CHAPTER

3

Python Basic Syntax

The Python language has many similarities to Perl, C and Java. However, there are some definite differences between the languages. This chapter is designed to quickly get you up to speed on the syntax that is expected in Python.

First Python Program:

INTERACTIVE MODE PROGRAMMING:

Invoking the interpreter without passing a script file as a parameter brings up the following prompt:

```
$ python
Python 2.4.3 (#1, Nov 11 2010, 13:34:43)
[GCC 4.1.2 20080704 (Red Hat 4.1.2-48)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

Type the following text to the right of the Python prompt and press the Enter key:

```
>>> print "Hello, Python!";
```

If you are running new version of Python, then you would need to use print statement with parenthesis like **print ("Hello, Python!");**. However at Python version 2.4.3, this will produce following result:

```
Hello, Python!
```

SCRIPT MODE PROGRAMMING:

Invoking the interpreter with a script parameter begins execution of the script and continues until the script is finished. When the script is finished, the interpreter is no longer active.

Let us write a simple Python program in a script. All python files will have extension **.py**. So put the following source code in a test.py file.

```
print "Hello, Python!";
```

Here, I assumed that you have Python interpreter set in PATH variable. Now, try to run this program as follows:

```
$ python test.py
```

This will produce the following result:

```
Hello, Python!
```

Let's try another way to execute a Python script. Below is the modified test.py file:

```
#!/usr/bin/python

print "Hello, Python!";
```

Here, I assumed that you have Python interpreter available in /usr/bin directory. Now, try to run this program as follows:

```
$ chmod +x test.py     # This is to make file executable
$./test.py
```

This will produce the following result:

```
Hello, Python!
```

Python Identifiers:

A Python identifier is a name used to identify a variable, function, class, module or other object. An identifier starts with a letter A to Z or a to z or an underscore (_) followed by zero or more letters, underscores and digits (0 to 9).

Python does not allow punctuation characters such as @, $ and % within identifiers. Python is a case sensitive programming language. Thus, **Manpower** and **manpower** are two different identifiers in Python.

Here are following identifier naming convention for Python:

- Class names start with an uppercase letter and all other identifiers with a lowercase letter.
- Starting an identifier with a single leading underscore indicates by convention that the identifier is meant to be private.
- Starting an identifier with two leading underscores indicates a strongly private identifier.
- If the identifier also ends with two trailing underscores, the identifier is a language-defined special name.

Reserved Words:

The following list shows the reserved words in Python. These reserved words may not be used as constant or variable or any other identifier names. All the Python keywords contain lowercase letters only.

And	Exec	Not
Assert	Finally	Or
Break	For	Pass
Class	From	Print
Continue	Global	Raise
Def	if	Return

Del	import	Try
Elif	in	While
Else	is	With
Except	lambda	Yield

Lines and Indentation:

One of the first caveats programmers encounter when learning Python is the fact that there are no 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. Both blocks in this example are fine:

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

However, the second block in this example will generate an error:

```
if True:
    print "Answer"
    print "True"
else:
    print "Answer"
  print "False"
```

Thus, in Python all the continous lines indented with similar number of spaces would form a block. Following is the example having various statement blocks:

Note: Don't try to understand logic or different functions used. Just make sure you undertood various blocks even if they are without braces.

```
#!/usr/bin/python

import sys

try:
  # open file stream
  file = open(file_name, "w")
except IOError:
  print "There was an error writing to", file_name
  sys.exit()
print "Enter '", file_finish,
print "' When finished"
while file_text != file_finish:
  file_text = raw_input("Enter text: ")
  if file_text == file_finish:
    # close the file
    file.close
    break
  file.write(file_text)
  file.write("\n")
file.close()
```

```
file_name = raw_input("Enter filename: ")
if len(file_name) == 0:
  print "Next time please enter something"
  sys.exit()
try:
  file = open(file_name, "r")
except IOError:
  print "There was an error reading file"
  sys.exit()
file_text = file.read()
file.close()
print file_text
```

Multi-Line Statements:

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

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

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 can be 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:

A hash sign (#) that is not inside a string literal begins a comment. All characters after the # and up to the physical line end are part of the comment and the Python interpreter ignores them.

```
#!/usr/bin/python

# First comment
print "Hello, Python!";  # second comment
```

This will produce the following result:

```
Hello, Python!
```

A comment may be on the same line after a statement or expression:

```
name = "Madisetti" # This is again comment
```

You can comment multiple lines as follows:

```
# This is a comment.
# This is a comment, too.
# This is a comment, too.
# I said that already.
```

Using Blank Lines:

A line containing only whitespace, possibly with a comment, is known as a blank line and Python totally ignores it.

In an interactive interpreter session, you must enter an empty physical line to terminate a multiline statement.

Waiting for the User:

The following line of the program displays the prompt, Press the enter key to exit and waits for the user to press the Enter key:

```
#!/usr/bin/python

raw_input("\n\nPress the enter key to exit.")
```

Here, "\n\n" are being used to create two new lines before displaying the actual line. Once the user presses the key, the program ends. This is a nice trick to keep a console window open until the user is done with an application.

Multiple Statements on a Single Line:

The semicolon (;) allows multiple statements on the single line given that neither statement starts a new code block. Here is a sample snip using the semicolon:

```
import sys; x = 'foo'; sys.stdout.write(x + '\n')
```

Multiple Statement Groups as Suites:

A group of individual statements, which make a single code block are called **suites** in Python. Compound or complex statements, such as if, while, def, and class, are those which require a header line and a suite.

Header lines begin the statement (with the keyword) and terminate with a colon (:) and are followed by one or more lines, which make up the suite. For example:

```
if expression :
   suite
elif expression :
   suite
else :
   suite
```

Command-Line Arguments:

You may have seen, for instance, that many programs can be run so that they provide you with some basic information about how they should be run. Python enables you to do this with -h:

```
$ python -h
usage: python [option] ... [-c cmd | -m mod | file | -] [arg] ...
Options and arguments (and corresponding environment variables):
-c cmd : program passed in as string (terminates option list)
-d     : debug output from parser (also PYTHONDEBUG=x)
-E     : ignore environment variables (such as PYTHONPATH)
-h     : print this help message and exit

[ etc. ]
```

You can also program your script in such a way that it should accept various options.

Accessing Command-Line Arguments:

Python provides a **getopt** module that helps you parse command-line options and arguments.

