either pair of single or double quotes.

Subsets of strings can be taken using the **slice operator** ([ ] and [:]) with indexes starting at 0 in the beginning of the string and working their way from -1 to the end.

The plus (+) sign is the string **concatenation operator** and the asterisk (*) is the **repetition operator.**

```
str = 'Hello World!'

print (str)        # Prints complete string

print (str[0])      # Prints first character of the string

print (str[2:5])    # Prints characters starting from 3rd to 5th

print (str[2:])     # Prints string starting from 3rd character

print (str * 2)     # Prints string two times

print (str + "TEST") # Prints concatenated string

print (str [ -1])     # Prints Last character of the string
```

OUTPUT:

```
Hello World!
H
llo
llo World!
Hello World!Hello World!
Hello World!TEST
!
```

Python Lists

Lists are the most versatile of Python's compound data types. **A list contains items separated by commas and enclosed within square brackets ([]).** To some extent, lists are similar to **arrays** in C. **One of the differences between them is that all the items belonging to a list can be of different data type**.

The values stored in a list can be accessed using the **slice operator ([ ] and [:])** with indexes starting at 0 in the beginning of the list and working their way to end -1. The plus (+) sign is the list **concatenation operator**, and the asterisk (*) is the **repetition operator**.

For example −

```
list = [ 'abcd', 786 , 2.23, 'john', 70.2 ]

tinylist = [123, 'john']

print (list)         # Prints complete list

print (list[0])      # Prints first element of the list

print (list[1:3])    # Prints elements starting from 2nd till 3rd
print (list[2:])     # Prints elements starting from 3rd element

print (tinylist * 2)  # Prints list two times

print (list + tinylist) # Prints concatenated lists
```

OUTPUT:

```
['abcd', 786, 2.23, 'john', 70.200000000000003]
abcd
[786, 2.23]
[2.23, 'john', 70.200000000000003]
[123, 'john', 123, 'john']
['abcd', 786, 2.23, 'john', 70.200000000000003, 123, 'john']
```

Python Tuples

A tuple is another sequence data type that is similar to the list. A tuple consists of a number of values separated by commas. Unlike lists, however, **tuples are enclosed within parenthesis.**

The main difference between lists and tuples are − Lists are enclosed in brackets ([ ]) and their elements and size can be changed, while tuples are enclosed in parentheses (( )) and cannot be updated. Tuples can be thought of as read-only lists.

For example −

```
tuple = ( 'abcd', 786 , 2.23, 'john', 70.2  )

tinytuple = (123, 'john')

print (tuple)          # Prints complete tuple

print (tuple[0])       # Prints first element of the tuple

print (tuple[1:3])     # Prints elements starting from 2nd till 3rd
print (tuple[2:])      # Prints elements starting from 3rd element

print (tinytuple * 2)   # Prints tuple two times

print (tuple + tinytuple) # Prints concatenated tuple
```

OUTPUT:

```
('abcd', 786, 2.23, 'john', 70.200000000000003)
abcd
(786, 2.23)
(2.23, 'john', 70.200000000000003)
(123, 'john', 123, 'john')
('abcd', 786, 2.23, 'john', 70.200000000000003, 123, 'john')
```

The following code is invalid with tuple, because we attempted to update a tuple, which is not allowed. Similar case is possible with lists –

```
tuple = ( 'abcd', 786 , 2.23, 'john', 70.2  )

list = [ 'abcd', 786 , 2.23, 'john', 70.2  ]

tuple[2] = 1000    # Invalid syntax with tuple

list[2] = 1000     # Valid syntax with l
```

Python Dictionary

They work like associative arrays or hashes found in Perl and **consist of key-value pairs**. A dictionary key can be almost any Python type, but are usually numbers or strings. Values, on the other hand, can be any arbitrary Python object.

Dictionaries are enclosed by curly braces ({ }) and values can be assigned and accessed using square braces ([]).

For example –

```
dict = {}

dict['one'] = "This is one"

dict[2]     = "This is two"

tinydict = {'name': 'john','code':6734, 'dept': 'sales'}

print (dict['one'])      # Prints value for 'one' key

print (dict[2])          # Prints value for 2 key

print (tinydict)         # Prints complete dictionary

print (tinydict.keys())            # Prints all the keys

print (tinydict.values())        # Prints all the values
```

OUTPUT—

```
This is one
This is two
{'name': 'john', 'dept': 'sales', 'code': 6734}
dict_keys(['name', 'dept', 'code'])
dict_values(['john', 'sales', 6734])
```

Dictionaries have no concept of order among the elements. It is incorrect to say that the elements are "out of order"; **they are simply unordered**.

Set

A set is an **unordered collection of items**. Every element is **unique (no duplicates) and must be immutable (which cannot be changed)**. However, **the set itself is mutable**. We can add or remove items from it. Sets can be used to perform mathematical set operations like **union, intersection, symmetric difference** etc.

A set is created by placing all the items (elements) inside curly braces {}, separated by comma or by using the built-in function set().It can have any number of items and they may be of different types (integer, float, tuple, string etc.). But a **set cannot have a mutable element, like list, set or dictionary, as its element**.

For eg:

my_set = {1, 2, 3}

print(my_set) **Output:{1,2,3}**

my_set = {1.0, "Hello", (1, 2, 3)}

print(my_set) **Output:{1.0,"Hello",(1,2,3)}**

*** Set do not have duplicates**

my_set = {1,2,3,4,3,2}

print(my_set) **Output:{1,2,2,4}**

***Set cannot have mutable items**

my_set = {1, 2

, [3, 4]} **Output: Type Error: unhashable type: 'list'**

*__Using set() Function__

my_set = set([1,2,3,2])

print(my_set) Output: {1, 2, 3}

* **Creating an empty set**

Empty curly braces {} will make an empty dictionary in Python. To make a set without any elements we use the **set() function without any argument**.

For eg:

a = set()

*We cannot access or change an element of set using indexing or slicing. Set does not support it. We can add single element using the **add()** method and multiple elements using the **update()** method. The update() method can take tuples, lists, strings or other sets as its argument. In all cases, duplicates are avoided.

For eg:

```
my_set = {1,3}

print(my_set)                                   Output:{1,3}

my_set.add(2)

print(my_set)                                   Output:{1,2,3}

my_set.update([2,3,4])

print(my_set)      Output:{1,2,3,4}

my_set.update(((4,5), 1,6,8}))

print(my_set)    Output: {1, 2, 3, 4, (4,5), 6, 8}
```

***A particular item can be removed from set using methods, discard() and remove().**

The only difference between the two is that, while using discard() if the item does not exist in the set, it remains unchanged. But remove() will raise an error in such condition.

The following example will illustrate this.

```
# initialize my_set

my_set = {1, 3, 4, 5, 6}

print(my_set)                                  Output: {1, 3, 4, 5, 6}

#discard an element

my_set.discard(4)

print(my_set)                                  Output: {1, 3, 5, 6}

# remove an element

my_set.remove(6)

print(my_set)                                  Output: {1, 3, 5}

# discard an element

# not present in my_set

my_set.discard(2)

print(my_set)                                    Output: {1, 3, 5}


# remove an element

# not present in my_set

# we will get an error.
```

my_set.remove(2) **Output: Key Error: 2**

Python Booleans

Booleans represent one of two values: True or False.

Python None Type

None is a data type of its own (NoneType) and only None can be None.

The None keyword is used to define a null value, or no value at all. None is not the same as 0, False, or an empty string

Data Type Conversion

Sometimes, you may need to perform conversions between the built-in types. To convert between types, you simply use the type-names as a function. There are several built-in functions to perform conversion from one data type to another. These functions return a new object representing the converted value.

r.No.	Function & Description
1	**int(x [,base])** Converts x to an integer. The base specifies the base if x is a string.
2	**float(x)** Converts x to a floating-point number.
3	**complex(real [,imag])** Creates a complex number.
4	**str(x)** Converts object x to a string representation.
5	**repr(x)** Converts object x to an expression string.

6	**eval(str)** Evaluates a string and returns an object.
7	**tuple(s)** Converts s to a tuple.
8	**list(s)** Converts s to a list.
9	**set(s)** Converts s to a set.
10	**dict(d)** Creates a dictionary. d must be a sequence of (key,value) tuples.
11	**frozenset(s)** Converts s to a frozen set.
12	**chr(x)** Converts an integer to a character.
13	**unichr(x)** Conv4erts an integer to a Unicode character.
14	**ord(x)** Converts a single character to its integer value.
15	**hex(x)** Converts an integer to a hexadecimal string.
16	**oct(x)** Converts an integer to an octal string.

OPERATORS

Operators are the constructs, which can manipulate the value of operands.

Types of Operator

Python language supports the following types of operators −

- **Arithmetic Operators**
- **Comparison (Relational) Operators**
- **Assignment Operators**
- **Logical Operators**
- **Bitwise Operators**
- **Membership Operators**
- **Identity Operators**

Python Arithmetic Operators

Assume variable **a** holds the value 10 and variable **b** holds the value 21, then −

• **Operator**	• **Description**	**Example**
+ Addition	Adds values on either side of the operator.	a + b = 31
- Subtraction	Subtracts right hand operand from left hand operand.	a − b = -11
* Multiplication	Multiplies values on either side of the operator	a * b = 210
/ Division	Divides left hand operand by right hand operand	b / a = 2.1
% Modulus	Divides left hand operand by right hand operand and returns remainder	b % a = 1
** Exponent	Performs exponential (power) calculation on operators	a**b =10 to the

		power 20
//	Floor Division - The division of operands where the result is the quotient in which the digits after the decimal point are removed. But if one of the operands is negative, the result is floored, i.e., rounded away from zero (towards negative infinity):	9//2 = 4 and 9.0//2.0 = 4.0, -11//3 = -4, -11.0//3 = -4.0

Python Comparison Operators

These operators compare the values on either side of them and decide the relation among them. They are also called Relational operators.