```
$ python test.py arg1 arg2 arg3
```

The Python **sys** module provides access to any command-line arguments via the **sys.argv**. This serves two purpose:

- sys.argv is the list of command-line arguments.
- len(sys.argv) is the number of command-line arguments.

Here sys.argv[0] is the program ie. script name.

Example:

Consider the following script test.py:

```
#!/usr/bin/python

import sys

print 'Number of arguments:', len(sys.argv), 'arguments.'
print 'Argument List:', str(sys.argv)
```

Now run above script as follows:

```
$ python test.py arg1 arg2 arg3
```

This will produce following result:

```
Number of arguments: 4 arguments.
Argument List: ['test.py', 'arg1', 'arg2', 'arg3']
```

NOTE: As mentioned above, first argument is always script name and it is also being counted in number of arguments.

Parsing Command-Line Arguments:

Python provided a **getopt** module that helps you parse command-line options and arguments. This module provides two functions and an exception to enable command-line argument parsing. This tutorial would discuss about one method and one exception, which are sufficient for your programming requirements.

getopt.getopt method:

This method parses command-line options and parameter list. Following is simple syntax for this method:

```
getopt.getopt(args, options[, long_options])
```

Here is the detail of the parameters:

- **args**: This is the argument list to be parsed.
- **options**: This is the string of option letters that the script wants to recognize, with options that require an argument should be followed by a colon (:).
- **long_options**: This is optional parameter and if specified, must be a list of strings with the names of the long options, which should be supported. Long options, which require an argument should be followed by an equal sign ('='). To accept only long options, options should be an empty string.

This method returns value consisting of two elements: the first is a list of **(option, value)** pairs. The second is the list of program arguments left after the option list was stripped.

Each option-and-value pair returned has the option as its first element, prefixed with a hyphen for short options (e.g., '-x') or two hyphens for long options (e.g., '--long-option').

exception getopt.GetoptError:

This is raised when an unrecognized option is found in the argument list or when an option requiring an argument is given none.

The argument to the exception is a string indicating the cause of the error. The attributes **msg** and **opt** give the error message and related option

Example

Consider we want to pass two file names through command line and we also want to give an option to check the usage of the script. Usage of the script is as follows:

```
usage: test.py -i <inputfile> -o <outputfile>
```

Here is the following script to test.py:

```
#!/usr/bin/python

import sys, getopt

def main(argv):
   inputfile = ''
   outputfile = ''
   try:
      opts, args = getopt.getopt(argv,"hi:o:",["ifile=","ofile="])
   except getopt.GetoptError:
      print 'test.py -i <inputfile> -o <outputfile>'
      sys.exit(2)
   for opt, arg in opts:
      if opt == '-h':
         print 'test.py -i <inputfile> -o <outputfile>'
         sys.exit()
      elif opt in ("-i", "--ifile"):
         inputfile = arg
      elif opt in ("-o", "--ofile"):
         outputfile = arg
```

```
   print 'Input file is "', inputfile
   print 'Output file is "', outputfile

if __name__ == "__main__":
   main(sys.argv[1:])
```

Now, run above script as follows:

```
$ test.py -h
usage: test.py -i <inputfile> -o <outputfile>

$ test.py -i BMP -o
usage: test.py -i <inputfile> -o <outputfile>

$ test.py -i inputfile
Input file is " inputfile
Output file is "
```

CHAPTER

4

Python Variable Types

Variables are nothing but reserved memory locations to store values. This means that when you create a variable you reserve some space in 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 variables, you can store integers, decimals or characters in these variables.

Assigning Values to Variables:

Python variables do not have to be explicitly declared 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.

The operand to the left of the = operator is the name of the variable and the operand to the right of the = operator is the value stored in the variable. For example:

```
#!/usr/bin/python

counter = 100          # An integer assignment
miles   = 1000.0       # A floating point
name    = "John"       # A string

print counter
print miles
print name
```

Here, 100, 1000.0 and "John" are the values assigned to *counter*, *miles* and *name* variables, respectively. While running this program, this will produce the following result:

```
100
1000.0
John
```

Multiple Assignment:

Python allows you 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 three variables are assigned to the same memory location. You 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 variables a and b, 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. For example, a person's age is stored as a numeric value and his or her address is stored as alphanumeric characters. Python has various standard types that are used to define the operations possible on them and the storage method for each of them.

Python has five standard data types:

- Numbers
- String
- List
- Tuple
- Dictionary

Python Numbers:

Number data types store numeric values. They are immutable data types which means that changing the value of a number data type results in a newly allocated object.

Number objects are created when you assign a value to them. For example:

```
var1 = 1
var2 = 10
```

You 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
del var_a, var_b
```

Python supports four different numerical types:

- int (signed integers)
- long (long integers [can also be represented in octal and hexadecimal])
- float (floating point real values)

- complex (complex numbers)

Examples:

Here are some examples of numbers:

Int	Long	float	complex
10	51924361L	0.0	3.14j
100	-0x19323L	15.20	45.j
-786	0122L	-21.9	9.322e-36j
080	0xDEFABCECBDAECBFBAEl	32.3+e18	.876j
-0490	535633629843L	-90.	-.6545+0J
-0x260	-052318172735L	-32.54e100	3e+26J
0x69	-4721885298529L	70.2-E12	4.53e-7j

- Python allows you to use a lowercase L with long, but it is recommended that you use only an uppercase L to avoid confusion with the number 1. Python displays long integers with an uppercase L.

- A complex number consists of an ordered pair of real floating-point numbers denoted by a + bj, where a is the real part and b is the imaginary part of the complex number.

Python Strings:

Strings in Python are identified as a contiguous set of characters in between quotation marks. Python allows for either pairs 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 at the end.