Assume variable **a** holds the value 10 and variable **b** holds the value 20, then −

Operator	Description	Example
==	If the values of two operands are equal, then the condition becomes true.	(a == b) is not true.
!=	If values of two operands are not equal, then condition becomes true.	(a!= b) is true.
>	If the value of left operand is greater than the value of right operand, then condition becomes true.	(a > b) is not true.
<	If the value of left operand is less than the value of right operand, then condition becomes true.	(a < b) is true.
>=	If the value of left operand is greater than or equal to the value of right operand, then condition becomes true.	(a >= b) is not true.
<=	If the value of left operand is less than or equal to the value of right operand, then condition becomes true.	(a <= b) is true.

Python Assignment Operators

Assume variable **a** holds the value 10 and variable **b** holds the value 20, then −

Operator	Description	Example
=	Assigns values from right side operands to left side operand	c = a + b assigns value of a + b into c
+= Add AND	It adds right operand to the left operand and assign the result to left operand	c += a is equivalent to c = c + a
-= Subtract AND	It subtracts right operand from the left operand and assign the result to left operand	c -= a is equivalent to c = c - a
*= Multiply AND	It multiplies right operand with the left operand and assign the result to left operand	c *= a is equivalent to c = c * a
/= Divide AND	It divides left operand with the right operand and assign the result to left operand	c /= a is equivalent to c = c / ac /= a is equivalent to c = c / a
%= Modulus AND	It takes modulus using two operands and assign the result to left operand	c %= a is equivalent to c = c % a
**= Exponent AND	Performs exponential (power) calculation on operators and assign value to the left operand	c **= a is equivalent to c = c ** a
//= Floor Division	It performs floor division on operators and assign value to the left operand	c //= a is equivalent to c = c // a

Python Bitwise Operators

Bitwise operator works on bits and performs bit-by-bit operation. Assume if a = 60; and b = 13; Now in binary format they will be as follows −

a = 0011 1100

b = 0000 1101

----

a&b = 0000 1100

a|b = 0011 1101

a^b = 0011 0001

~a = 1100 0011

Python's built-in function **bin()** can be used to obtain binary representation of an integer number.

The following Bitwise operators are supported by Python language –

Operator	**Description**	**Example**
& Binary AND	Operator copies a bit, to the result, if it exists in both operands	(a & b) (means 0000 1100)
| Binary OR	It copies a bit, if it exists in either operand.	(a | b) = 61 (means 0011 1101)
^ Binary XOR	It copies the bit, if it is set in one operand but not both.	(a ^ b) = 49 (means 0011 0001)
~ Binary Ones Complement	It is unary and has the effect of 'flipping' bits.	(~a) = -61 (means 1100 0011 in 2's complement form due to a signed binary number.
<< Binary Left Shift	The left operand's value is moved left by the number of bits specified by the right operand.	a << = 240 (means 1111 0000)

>> Binary Right Shift	The left operand's value is moved right by the number of bits specified by the right operand.	a >> = 15 (means 0000 1111)

Python Logical Operators

The following logical operators are supported by Python language. Assume variable **a** holds True and variable **b** holds False then —

Operator	Description	Example
and Logical AND	If both the operands are true then condition becomes true.	(a and b) is False.
or Logical OR	If any of the two operands are non-zero then condition becomes true.	(a or b) is True.
not Logical NOT	Used to reverse the logical state of its operand.	Not (a and b) is True.

Python Membership Operators

Python's membership operators test for membership in a sequence, such as strings, lists, or tuples. There are two membership operators as explained below —

Operator	Description	Example
In	Evaluates to true if it finds a variable in the specified sequence and false otherwise.	x in y, here in results in a 1 if x is a member of sequence y.
not in	Evaluates to true if it does not finds a variable in the specified sequence and false otherwise.	x not in y, here not in results in a

		1 if x is not a member of sequence y.

Python Identity Operators

Identity operators compare the memory locations of two objects. There are two Identity operators as explained below −

Operator	Description	Example
Is	Evaluates to true if the variables on either side of the operator point to the same object and false otherwise.	x is y, here **is** results in 1 if id(x) equals id(y).
is not	Evaluates to false if the variables on either side of the operator point to the same object and true otherwise.	x is not y, here **is not** results in 1 if id(x) is not equal to id(y).

Python Operators Precedence

The following table lists all operators from highest precedence to the lowest.

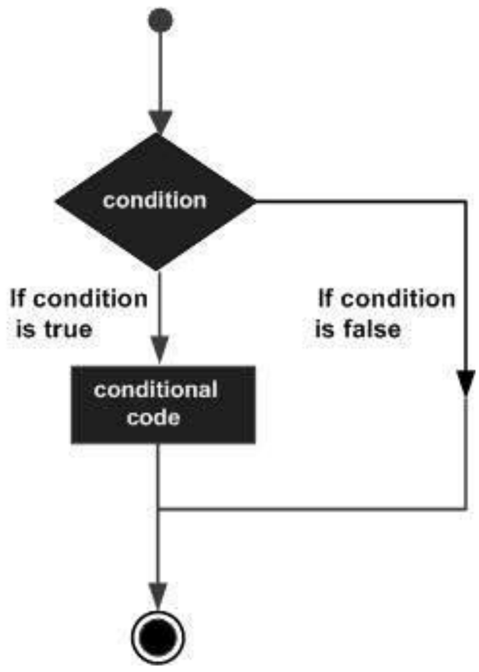
Sr.No.	Operator & Description
1	** Exponentiation (raise to the power)
2	**~ + -** Complement, unary plus and minus (method names for the last two are +@ and -@)
3	*** / % //** Multiply, divide, modulo and floor division

4	**+ -** Addition and subtraction
5	**>> <<** Right and left bitwise shift
6	**&** Bitwise 'AND'
7	**^ |** Bitwise exclusive `OR' and regular `OR'
8	**<= < a> >=** Comparison operators
9	**<> == !=** Equality operators
10	**= %= /= //= -= += *= **=** Assignment operators
11	**is is not** Identity operators
12	**in not in** Membership operators
13	**not or and** Logical operators

DECISION MAKING STATEMENTS

Decision making is about deciding the order of execution of statements based on certain conditions. **Decision making** structures require that the programmer specifies one or more conditions to be evaluated or tested by the program, along with a **statement** or **statements** to be executed if the condition is determined to be true, and optionally, other **statements** to be executed if the condition is determined to be false.

Following is the general form of a typical decision making structure found in most of the programming languages –



Python programming language assumes any **non-zero** and **non-null** values as TRUE, and if it is either **zero** or **null**, then it is assumed as FALSE value.

Python programming language provides following types of decision making statements.

1	**if statements** An **if statement** consists of a boolean expression followed by one or more statements.
2	**if...else statements** An **if statement** can be followed by an optional **else statement**, which executes when the boolean expression is FALSE.
3	**if ..elif..else statements**

	You can use one **if** or **else if** statement inside another **if** or **else if** statement(s).
4	**nested if statements** You can use one **if** or **else if** statement inside another **if** or **else if** statement(s).

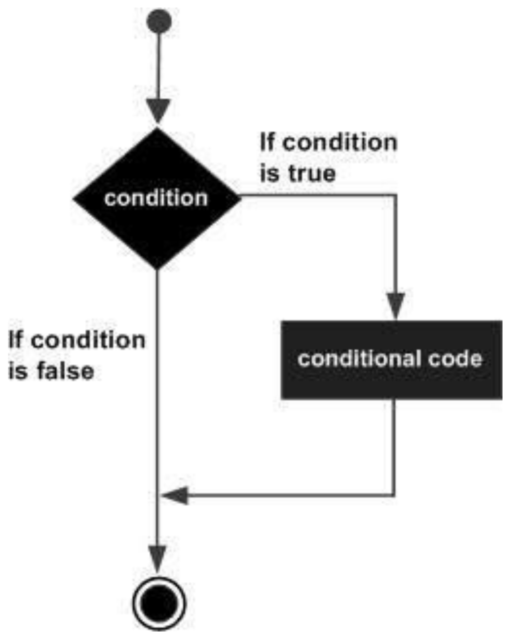
- **IF statement**

Syntax

```
if expression:
  statement(s)
```

If the boolean expression evaluates to TRUE, then the block of statement(s) inside the if statement is executed. If boolean expression evaluates to FALSE, then the first set of code after the end of the if statement(s) is executed.

Flow Diagram



For eg:

a=int(input("Enter the First Number"))

```
b=int(input("Enter the Second Number"))

if(a>b):

        print("First Number is Biggest")

print("Hello World")
```

Output: Suppose a=10

```
b=20

Hello World
```

2).IF ELSE STATEMENT

An **else** statement can be combined with an **if** statement. An **else** statement contains the block of code that executes if the conditional expression in the if statement resolves to 0 or a FALSE value.