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

```
#!/usr/bin/python

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
```

This will produce the following result:

```
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 difference 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:

```
#!/usr/bin/python

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
```

This will produce the following result:

```
['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 parentheses.

The main differences 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:

```
#!/usr/bin/python

tuple = ( 'abcd', 786 , 2.23, 'john', 70.2  )
tinytuple = (123, 'john')

print tuple           # Prints complete list
print tuple[0]        # Prints first element of the list
print tuple[1:3]      # Prints elements starting from 2nd till 3rd
print tuple[2:]       # Prints elements starting from 3rd element
print tinytuple * 2   # Prints list two times
print tuple + tinytuple # Prints concatenated lists
```

This will produce the following result:

```
('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')
```

Following is invalid with tuple, because we attempted to update a tuple, which is not allowed. Similar case is possible with lists:

```
#!/usr/bin/python

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 list
```

Python Dictionary:

Python's dictionaries are kind of hash table type. 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:

```
#!/usr/bin/python

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
```

This will produce the following result:

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

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

Data Type Conversion:

Sometimes, you may need to perform conversions between the built-in types. To convert between types, you simply use the type name 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.

Function	Description
int(x [,base])	Converts x to an integer. base specifies the base if x is a string.
long(x [,base])	Converts x to a long integer. base specifies the base if x is a string.
float(x)	Converts x to a floating-point number.
complex(real [,imag])	Creates a complex number.
str(x)	Converts object x to a string representation.
repr(x)	Converts object x to an expression string.
eval(str)	Evaluates a string and returns an object.
tuple(s)	Converts s to a tuple.
list(s)	Converts s to a list.
set(s)	Converts s to a set.
dict(d)	Creates a dictionary. d must be a sequence of (key,value) tuples.
frozenset(s)	Converts s to a frozen set.
chr(x)	Converts an integer to a character.
unichr(x)	Converts an integer to a Unicode character.

ord(x)	Converts a single character to its integer value.
hex(x)	Converts an integer to a hexadecimal string.
oct(x)	Converts an integer to an octal string.

CHAPTER 5

Python Basic Operators

What is an Operator?

Simple answer can be given using expression *4 + 5 is equal to 9*. Here, 4 and 5 are called operands and + is called operator. Python language supports the following types of operators.

- Arithmetic Operators
- Comparison (i.e., Relational) Operators
- Assignment Operators
- Logical Operators
- Bitwise Operators
- Membership Operators
- Identity Operators

Let's have a look on all operators one by one.

Python Arithmetic Operators:

Assume variable a holds 10 and variable b holds 20, then:

Operator	Description	Example
+	Addition - Adds values on either side of the operator	a + b will give 30
-	Subtraction - Subtracts right hand operand from left hand operand	a - b will give -10
*	Multiplication - Multiplies values on either side of the operator	a * b will give 200

/	Division - Divides left hand operand by right hand operand	b / a will give 2
%	Modulus - Divides left hand operand by right hand operand and returns remainder	b % a will give 0
**	Exponent - Performs exponential (power) calculation on operators	a**b will give 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.	9//2 is equal to 4 and 9.0//2.0 is equal to 4.0

Example:

Try the following example to understand all the arithmetic operators available in Python programming language:

```
#!/usr/bin/python

a = 21
b = 10
c = 0

c = a + b
print "Line 1 - Value of c is ", c

c = a - b
print "Line 2 - Value of c is ", c

c = a * b
print "Line 3 - Value of c is ", c

c = a / b
print "Line 4 - Value of c is ", c

c = a % b
print "Line 5 - Value of c is ", c

a = 2
b = 3
c = a**b
print "Line 6 - Value of c is ", c

a = 10
b = 5
c = a//b
print "Line 7 - Value of c is ", c
```

When you execute the above program, it produces the following result:

```
Line 1 - Value of c is 31
Line 2 - Value of c is 11
Line 3 - Value of c is 210
```

```
Line 4 - Value of c is 2
Line 5 - Value of c is 1
Line 6 - Value of c is 8
Line 7 - Value of c is 2
```

Python Comparison Operators:

Following table shows all the comparison operators supported by Python language. Assume variable a holds 10 and variable b holds 20, then:

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

Example:

Try following example to understand all the comparison operators available in Python programming language:

```
#!/usr/bin/python


a = 21

b = 10

c = 0


if ( a == b ):

   print "Line 1 - a is equal to b"

else:

   print "Line 1 - a is not equal to b"


if ( a != b ):
```

```
   print "Line 2 - a is not equal to b"
else:
   print "Line 2 - a is equal to b"

if ( a <> b ):
   print "Line 3 - a is not equal to b"
else:
   print "Line 3 - a is equal to b"

if ( a < b ):
   print "Line 4 - a is less than b"
else:
   print "Line 4 - a is not less than b"

if ( a > b ):
   print "Line 5 - a is greater than b"
else:
   print "Line 5 - a is not greater than b"

a = 5;
b = 20;
if ( a <= b ):
   print "Line 6 - a is either less than or equal to  b"
else:
   print "Line 6 - a is neither less than nor equal to  b"

if ( b >= a ):
   print "Line 7 - b is either greater than or equal to b"
else:
   print "Line 7 - b is neither greater than nor equal to b"
```

When you execute the above program, it produces the following result:

```
Line 1 - a is not equal to b
Line 2 - a is not equal to b
Line 3 - a is not equal to b
Line 4 - a is not less than b
```

```
Line 5 - a is greater than b
Line 6 - a is either less than or equal to b
Line 7 - b is either greater than or equal to b
```

Python Assignment Operators:

Assume variable a holds 10 and variable b holds 20, then:

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

Example:

Try following example to understand all the assignment operators available in Python programming language:

```
#!/usr/bin/python

a = 21
b = 10
c = 0

c = a + b
print "Line 1 - Value of c is ", c

c += a
print "Line 2 - Value of c is ", c
```

```
c *= a
print "Line 3 - Value of c is ", c

c /= a
print "Line 4 - Value of c is ", c

c  = 2
c %= a
print "Line 5 - Value of c is ", c

c **= a
print "Line 6 - Value of c is ", c

c //= a
print "Line 7 - Value of c is ", c
```