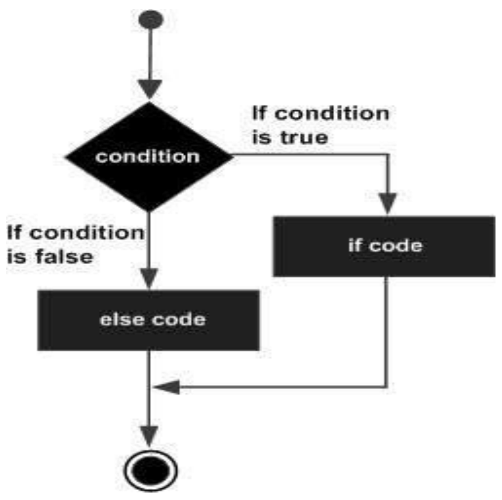
The else statement is an optional statement and there could be at most only one **else** statement following **if**.

Syntax

The syntax of the if...else statement is –

```
if expression:
   statement(s)
else:
    statement(s)
```

Flow Diagram



For eg:

```
a=int(input("Enter the First Number"))

b=int(input("Enter the Second Number"))

if(a>b):

        print("First Number is Biggest")

else:

        print("Second Number is Biggest")

print("Hello World")
```

Output: Suppose a=10 b=20

```
Second Number is Biggest

Hello World
```

<u>3.IF-ELIF-ELSE STATEMENT</u>

The **elif** statement allows you to check multiple expressions for TRUE and execute a block of code as soon as one of the conditions evaluates to TRUE.

Similar to the **else**, the **elif** statement is optional. However, unlike **else**, for which there can be at most one statement, there can be an arbitrary number of **elif** statements following an **if**.

Syntax

```
if expression1:
   statement(s)
elif expression2:
   statement(s)
elif expression3:
   statement(s)
else:
   statement(s)
```

Core Python does not provide switch or case statements as in other languages, but we can use if..elif...statements to simulate switch case as follows –

For eg:

```
a=int(input(“Enter The First Number”))
b=int(input(“Enter The Second Number”))
op=input(“Enter the operator(+,-,*,/)”)
if(op==’+’):
        print(a+b)
elif(op==’-’):
        print(a-b)
elif(op==’*’):
        print(a*b)
elif(op==’/’):
        print(a/b)
else:
        print(“No Operation”)
```

OUTPUT: Suppose a=10   b=7   op=’-‘

FLOW DIAGRAM

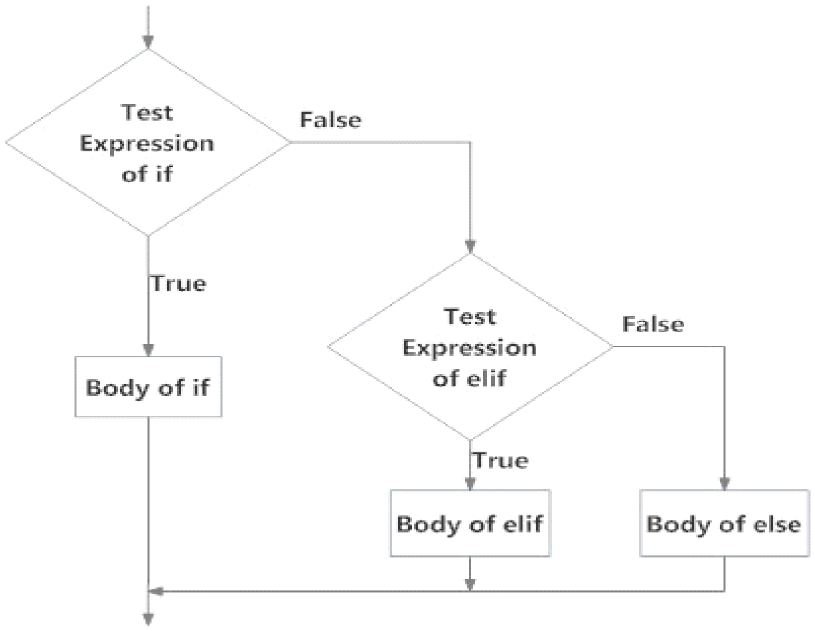


Fig: Operation of if...elif...else statement

4).NESTED IF CONSTRUCT

There may be a situation when you want to check for another condition after a condition resolves to true. In such a situation, you can use the nested **if**construct.

In a nested **if** construct, you can have an **if...elif...else** construct inside another **if...elif...else** construct**.**

Syntax

The syntax of the nested if...elif...else construct may be −

```
if expression1:
  statement(s)
  if expression2:
    statement(s)
  elif expression3:
    statement(s)
  else:
     statement(s)
elif expression4:
     statement(s)
else:
  statement(s)
```

For eg:

```
num=int(input("Enter the number"))
if (num%2==0):
        if (num%3==0):
                print ("Divisible by 3 and 2")
        else:
                print ("divisible by 2 not divisible by 3")
else:
        if (num%3==0):
                print ("divisible by 3 not divisible by 2")
        else:
                print ("not Divisible by 2 not divisible by 3")
```

OUTPUT:

```
Enter the number     8
divisible by 2 not divisible by 3
Enter the number     15
divisible by 3 not divisible by 2
Enter the number     12
 Divisible by 3 and 2
 Enter the number     5
          not Divisible by 2 not divisible by 3
```

LOOPING STATEMENTS

In general, statements are executed sequentially- The first statement in a function is executed first, followed by the second, and so on. There may be a situation when you need to execute a block of code several number of times.

A loop statement allows us to execute a statement or group of statements multiple times while a given **condition** is true. It tests the **condition** before executing the **loop body**.

Python programming language provides the following types of loops to handle looping requirements.

while loop :-Repeats a statement or group of statements while a given

condition is TRUE. It tests the condition before executing the

loop body.

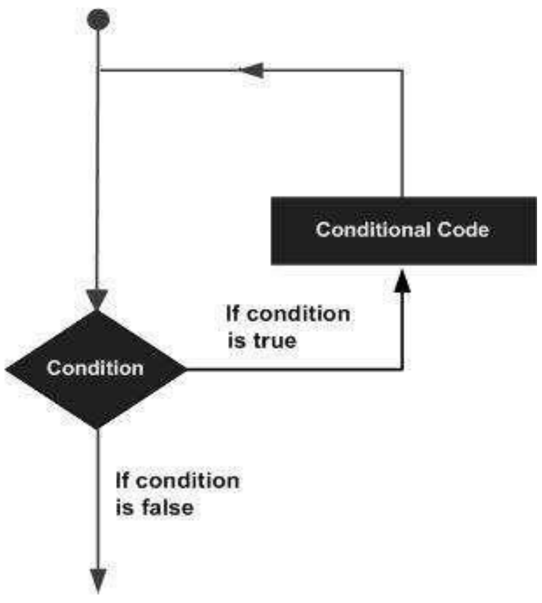
for loop :-Executes a sequence of statements multiple times and

abbreviates the code that manages the loop variable**.**

nested loops:- we can use one or more loop inside any another while, or

for loop.

The following diagram illustrates a loop statement



WHILE LOOP

A **while** loop statement in Python programming language repeatedly executes a target statement as long as a given condition is true.

Syntax

The syntax of a **while** loop in Python programming language is

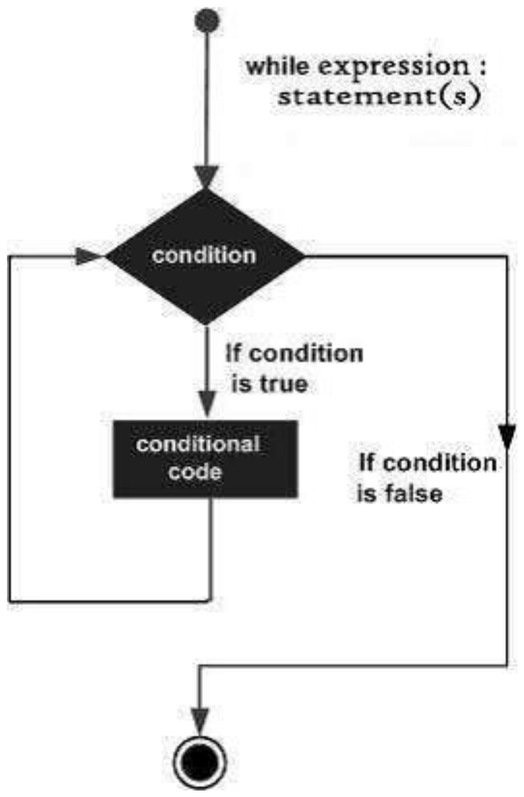
```
while expression:
        statement(s)
```

Here, **statement(s)** may be a single statement or a block of statements with uniform indent. The **condition** may be any expression, and true is any non-zero value. **The loop** iterates while the condition is **true.**

When the condition becomes **false**, program control passes to the line immediately following the loop.

In Python, all the statements indented by the same number of character spaces after a programming construct are considered to be part of a single block of code. Python uses indentation as its method of grouping statements.

Flow Diagram



For eg:
count = 1
sum=0

```
while (count <=10):
        sum=sum+count

        count = count + 1
print(sum)
```

OUTPUT:55

The Infinite Loop

A loop becomes infinite loop if a condition never becomes FALSE. You must be cautious when using while loops because of the possibility that this condition never resolves to a FALSE value. This results in a loop that never ends. Such a loop is called an infinite loop.

Using else Statement with Loops

Python supports having an **else** statement associated with a loop statement.