When you execute the above program, it produces the following result:

```
Line 1 - Value of c is 31
Line 2 - Value of c is 52
Line 3 - Value of c is 1092
Line 4 - Value of c is 52
Line 5 - Value of c is 2
Line 6 - Value of c is 2097152
Line 7 - Value of c is 99864
```

Python Bitwise Operators:

Bitwise operator works on bits and perform 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

alb = 0011 1101

a^b = 0011 0001

~a = 1100 0011

There are following Bitwise operators supported by Python language:

Operator	Description	Example
&	Binary AND Operator copies a bit to the result if it exists in both operands.	(a & b) will give 12 which is 0000 1100

|	Binary OR Operator copies a bit if it exists in either operand.	(a | b) will give 61 which is 0011 1101
^	Binary XOR Operator copies the bit if it is set in one operand but not both.	(a ^ b) will give 49 which is 0011 0001
~	Binary Ones Complement Operator is unary and has the effect of 'flipping' bits.	(~a) will give -60 which is 1100 0011
<<	Binary Left Shift Operator. The left operands value is moved left by the number of bits specified by the right operand.	a << 2 will give 240 which is 1111 0000
>>	Binary Right Shift Operator. The left operands value is moved right by the number of bits specified by the right operand.	a >> 2 will give 15 which is 0000 1111

Example:

Try following example to understand all the bitwise operators available in Python programming language:

```
#!/usr/bin/python

a = 60            # 60 = 0011 1100
b = 13            # 13 = 0000 1101
c = 0

c = a & b;        # 12 = 0000 1100
print "Line 1 - Value of c is ", c

c = a | b;        # 61 = 0011 1101
print "Line 2 - Value of c is ", c

c = a ^ b;        # 49 = 0011 0001
print "Line 3 - Value of c is ", c

c = ~a;           # -61 = 1100 0011
print "Line 4 - Value of c is ", c

c = a << 2;       # 240 = 1111 0000
print "Line 5 - Value of c is ", c

c = a >> 2;       # 15 = 0000 1111
print "Line 6 - Value of c is ", c
```

When you execute the above program, it produces the following result:

```
Line 1 - Value of c is 12
Line 2 - Value of c is 61
Line 3 - Value of c is 49
Line 4 - Value of c is -61
Line 5 - Value of c is 240
Line 6 - Value of c is 15
```

Python Logical Operators:

There are following logical operators supported by Python language. Assume variable a holds 10 and variable b holds 20, then:

Operator	Description	Example
and	Called Logical AND operator. If both the operands are true, then the condition becomes true.	(a and b) is true.
or	Called Logical OR Operator. If any of the two operands are non zero, then the condition becomes true.	(a or b) is true.
not	Called Logical NOT Operator. Used to reverse the logical state of its operand. If a condition is true, then Logical NOT operator will make it false.	not(a and b) is false.

Example:

Try the following example to understand all the logical operators available in Python programming language:

```
#!/usr/bin/python

a = 10
b = 20
c = 0

if ( a and b ):
   print "Line 1 - a and b are true"
else:
   print "Line 1 - Either a is not true or b is not true"

if ( a or b ):
   print "Line 2 - Either a is true or b is true or both are true"
else:
   print "Line 2 - Neither a is true nor b is true"

a = 0
if ( a and b ):
```

```
   print "Line 3 - a and b are true"
else:
   print "Line 3 - Either a is not true or b is not true"

if ( a or b ):
   print "Line 4 - Either a is true or b is true or both are true"
else:
   print "Line 4 - Neither a is true nor b is true"

if not( a and b ):
   print "Line 5 - Either a is not true or b is not true"
else:
   print "Line 5 - a and b are true"
```

When you execute the above program, it produces the following result:

```
Line 1 - a and b are true
Line 2 - Either a is true or b is true or both are true
Line 3 - Either a is not true or b is not true
Line 4 - Either a is true or b is true or both are true
Line 5 - Either a is not true or b is not true
```

Python Membership Operators:

In addition to the operators discussed previously, Python has membership operators, which test for membership in a sequence, such as strings, lists or tuples. There are two membership operators 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.

Example:

Try following example to understand all the membership operators available in Python programming language:

```
#!/usr/bin/python

a = 10
b = 20
list = [1, 2, 3, 4, 5 ];
```

```
if ( a in list ):
   print "Line 1 - a is available in the given list"
else:
   print "Line 1 - a is not available in the given list"

if ( b not in list ):
   print "Line 2 - b is not available in the given list"
else:
   print "Line 2 - b is available in the given list"

a = 2
if ( a in list ):
   print "Line 3 - a is available in the given list"
else:
   print "Line 3 - a is not available in the given list"
```

When you execute the above program, it produces the following result:

```
Line 1 - a is not available in the given list
Line 2 - b is not available in the given list
Line 3 - a is available in the given list
```

Python Identity Operators:

Identity operators compare the memory locations of two objects. There are two Identity operators 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).

Example:

Try following example to understand all the identity operators available in Python programming language:

```
#!/usr/bin/python

a = 20

b = 20


if ( a is b ):

   print "Line 1 - a and b have same identity"

else:

   print "Line 1 - a and b do not have same identity"
```

```
if ( id(a) == id(b) ):
   print "Line 2 - a and b have same identity"
else:
   print "Line 2 - a and b do not have same identity"

b = 30
if ( a is b ):
   print "Line 3 - a and b have same identity"
else:
   print "Line 3 - a and b do not have same identity"

if ( a is not b ):
   print "Line 4 - a and b do not have same identity"
else:
   print "Line 4 - a and b have same identity"
```

When you execute the above program, it produces the following result:

```
Line 1 - a and b have same identity
Line 2 - a and b have same identity
Line 3 - a and b do not have same identity
Line 4 - a and b do not have same identity
```

Python Operators Precedence

Operator precedence determines the grouping of terms in an expression. This affects how an expression is evaluated. Certain operators have higher precedence than others; for example, the multiplication operator has higher precedence than the addition operator.

For example, x = 7 + 3 * 2; here, x is assigned 13, not 20 because operator * has higher precedence than +, so it first multiplies 3*2 and then adds into 7.