If the **else** statement is used with a **for** loop, the **else** statement is executed when the loop has exhausted iterating the list.

If the **else** statement is used with a **while** loop, the **else** statement is executed when the condition becomes false.

The following example illustrates the combination of an else statement with a while statement that prints a number as long as it is less than 5, otherwise the else statement gets executed.

For eg:

```
count = 0

while (count < 5):

        print (count, " is less than 5")

        count = count + 1

else:

        print (count, " is not less than 5")
```

OUTPUT:

```
0 is less than 5
1 is less than 5
2 is less than 5
```

```
3 is less than 5
4 is less than 5
5 is not less than 5
```

For Loop Statements

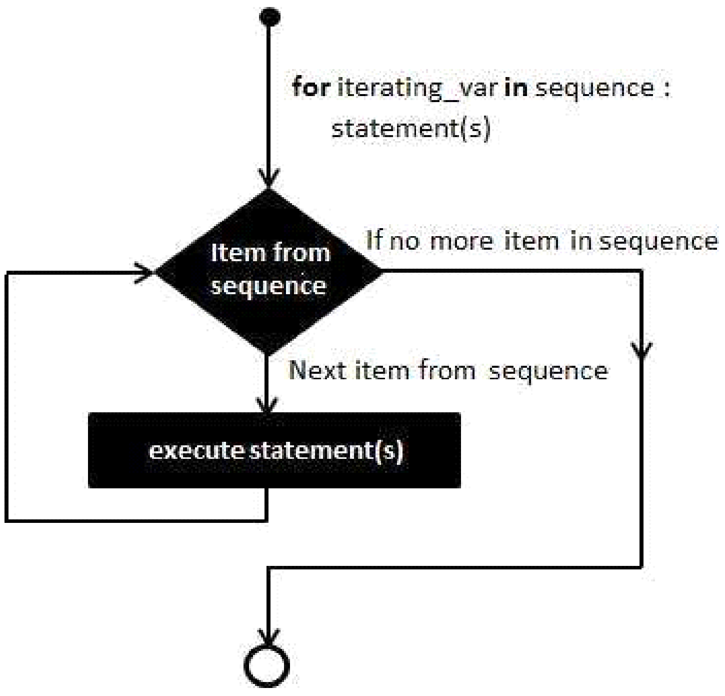
The for loop in Python is used to iterate over a sequence (list, tuple, string) or other iterable objects. Iterating over a sequence is called traversal.

Syntax

```
for iterating_var in sequence:

        statements(s)
```

If a sequence contains an expression list, it is evaluated first. Then, the first item in the sequence is assigned to the iterating variable *iterating_var*. Next, the statements block is executed. Each item in the list is assigned to *iterating_var*, and the statement(s) block is executed until the entire sequence is exhausted

FLOW DIAGRAM



<u>The range() function</u>

We can generate a sequence of numbers using range() function. range(10) will generate numbers from 0 to 9 (10 numbers).

We can also define the start, stop and step size as range(start,stop,step size). step size defaults to 1 if not provided. This function does not store all the values in memory, it would be inefficient. So it remembers the start, stop, step size and generates the next number on the go.

To force this function to output all the items, we can use the function list().

The built-in function range() is the right function to iterate over a sequence of numbers. It generates an iterator of arithmetic progressions.

```
>>> range(5)
range(0, 5)
>>> list(range(5))
[0, 1, 2, 3, 4]
```

range() generates an iterator to progress integers starting with 0 upto n-1. To obtain a list object of the sequence, it is typecasted to list(). Now this list can be iterated using the for statement.

```
>>> for var in list(range(5)):
        print (var)
```

This will produce the following **output**.

```
0
1
2
3
4
>>>print(list(range(2, 8)))                    # Output: [2, 3, 4, 5, 6, 7]
>>>print(list(range(2, 20, 3)))>                # Output: [2, 5, 8, 11, 14, 17]
```

For eg:

```
for letter in 'Python':                    # traversal of a string sequence
        print ('Current Letter :', letter)
print()
fruits = ['banana', 'apple', 'mango']
for fruit in fruits:                       # traversal of List sequence
        print ('Current fruit :', fruit)
print ("Good bye!")
```

```
Current Letter : P
Current Letter : y
Current Letter : t
Current Letter : h
Current Letter : o
Current Letter : n

Current fruit : banana
Current fruit : apple
Current fruit : mango
Good bye!
```

Iterating by Sequence Index

An alternative way of iterating through each item is by index offset into the sequence itself. Following is a simple example-

```
fruits = ['banana', 'apple', 'mango']

for index in range(len(fruits)):

print ('Current fruit :', fruits[index])

print ("Good bye!")
```

OUTPUT

```
Current fruit : banana

Current fruit : apple

Current fruit : mango

Good bye!
```

Here, we took the assistance of the len() built-in function, which provides the total number of elements in the tuple as well as the range() built-in function to give us the actual sequence to iterate over.

Loop Control Statements

Loop control statements change execution from its normal sequence. When execution leaves a scope, all automatic objects that were created in that scope are destroyed.

Python supports the following control statements.

- **break statement**

Terminates the loop statement and transfers execution to the statement immediately following the loop.

- **continue statement**

Causes the loop to skip the remainder of its body and immediately retest its condition prior to reiterating.

- **pass statement**

The pass statement in Python is used when a statement is required syntactically but you do not want any command or code to execute.

Break

It terminates the current loop and resumes execution at the next statement, just like the traditional break statement in C.

The most common use for break is when some external condition is triggered requiring a hasty exit from a loop. The break statement can be used in both while and for loops.

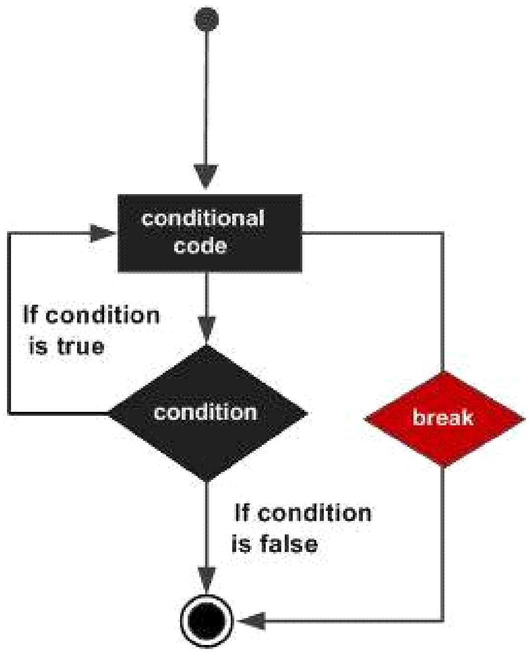
If you are using nested loops, the break statement stops the execution of the innermost loop and start executing the next line of code after the block.

Syntax

The syntax for a **break** statement in Python is as follows −

```
break
```

Flow Diagram



For eg

```
for letter in 'Python':                         # First Example
          if (letter == 'h')
                    break
```

```
        print ('Current Letter :', letter)


var = 10                                          # Second Example

while var > 0:

        print ('Current variable value :', var)

        var = var -1

       if var == 5:

                break


print "Good bye!"
```

When the above code is executed, it produces the following output −

```
Current Letter : P

Current Letter : y

Current Letter : t


Current variable value : 10

Current variable value : 9

Current variable value : 8

Current variable value : 7

Current variable value : 6

Good bye!
```

CONTINUE

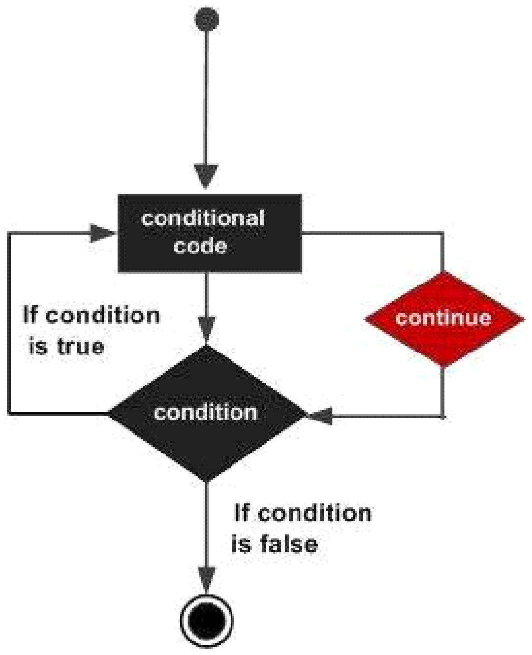
It returns the control to the beginning of a loop. The **continue** statement rejects all the remaining statements in the current iteration of the loop and moves the control back to the top of the loop.

The **continue** statement can be used in both while and for loops.

Syntax

```
continue
```

Flow Diagram



For eg

```
for letter in 'Python':                    # First Example
        if (letter == 'h'):
                continue
         print ('Current Letter :', letter)


var = 10                                   # Second Example
while (var > 0):
        var = var -1
         if (var == 5):
                continue
print( 'Current variable value :', var)
```

```
print "Good bye!"
```

When the above code is executed, it produces the following output−

```
Current Letter : P

Current Letter : y

Current Letter : t

Current Letter : o

Current Letter : n


Current variable value : 9

Current variable value : 8

Current variable value : 7

Current variable value : 6

Current variable value : 4

Current variable value : 3

Current variable value : 2

Current variable value : 1

Current variable value : 0

Good bye!
```

Pass

In Python programming, `pass` is a null statement. The difference between a comment and `pass` statement in Python is that, while the interpreter ignores a comment entirely, `pass` is not ignored.