Here, operators with the highest precedence appear at the top of the table, those with the lowest appear at the bottom. Within an expression, higher precedence operators will be evaluated first.

The following table lists all operators from highest precedence to lowest:

Operator	Description
**	Exponentiation (raise to the power)
~ + -	Complement, unary plus and minus (method names for the last two are +@ and -@)

* / % //	Multiply, divide, modulo and floor division
+ -	Addition and subtraction
>> <<	Right and left bitwise shift
&	Bitwise 'AND'
^ |	Bitwise exclusive `OR' and regular `OR'
<= < > >=	Comparison operators
<> == !=	Equality operators
= %= /= //= -= += *= **=	Assignment operators
is is not	Identity operators
in not in	Membership operators
not or and	Logical operators

Example:

Try following example to understand operator precedence available in Python programming language:

```
#!/usr/bin/python

a = 20
b = 10
c = 15
d = 5
e = 0

e = (a + b) * c / d       #( 30 * 15 ) / 5
print "Value of (a + b) * c / d is ", e

e = ((a + b) * c) / d     # (30 * 15 ) / 5
print "Value of ((a + b) * c) / d is ", e

e = (a + b) * (c / d);    # (30) * (15/5)
print "Value of (a + b) * (c / d) is ", e

e = a + (b * c) / d;      #  20 + (150/5)
print "Value of a + (b * c) / d is ", e
```

When you execute the above program, it produces the following result:

```
Value of (a + b) * c / d is 90
Value of ((a + b) * c) / d is 90
Value of (a + b) * (c / d) is 90
Value of a + (b * c) / d is 50
```

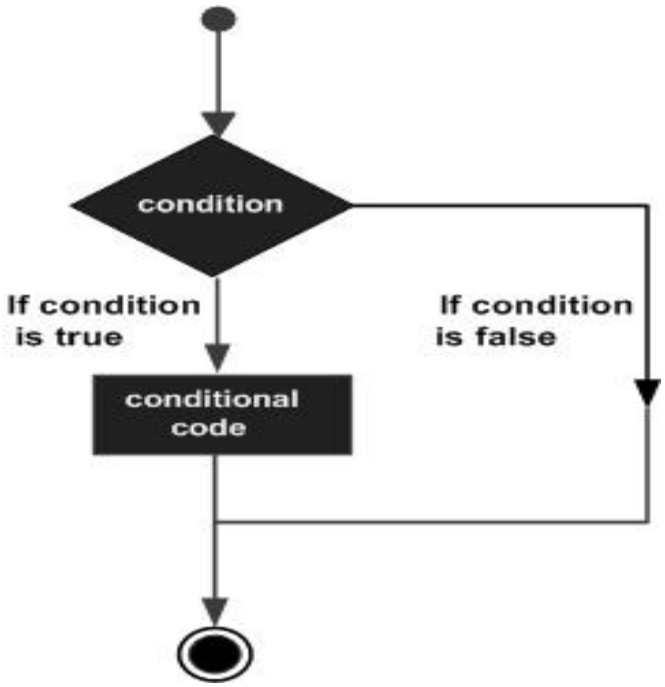
CHAPTER

6

Python Decision Making

Decision making structures require that the programmer specify 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. Click the following links to check their detail.

Statement	Description

if statements	An **if statement** consists of a boolean expression followed by one or more statements.
if...else statements	An **if statement** can be followed by an optional **else statement**, which executes when the boolean expression is false.
nested if statements	You can use one **if** or **else if** statement inside another **if** or **else if** statement(s).

If statements

The **if** statement of Python is similar to that of other languages. The **if** statement contains a logical expression using which data is compared and a decision is made based on the result of the comparison.

Syntax:

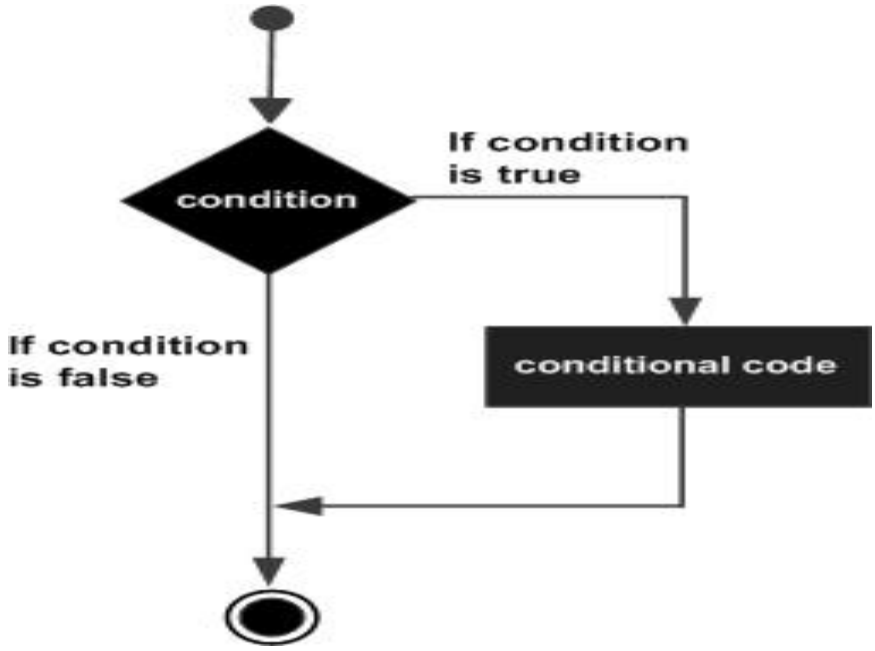
The syntax of an **if** statement in Python programming language is:

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

If the boolean **expression** evaluates to **true,** then the block of statement(s) inside the if statement will be executed. If boolean expression evaluates to **false,** then the first set of code after the end of the if statement(s) will be executed.

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.