However, nothing happens when pass is executed. It results into no operation (NOP).

Syntax

```
pass
```

We generally use it as a placeholder.

Suppose we have a loop or a function that is not implemented yet, but we want to implement it in the future. They cannot have an empty body. The interpreter would complain. So, we use the pass statement to construct a body that does nothing.

For eg

```
sequence = {'p', 'a', 's', 's'}                # pass is just a placeholder for

for val in sequence:                           # functionality to be added later

        pass
```

We can do the same thing in an empty function or class as well.

```
def function(args):
    pass
class example:
    pass
```

NESTED LOOPS

Python programming language allows to use one loop inside another loop.

Syntax

```
for iterating_var in sequence:
  for iterating_var in sequence:
    statements(s)
  statements(s)
```

The syntax for a **nested while loop** statement in Python programming language is as follows –

```
while expression:
  while expression:
    statement(s)
  statement(s)
```

Python Nested For Loop Example1

```
for i in range(1,6):
   for j in range (1,i+1):
        print(i,end="")
    print()
```

Output:

```
1
2 2
3 3 3
4 4 4 4
5 5 5 5 5
```

For each value of Outer loop the whole inner loop is executed.

For each value of inner loop the Body is executed each time.

Python Nested Loop Example 2

```
for i in range (1,6):
    for j in range (5,i-1,-1):
        print ("*",end="")
  print ()
```

Output:

```
* * * * *
* * * *
* * *
* *
*
```

Python Nested while Loop Example3

Prime Numbers from 2 to 100

```
i=2

while(i<=100):
 j=2
 while(j<i):
    if(i%j==0):
       break
    else:
       j=j+1
 else:
    print(i)
 i=i+1
```

OUTPUT

```
2
3
5
7
11
13
17
19
23
29
31
37
41
43
47
53
59
61
67
71
```

```
73

79

83

89

97
```

Python Nested Loop Example4

Find the elements (in a list) containing letter ‘n’

```
n= [“banana”,”orange”,”grapes”,”apple”]
for i in n:
        for j in i:
                if(j==’n’):
                        print(i)
                        break
```

OUTPUT

```
banana
orange
```

FUNCTIONS

A function is a block of organized, reusable code that is used to perform a single, related action. Functions provide better modularity for your application and a high degree of code reusing.

Functions help break our program into smaller and modular chunks. As our program grows larger and larger, functions make it more organized and manageable. Furthermore, it avoids repetition and makes code reusable.

Syntax

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

By default, parameters have a positional behavior and you need to inform them in the same order that they were defined.

Defining a Function

You can define functions to provide the required functionality. Here are simple rules to define a function in Python.

- Function blocks begin with the keyword **def** followed by the function name and parentheses (( )).
- Any input parameters or arguments should be placed within these parentheses. You can also define parameters inside these parentheses.
- The first statement of a function can be an optional statement - the documentation string of the function or docstring.
- The code block within every function starts with a colon (:) and is indented.
- The statement return [expression] exits a function, optionally passing back an expression to the caller. A return statement with no arguments is the same as return None.

There are three types of functions in Python:

- **Built-in functions**, such as help() to ask for help, min() to get the minimum value, print()to print an object to the terminal.
- **User-Defined Functions** (UDFs), which are functions that users create to help them out
- **Anonymous functions**, which are also called **lambda functions** **because** they are **not declared with the standard def keyword**.

***Example of a function**

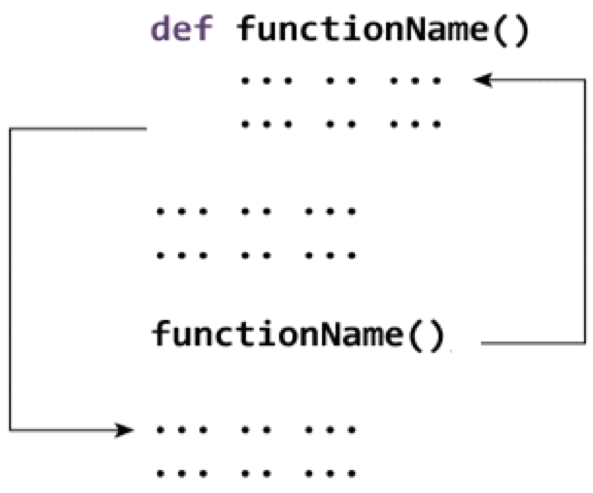
```
def greet(name):
        "This function greets to the person passed in as parameter "
        print("Hello, " + name + ". Good morning!")
```

How to call a function in python

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!
```

How Function works in Python



Function Argument and Parameter

There can be two types of data passed in the function.

1) The First type of data is the data passed in the function call. This data is called **arguments**

2) The second type of data is the data received in the function definition. This data is called **parameters**

Arguments can be literals, variables and expressions. Parameters must be variable to hold incoming values.

Alternatively, arguments can be called as **actual parameters or actual arguments** and parameters can be called as **formal parameters or formal arguments**.

Function Arguments

You can call a function by using the following types of formal arguments –

Required arguments

Keyword arguments

Default arguments

Variable-length arguments

1 Required arguments

Required arguments are the arguments passed to a function in correct positional order. Here, the number of arguments in the function call should match exactly with the function definition.

To call the function printme(), you definitely need to pass one argument, otherwise it gives a syntax error as follows –

```
# Function definition is here

def printme( str ):

   "This prints a passed string into this function"

   print (str)

   return;

# Now you can call printme function

printme()
```

When the above code is executed, it produces the following result –

```
Traceback (most recent call last):

   File "test.py", line 11, in <module>

      printme();
```

TypeError: printme() takes exactly 1 argument (0 given)

2 Keyword arguments

Keyword arguments are related to the function calls. When you use keyword arguments in a function call, the caller identifies the arguments by the parameter name.

This allows you to skip arguments or place them out of order because the Python interpreter is able to use the keywords provided to match the values with parameters. We can also make keyword calls to the printme() function in the following ways –

Ex1:

```
# Function definition is here

def printme( str ):

        "This prints a passed string into this function"

        print (str)

        return;

# Now we can call printme function

printme( str = "My string")
```

OUTPUT

```
My string
```

Ex2:

```
# Function definition is here

def printinfo( name, age ):
```

```
            "This prints a passed info into this function"

            print ("Name: ", name)

            print( "Age ", age)

           return;
```

# Now we can call printinfo function

```
printinfo( age=50, name="miki" )
```

OUTPUT

```
Name:  miki

Age  50
```

3 <u>Default arguments</u>

A default argument is an argument that assumes a default value if a value is not provided in the function call for that argument. The following example gives an idea on default arguments, it prints default age if it is not passed –

# Function definition is here

```
def printinfo( name, age = 35 ):

            "This prints a passed info into this function"

           print ("Name: ", name)

           print ("Age ", age)

           return
```

# Now we can call printinfo function

printinfo(age=50, name="miki")

printinfo(name="miki")

OUTPUT

Name: miki

Age 50

Name: miki

Age 35

4 Variable-length arguments

You may need to process a function for more arguments than you specified while defining the function. These arguments are called variable-length arguments and are not named in the function definition, unlike required and default arguments.

Syntax

```
def functionname([formal_args,] *var_args_tuple ):
             "function_docstring"
            function_suite
            return [expression]
```

An asterisk (*) is placed before the variable name that holds the values of all non keyword variable arguments. This tuple remains empty if no additional arguments are specified during the function call. Following is a simple example —

Example1

# Function definition is here

```
def printinfo( arg1, *vartuple ):

	"This prints a variable passed arguments"

	print ("Output is: ")

	print (arg1)

	for var in vartuple:

		print var

	return

# Now we can call printinfo function

printinfo( 10 )

printinfo( 70, 60, 50 )
```

OUTPUT

```
10

70

60

50
```

Example2

```
def varl(*a):

	sum=0

	for i in a:

		sum=sum+i

	print(sum)

	return
```

```
varl(10,8)

varl(6,5,4,3,2)

varl(7)
```

OUTPUT

```
18

20

7
```

The return Statement

The statement return [expression] exits a function, optionally passing back an expression to the caller. A return statement with no arguments is the same as return None.

All the above examples are not returning any value. You can return a value from a function as follows –

```
# Function definition is here

def sum( arg1, arg2 ):

        # Add both the parameters and return them."

        total = arg1 + arg2

        print ("Inside the function : ", total)

        return total;