Flow Diagram:



Example:

```
#!/usr/bin/python
```

```
var1 = 100
if var1:
   print "1 - Got a true expression value"
   print var1

var2 = 0
if var2:
   print "2 - Got a true expression value"
   print var2
print "Good bye!"
```

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

```
1 - Got a true expression value
100
Good bye!
```

if...else statements

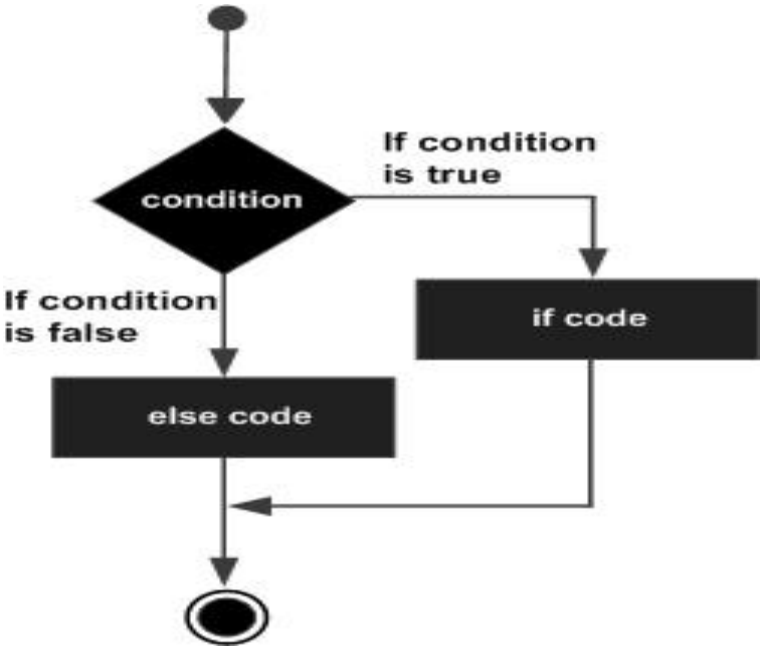
An **else** statement can be combined with an **if** statement. An **else** statement contains the block of code that executes if the conditional expression in the if statement resolves to 0 or a false value.
The *else* statement is an optional statement and there could be at most only one **else** statement following **if** .

Syntax:

The syntax of the *if...else* statement is:

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

Flow Diagram:



Example:

```
#!/usr/bin/python

var1 = 100
if var1:
   print "1 - Got a true expression value"
   print var1
else:
   print "1 - Got a false expression value"
   print var1

var2 = 0
if var2:
   print "2 - Got a true expression value"
   print var2
else:
   print "2 - Got a false expression value"
   print var2

print "Good bye!"
```

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

```
1 - Got a true expression value
100
2 - Got a false expression value
0
Good bye!
```

The *elif* Statement

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

Like 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**.

The syntax of the *if...elif* statement is:

```
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:

Example:

```
#!/usr/bin/python

var = 100
```

```
if var == 200:
   print "1 - Got a true expression value"
   print var
elif var == 150:
   print "2 - Got a true expression value"
   print var2
elif var == 100:
   print "3 - Got a true expression value"
   print var
else:
   print "4 - Got a false expression value"
   print var

print "Good bye!"
```

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

```
3 - Got a true expression value
100
Good bye!
```

nested if statements

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)
```

Example:

```
#!/usr/bin/python

var = 100
if var < 200:
   print "Expression value is less than 200"
   if var == 150:
      print "Which is 150"
   elif var == 100:
      print "Which is 100"
   elif var == 50:
      print "Which is 50"
elif var < 50:
   print "Expression value is less than 50"
```

```
else:
   print "Could not find true expression"

print "Good bye!"
```

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

```
Expression value is less than 200
Which is 100
Good bye!
```

Single Statement Suites:

If the suite of an **if** clause consists only of a single line, it may go on the same line as the header statement.

Here is an example of a **one-line if** clause:

```
#!/usr/bin/python

var = 100

if ( var  == 100 ) : print "Value of expression is 100"

print "Good bye!"
```

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

```
Value of expression is 100
Good bye!
```

CHAPTER

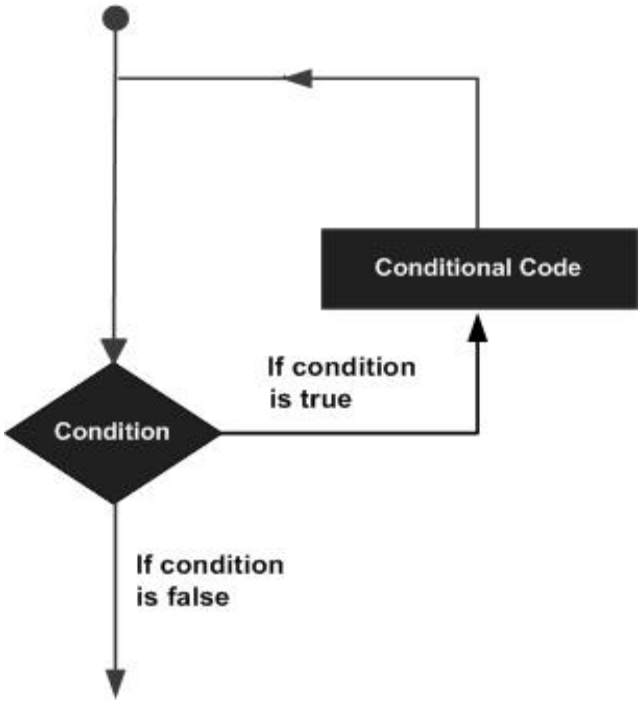
7

Python Loops

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

Programming languages provide various control structures that allow for more complicated execution paths.

A loop statement allows us to execute a statement or group of statements multiple times and following is the general form of a loop statement in most of the programming languages:



Python programming language provides following types of loops to handle looping requirements. Click the following links to check their detail.

Loop Type	Description
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	You can use one or more loop inside any another while, for or do..while loop.

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:

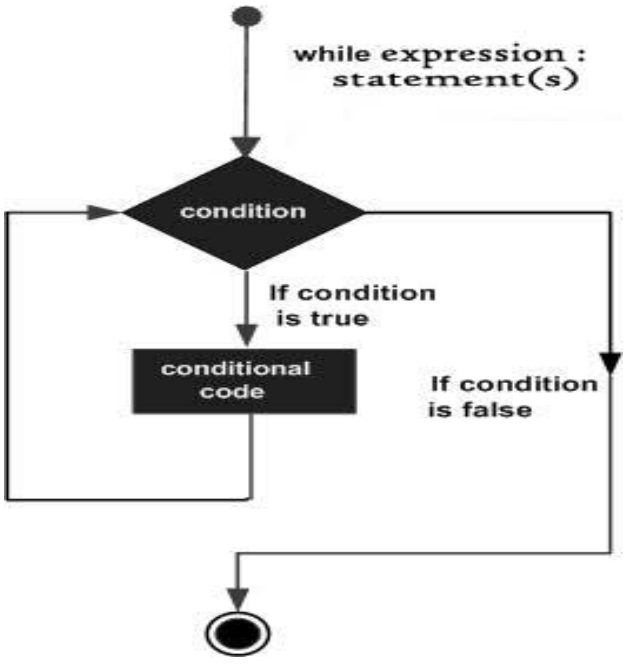
```
while expression:
   statement(s)
```

Here, **statement(s)** may be a single statement or a block of statements. 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:



Here, key point of the *while* loop is that the loop might not ever run. When the condition is tested and the result is false, the loop body will be skipped and the first statement after the while loop will be executed.

Example:

```
#!/usr/bin/python

count = 0
while (count < 9):
   print 'The count is:', count
   count = count + 1

print "Good bye!"
```

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

```
The count is: 0
The count is: 1
The count is: 2
The count is: 3
The count is: 4
The count is: 5
The count is: 6
The count is: 7
The count is: 8
Good bye!
```

The block here, consisting of the print and increment statements, is executed repeatedly until count is no longer less than 9. With each iteration, the current value of the index count is displayed and then increased by 1.

The Infinite Loop:

A loop becomes infinite loop if a condition never becomes false. You must use caution 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.

An infinite loop might be useful in client/server programming where the server needs to run continuously so that client programs can communicate with it as and when required.

```
#!/usr/bin/python

var = 1
while var == 1 :  # This constructs an infinite loop
   num = raw_input("Enter a number  :")
   print "You entered: ", num

print "Good bye!"
```

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

```
Enter a number  :20
You entered:  20
Enter a number  :29
You entered:  29
Enter a number  :3
You entered:  3
Enter a number between :Traceback (most recent call last):
  File "test.py", line 5, in <module>
```

```
    num = raw_input("Enter a number :")
KeyboardInterrupt
```

Above example will go in an infite loop and you would need to use CTRL+C to come out of the program.

The else Statement Used with Loops

Python supports to have 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 else statement gets executed.

```
#!/usr/bin/python

count = 0
while count < 5:
   print count, " is  less than 5"
   count = count + 1
else:
   print count, " is not less than 5"
```

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

```
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
```

Single Statement Suites:

Similar to the **if** statement syntax, if your **while** clause consists only of a single statement, it may be placed on the same line as the while header.

Here is the syntax and example of a **one-line while** clause:

```
#!/usr/bin/python

flag = 1

while (flag): print 'Given flag is really true!'

print "Good bye!"
```

Do not try above example because it will go into infinite loop and you will have to use CTRL+C keys to come out.

for loop

The **for** loop in Python has the ability to iterate over the items of any sequence, such as a list or a string.

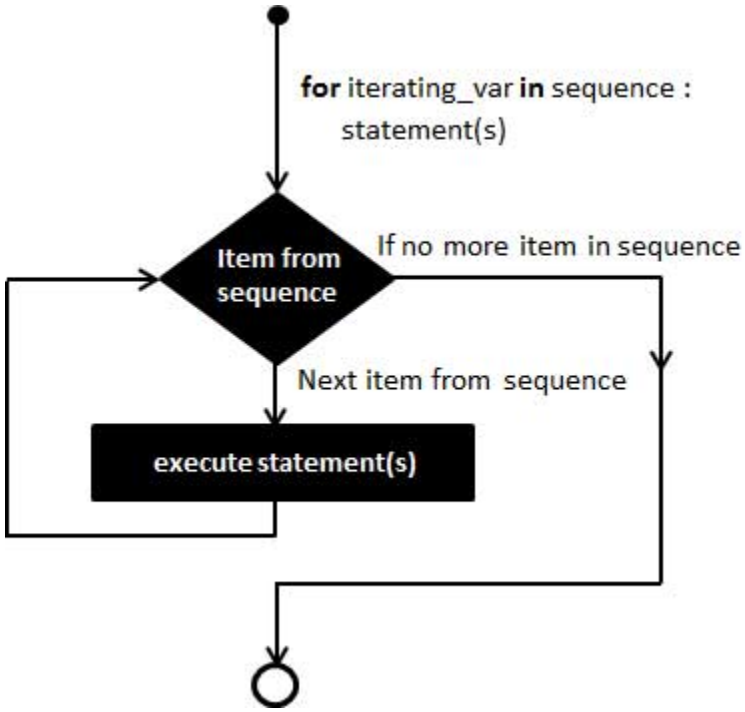
Syntax:

The syntax of a **for** loop look is as follows:

```
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:



Example:

```
#!/usr/bin/python

for letter in 'Python':     # First Example
   print 'Current Letter :', letter

fruits = ['banana', 'apple',  'mango']
for fruit in fruits:        # Second Example
   print 'Current fruit :', fruit

print "Good bye!"
```

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

```
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:

```
#!/usr/bin/python

fruits = ['banana', 'apple',  'mango']
for index in range(len(fruits)):
   print 'Current fruit :', fruits[index]

print "Good bye!"
```

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

```
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.

The else Statement Used with Loops

Python supports to have 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 for statement that searches for prime numbers from 10 through 20.