# Now we can call sum function

total = sum( 10, 20 );

print ("Outside the function : ", total )
```

OUTPUT

Inside the function : 30

Outside the function : 30

Python Parameter Passing

Pass-by-value vs Pass-by-reference

There are two common types of parameter passing: pass-by-value and pass-by-reference

pass-by-value: Copying the value of the parameter and passing it to the new variable in the function

pass-by-reference: Passing the reference of the parameter to the new variable, so that the original variable and the new variable will point to the same memory address

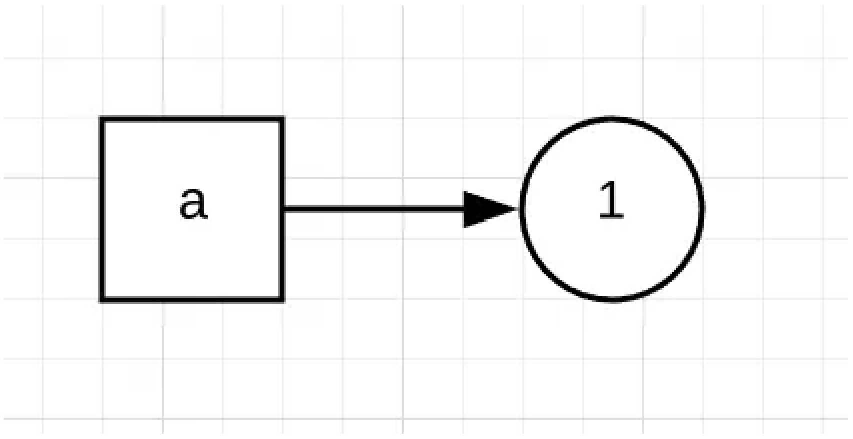
let’s first understand the basic principles of Python variables and assignments.

Python Variables and Assignments

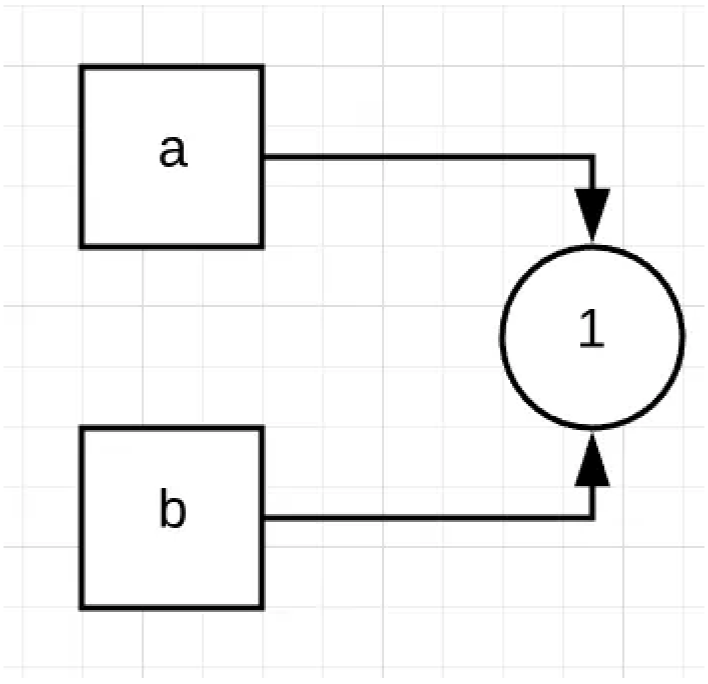
Let’s start by looking at the following Python code example:

```
a = 1

b = a

a = a + 1
```

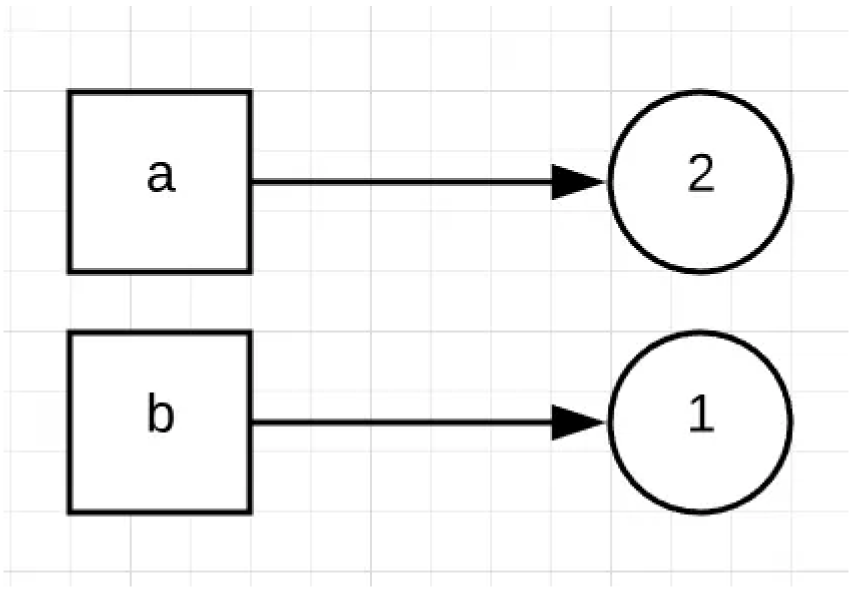
Here, 1 is first assigned to a, that is, a points to the object 1, as shown in the following flowchart:



Then b = a means, let the variable b also, point to the object 1 at the same time. Note here that objects in Python can be pointed to or referenced by multiple variables. Now the flowchart looks like this:



Finally the a = a + 1 statement. It should be noted that Python data types, such as integers (int), strings (string), etc., are immutable. So, a = a + 1, does not increase the value of a by 1, but means that a new object with a value of 2 is created and a points to it. But b remains unchanged and still points to the 1 object:



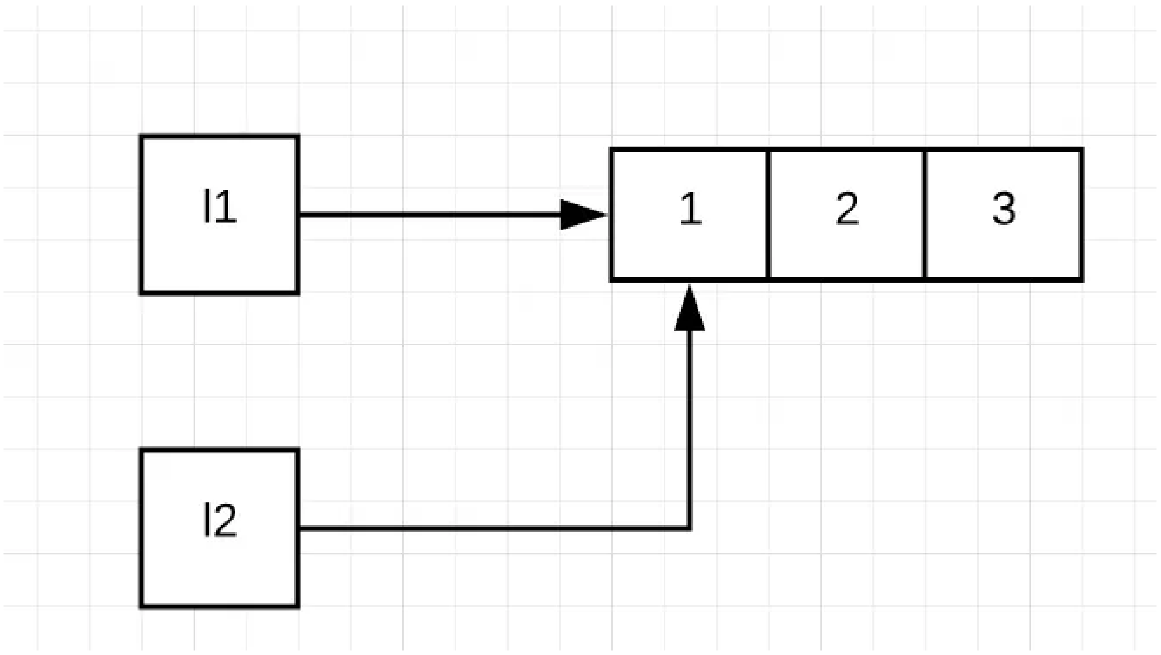
At this point, you can see that a simple assignment b = a does not mean that a new object is recreated, but that the same object is pointed or referenced by multiple variables.

At the same time, pointing to the same object does not mean that the two variables are bound together. If you reassign one of the variables, it will not affect the value of the other variables.

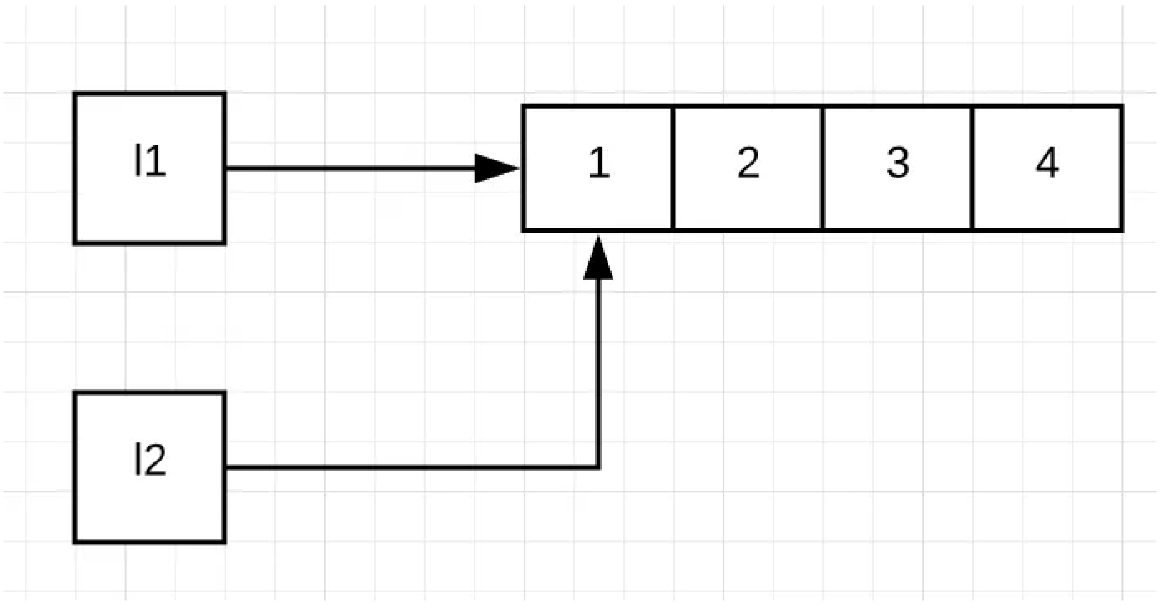
Now let’s take a look at a list examples:

```
l1 = [1, 2, 3]

l2 = l1

l1.append(4)

l1

[1, 2, 3, 4]

l2

[1, 2, 3, 4]
```

At first, we let the lists l1 and l2 point to the object [1, 2, 3] at the same time:



Since the list is mutable, l1.append(4) does not create a new list, it just inserts element 4 at the end of the original list, which becomes [1, 2, 3, 4]. Since l1 and l2 point to this list at the same time, the change of the list will be reflected in the two variables of l1 and l2 at the same time, then the values of l1 and l2 will become [1, 2, 3, 4] at the same time.



So, in Python:

The assignment of a variable only means that the variable points to an object, and does not mean that the object is copied to the variable; and an object can be pointed to by multiple variables.

Changes to mutable objects (lists, dictionaries, sets, etc.) affect all variables that point to that object.

For immutable objects (strings, ints, tuples, etc.), the value of all variables that point to the object is always the same and does not change. But when the value of an immutable object is updated by some operation (+= etc.), a new object is returned.

Argument Passing for Python Functions

Python's argument passing is passed by assignment, or pass by object reference. All data types in Python are objects, so when passing parameters, just let the new variable and the original variable point to the same object, and there is no such thing as passing by value or passing by reference.

For example:

```
def my_func1(b):

  b = 2

a = 1

my_func1(a)

a

1
```

The parameter passing here makes the variables a and b point to the object 1 at the same time. But when we get to b = 2, the system will create a new object with a value of 2 and let b point to it; a still points to the 1 object. So, the value of a doesn't change, it's still 1.

However, when a mutable object is passed as a parameter to a function, changing the value of the mutable object will affect all variables that point to it. For example:

```
def my_func3(l2):

  l2.append(4)

l1 = [1, 2, 3]

my_func3(l1)

l1
```

[1, 2, 3, 4]

Here l1 and l2 first both point to lists with values [1, 2, 3]. However, since the list is variable when the append() the function is executed and a new element 4 is added to the end of the list, the values of the variables l1 and l2 are also changed.

However, the following example, which seems to add a new element to the list, yields significantly different results.

```
def my_func4(l2):
  l2 = l2 + [4]
l1 = [1, 2, 3]
my_func4(l1)
l1
[1, 2, 3]
```

This is because statement l2 = l2 + [4], which means that a new list with "element 4 added at the end" is created, and l2 points to this new object.

Scope and Lifetime of variables

Scope of a variable is the portion of a program where the variable is recognized.

All variables in a program may not be accessible at all locations in that program. This depends on where you have declared a variable.

The scope of a variable determines the portion of the program where you can access a particular identifier.

There are 4 types of Variable Scope in Python

Global

Local

Enclosed or non-local

Built in

Global vs. Local variables

Variables that are defined inside a function body have a local scope, and those defined outside have a global scope.

This means that local variables can be accessed only inside the function in which they are declared, whereas global variables can be accessed throughout the program body by all functions.

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.

When you call a function, the variables declared inside it are brought into scope. Following is a simple example –

```
def my_func():
        x = 10          #Here x is local variable
        print("Value inside function:",x)
x = 20                          #global variable
my_func()
print("Value outside function:", x)
```

OUTPUT

```
Value inside function: 10
Value outside function: 20
```

Here, we can see that the value of x is 20 initially. Even though the function my_func()changed the value of x to 10, it did not effect the value outside the function.

This is because the variable x inside the function is different (local to the function) from the one outside. Although they have same names, they are two different variables with different scope.

On the other hand, variables outside of the function are visible from inside. They have a global scope.

We can read these values from inside the function but cannot change (write) them. In order to modify the value of variables outside the function, they must be declared as global variables using the keyword **global.**

In Python, **global keyword** allows you to modify the variable outside of the current scope. It is used to create a global variable and make changes to the variable in a local context.

Rules of global Keyword

The **basic rules for global keyword in Python are:**

- **When we create a variable inside a function, it's local by default.**
- **When we define a variable outside of a function, it's global by default. You don't have to use global keyword.**
- **We use global keyword to read and write a global variable inside a function.**
- **Use of global keyword outside a function has no effect**

```
def add():
   global c
   c = c + 2       # increment by 2
   print("Inside add():", c)
c = 0              # global variable
```

add()

print(“Outside:”,c)

OUTPUT

```
Inside add(): 2

Outside: 2
```

Enclosed or non local scope

A python variable scope that isn’t global or local is nonlocal. This is also called the enclosing scope**.**Enclosing (or nonlocal) scope is a special scope that only exists for nested functions

```
print ("Value of a is : ", end ="")

def outer():

    a = 5

    def inner():

        a = 10

    inner()

    print (a)



outer()
```

```
Value of a is: 5
```

In Python, nonlocal keyword is used in the case of nested functions. This keyword works similar to the global, but rather than global, this keyword declares a variable to point to the variable of outside enclosing function, in case of nested functions. In the following code, we created an outer function, and there is a nested function inner(). In the scope of outer() function inner() function is defined. If we change the nonlocal variable as defined in the inner() function, then changes are reflected in the outer function.

```
# Python program to demonstrate

# nonlocal keyword



print ("Value of a using nonlocal is : ", end ="")

def outer():

    a = 5

    def inner():

        nonlocal a

        a = 10

    inner()

    print (a)
```

outer()

```
Value of a using nonlocal is :10
```

BuiltIn Scope:

When a python interpreter cannot find a variable in the Local, Enclosed and Global scope, it finally looks up in the builtIn scope. We are importing ‘pi’ from the math library in the following example. This imported ‘pi’ will belong to the builtIn scope. Note that this identifier shall not be redefined as then it’ll be available for python interpreter to be fetched from local, enclosed or global scope (depending on where it has been redefined)

```
from math import pi

def func1():

   print('inside func1 ', pi)

print('at global scope ', pi)

func1()
```

The Anonymous Functions

These functions are called anonymous because they are not declared in the standard manner by using the def keyword. You can use the lambda keyword to create small anonymous functions.

Lambda forms can take any number of arguments but return just one value in the form of an expression. They cannot contain commands or multiple expressions. An anonymous function cannot be a direct call to print because lambda requires an expression

Lambda functions have their own local namespace and cannot access variables other than those in their parameter list and those in the global namespace.

Syntax

The syntax of lambda functions contains only a single statement, which is as follows −

lambda [arg1 [,arg2,.....argn]]:expression

Example1

```
# Function definition is here

double = lambda x: x * 2

# Now you can call double as a function

 print(double(5))
```

In the above program, lambda x: x * 2 is the lambda function. Here x is the argument and x * 2 is the expression that gets evaluated and returned.

This function has no name. It returns a function object which is assigned to the identifier double. We can now call it as a normal function. The statement

```
double = lambda x: x * 2
```

is nearly the same as

```
def double(x):

   return x * 2
```

OUTPUT

```
5
```

Example2

```
# Function definition is here

sum = lambda arg1, arg2: arg1 + arg2;

# Now you can call sum as a function

print ("Value of total : ", sum( 10, 20 ))

print ("Value of total : ", sum( 20, 20 ))
```

OUTPUT

Value of total : 30

Value of total : 40

Use of Lambda Function in python

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 map() , filter(), reduce() etc

map Function

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.

Syntax

map (function, sequence)

Here sequence means list, tuple or strings. If we want to apply some function on each elements in a sequence then we can use map() function.

Example1

Find the square of each elements in a list

*** map function without Using lambda function**

a=[1,2,3,4]

first we need to define function

```
def square(x):
        return x:x*x
```

Next we will use map function

map(square,a)

In python3 it will return an iterator object and in python2 it will return as a list. In python 3 if we want to get the output as list we should use

list(map(square,a))

*If we want to get the output as tuple we need to use tuple(map(square,a))

OUTPUT

[1,4,9,16]

In python 2 we need not mention list or tuple function. Directly we can write map(square,a). In python2 it will return output as list.

*map function using lambda function

map(lambda x:x*x,a)

To get the output in list form we should use

list(map(lambda x:x*x,a)

We can use more than one list or tuple in the map function. Suppose we want to add the elements of two lists we can use map function for that. We already have one list a=[1,2,3,4]

b=[1,1,1,1]

while adding two lists or tuples we should remember both the lists or tuples should have same length and same types of elements.

map (lambda x,y:x+y,a,b)

convert output into tuple or list

so list(map(lambda x,y:x+y,a,b))

we can add list and tuple in the same way we will get the output

a=[1,2,3,4]

```
b=(1,1,1,1)

list(map(lambda x,y:x+y,a,b))
```

Filter Function

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 evaluates to True.

Syntax

filter (function ,iterables)

This filter function will return the elements from this iterables for which the function will return true.

Here is an example use of filter() function to filter out only even numbers from 1 to 10 numbers

*Without using lambda function

For this we use for loop

```
For i in range(1,11):

        If(i%2==0);

                print(i)
```

OUTPUT

```
2

4

6

8
```

10

***Filter function using lambda**

filter(lambda x:x%2==0,range(1,11))

Here we get the filter object as output. In order to get as list we should use

list(filter(lambda x:x%2==0,range(1,11)))

OUTPUT

[2,4,6,8,10]

In the filter function we can only use 1 iterable.

Reduce Function

Reduce function is used to reduce the iterable into a single element using some function.so output from the reduce function will be a single element. If we want to perform some computation on lists or tuples we use reduce function.

Syntax

reduce(function, iterable)

Example

Sum of all the elements in a list

In python3 reduce function is defined in a module called functools. So for using reduce function we have to import this module first.

Import functools

num=[1,2,3,4]

functools.reduce(lambda x,y:x+y,num)

OUTPUT

```
10
```

In the reduce function we can only use 1 iterable.

Python Module

Modular programming refers to the process of breaking a large, unwieldy programming task into separate, smaller, more manageable subtasks or **modules**. Individual modules can then be cobbled together like building blocks to create a larger application.

Modules are used to categorize Python code into smaller parts. A **module is simply a Python file, where classes, functions and variables are defined**. Grouping similar code into a single file makes it easy to access..

Python Module Advantages

Python provides the following advantages for using module:

1**) Reusability**: Module can be used in some other python code. Hence it provides the facility of code reusability.

2) **Categorization:** Similar type of attributes can be placed in one module.

Importing a Module:

There are different ways by which you we can import a module. :

1) Using import statement:

Module contents are made available to the caller with the **import statement.**

Syntax:

import <file_name1, file_name2,... file_name(n) >

Example

```
def add(a,b):

   c=a+b

   print( c)

   return
```

Save the file by the name **addition.py**. To import this file "import" statement is used.

```
import addition
```

Note that this does not make the module contents directly accessible to the caller. Each module has its own private symbol table, which serves as the global symbol table for all objects defined in the module.

The statement import <module_name> only places <module_name> in the caller's symbol table. The objects that are defined in the module remain in the module's private symbol table.

From the caller, objects in the module are only accessible when prefixed with <module_name> via dot notation, as illustrated below.

After the following import statement, addition is placed into the local symbol table. Thus, addition has meaning in the caller's local context: But add remain in the module's private symbol table and are not meaningful in the local context. To be accessed in the local context, names of objects defined in the module must be prefixed by module name:

```
addition.add(10,20)

addition.add(30,40)
```

Output:

```
>>>   30

70
```

```
>>>
```

NOTE: You can access any function which is inside a module by module name and function name separated by dot. It is also known as period. Whole notation is known as **dot notation.**

2) Python Importing Multiple Modules Example

1) msg.py:

```
def msg_method():
    print ("Today the weather is rainy"  )
    return
```

2) display.py:

```
def display_method():
    print ("The weather is Sunny" )
    return
```

3) multiimport.py:

```
import msg, display
msg.msg_method()
display.display_method()
```

Output:

```
>>>
Today the weather is rainy
The weather is Sunny
>>>
```

3) Using from.. import statement:

from..import statement is used to import particular attribute from a module. In case you do not want whole of the module to be imported then you can use

from .. import statement.

Syntax:

from <module_name> import <attribute1,attribute2,attribute3,...attributen>

Python from.. import Example

1).area.py

```
def circle(r):
    print 3.14*r*r
    return
  def square(l):
    print l*l
    return
  def rectangle(l,b):
    print l*b
    return
  def triangle(b,h):
    print 0.5*b*h
    return
```

2) area1.py

```
from area import square, rectangle

square(10)

rectangle(2,5)
```

Output:

```
>>>

100

10

>>>
```

4) To import whole module:

You can import whole of the module using "from …. import *"

Syntax:

```
from <module_name> import *
```

Using the above statement all the attributes defined in the module will be imported and hence you can access each attribute.

1) area.py

Same as above example

2) area1.py

```
from area import *

square(10)

rectangle(2,5)
```

circle(5)

triangle(10,20)

Output:

```
>>>
100
10
78.5
100.0
>>>
```

<u>Built in Modules in Python:</u>

There are many built in modules in Python. Some of them are as follows:

math, random , threading , collections , os , mailbox , string , time , tkinter etc..

Each module has a number of built in functions which can be used to perform various functions.

1) math:

Using math module , you can use different built in mathematical functions.

Functions:

Function	**Description**
ceil(n)	**It returns the next integer number of the given number**
sqrt(n)	**It returns the Square root of the given number.**
exp(n)	**It returns the natural logarithm e raised to the given number**

floor(n)	It returns the previous integer number of the given number.
log(n,baseto)	It returns the natural logarithm of the number.
pow(baseto, exp)	It returns baseto raised to the exp power.
sin(n)	It returns sine of the given radian.
cos(n)	It returns cosine of the given radian.
tan(n)	It returns tangent of the given radian.

Python Math Module Example

```
import math

a=4.6

print math.ceil(a)

print math.floor(a)

b=9

print math.sqrt(b)

print math.exp(3.0)

print math.log(2.0)

print math.pow(2.0,3.0)

print math.sin(0)

print math.cos(0)

print math.tan(45)
```

Output:

```
>>>
```

```
5.0

4.0

3.0

20.0855369232

0.69314718056

8.0

0.0

1.0

1.61977519054

>>>
```

Constants:

The math module provides two constants for mathematical Operations:

Constants	**Descriptions**
Pi	Returns constant ? = 3.14159...
e	Returns constant e= 2.71828...

Example

```
import math

print math.pi

print math.e
```

Output:

```
>>>
3.14159265359
2.71828182846
```

2) random:

The random module is used to generate the random numbers. It provides the following two built in functions:

Function	Description
random()	**It returns a random number between 0.0 and 1.0 where 1.0 is exclusive.**
randint(x,y)	**It returns a random number between x and y where both the numbers are inclusive.**

Python Module Example

```
import random
print random.random()
print random.randint(2,8)
```

Output:

```
>>>
0.797473843839
7
```

Packages

We don't usually store all of our files in our computer in the same location. We use a well-organized hierarchy of directories for easier access. Similar files are kept in the same directory, for example, we may keep all the songs in the "music" directory. Analogous to this, Python has packages for directories and modules for files.

As our application program grows larger in size with a lot of modules, we place **similar modules in one package and different modules in different packages**. This makes a project (program) easy to manage and conceptually clear. Similar, as a directory can contain sub-directories and files, a Python package can have sub-packages and modules.

A package is basically a directory with Python files and a file with the name __init__.py. This means that every directory inside of the Python path, which contains a file named __init__.py, will be treated as a package by Python. It's possible to put several modules into a Package.

Packages are a way of structuring Python's module namespace by using "dotted module names". A.B stands for a submodule named B in a package named A. Two different packages like P1 and P2 can both have modules with the same name, let's say A, for example. The submodule A of the package P1 and the submodule A of the package P2 can be totally different. A package is imported like a "normal" module.

Steps to create and import Package:

1) Create a directory

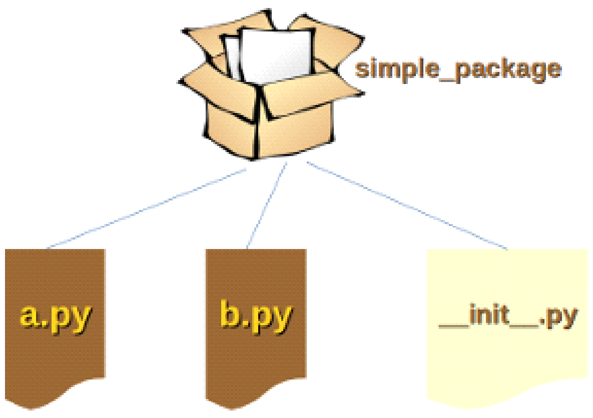
2) Place different modules inside the directory.

3) Create a file __init__.py which specifies attributes in each module.

4) Import the package and use the attributes using package.

A Simple Example

We will demonstrate with a very simple example how to create a package with some Python modules.



First of all, we need a directory. The name of this directory will be the name of the package, which we want to create. We will call our package "simple_package".

1). **Create the directory:**

```
import os
os.mkdir("simple_package")
```

Now we can put into this directory all the Python files which will be the submodules of our module. We create two simple files a.py and b.py just for the sake of filling the package with modules.

2). **Place different modules in package: (Save different modules inside the simple_package package)**

a.py

```
def msg1():
   print ("This is msg1" )
```

b.py

```
def msg2():
   print ("This is msg2" )
```

3).We will also add an empty file with the name __init__.py inside of simple_package directory.

4). Import package and use the attributes:

when we import simple_package from the interactive Python shell, assuming that the directory simple_package is either in the directory from which you call the shell or that it is contained in the search path or environment variable "PYTHONPATH" (from your operating system):

```
>>> import simple_package
>>>
```

We can see that the package simple_package has been loaded but neither the module "a" nor the module "b"! We can import the modules a and b in the following way

```
>>> from simple_package import a, b
>>> a.msg1()
This is msg1
>>> b.msg2()
This is msg2
```

we can't access neither "a" nor "b" by solely importing simple_package. There is a way to automatically load these modules. We can use the file __init__.py for this purpose. All we have to do is add the following lines to the so far empty file __init__.py:

```
import simple_package.a
import simple_package.b
```

It will work now:

```
>>> import simple_package
>>> simple_package.a.msg1()

This is msg1

>>> simple_package.b.msg2()

This is msg2
```