```
#!/usr/bin/python

for num in range(10,20):  #to iterate between 10 to 20
   for i in range(2,num): #to iterate on the factors of the number
      if num%i == 0:      #to determine the first factor
         j=num/i          #to calculate the second factor
         print '%d equals %d * %d' % (num,i,j)
         break #to move to the next number, the #first FOR
   else:                  # else part of the loop
      print num, 'is a prime number'
```

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

```
10 equals 2 * 5
11 is a prime number
12 equals 2 * 6
13 is a prime number
14 equals 2 * 7
15 equals 3 * 5
16 equals 2 * 8
17 is a prime number
18 equals 2 * 9
19 is a prime number
```

nested loops

Python programming language allows to use one loop inside another loop. Following section shows few examples to illustrate the concept.

Syntax:

The syntax for a **nested for loop** statement in Python is as follows:

```
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)
```

A final note on loop nesting is that you can put any type of loop inside of any other type of loop. For example, a for loop can be inside a while loop or vice versa.

Example:

The following program uses a nested for loop to find the prime numbers from 2 to 100:

```
#!/usr/bin/python

i = 2
while(i < 100):
   j = 2
   while(j <= (i/j)):
      if not(i%j): break
      j = j + 1
   if (j > i/j) : print i, " is prime"
   i = i + 1

print "Good bye!"
```

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

```
2 is prime
3 is prime
5 is prime
7 is prime
```

```
11 is prime
13 is prime
17 is prime
19 is prime
23 is prime
29 is prime
31 is prime
37 is prime
41 is prime
43 is prime
47 is prime
53 is prime
59 is prime
61 is prime
67 is prime
71 is prime
73 is prime
79 is prime
83 is prime
89 is prime
97 is prime
Good bye!
```

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. Click the following links to check their detail.

Control Statement	Description
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 statement

The **break** statement in Python terminates the current loop and resumes execution at the next statement, just like the traditional break found 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.

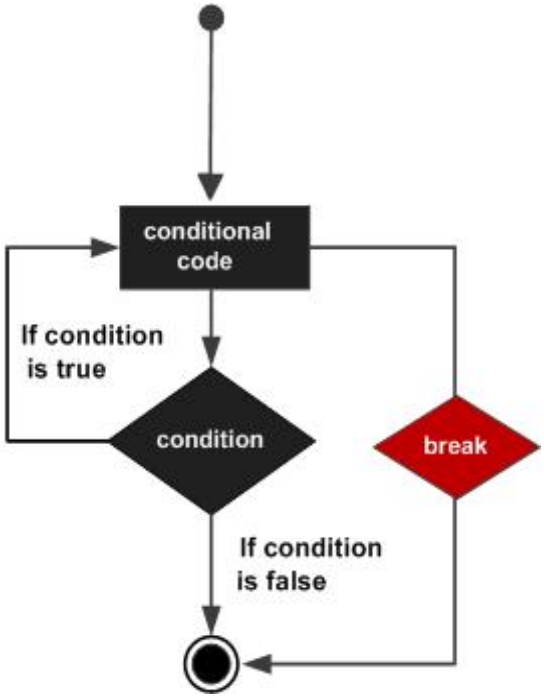
If you are using nested loops (i.e., one loop inside another loop), the break statement will stop the execution of the innermost loop and start executing the next line of code after the block.

Syntax:

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

```
break
```

Flow Diagram:



Example:

```
#!/usr/bin/python

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 result:

```
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 statement

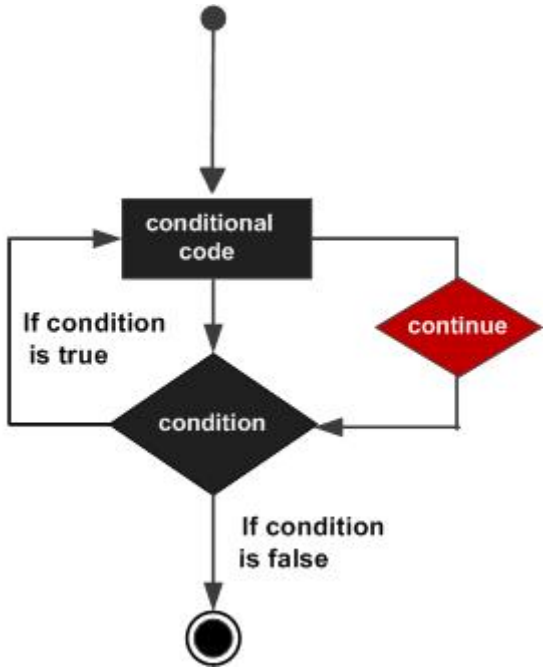
The **continue** statement in Python returns the control to the beginning of the while loop. The **continue** statement rejects all the remaining statements in the current iteration of the loop and moves the control back to the top of the loop.
The **continue** statement can be used in both *while* and *for* loops.

Syntax:

The syntax for a **continue** statement in Python is as follows:

```
continue
```

Flow Diagram:



Example:

```
#!/usr/bin/python

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 result:

```
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 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.
The **pass** statement is a *null* operation; nothing happens when it executes. The **pass** is also useful in places where your code will eventually go, but has not been written yet (e.g., in stubs for example):

Syntax:

The syntax for a **pass** statement in Python is as follows:

```
pass
```

Example:

```
#!/usr/bin/python

for letter in 'Python':
   if letter == 'h':
      pass
      print 'This is pass block'
   print 'Current Letter :', letter

print "Good bye!"
```

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

```
Current Letter : P
Current Letter : y
Current Letter : t
This is pass block
Current Letter : h
Current Letter : o
Current Letter : n
Good bye!
```

CHAPTER

14

Python Function

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.

As you already know, Python gives you many built-in functions like print(), etc., but you can also create your own functions. These functions are called *user-defined functions.*

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.

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.

Example:

Here is the simplest form of a Python function. This function takes a string as input parameter and prints it on standard screen.

```
def printme( str ):
   "This prints a passed string into this function"
   print str
   return
```

Calling a Function

Defining a function only gives it a name, specifies the parameters that are to be included in the function and structures the blocks of code.

Once the basic structure of a function is finalized, you can execute it by calling it from another function or directly from the Python prompt. Following is the example to call printme() function:

```
#!/usr/bin/python

# 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("I'm first call to user defined function!");
printme("Again second call to the same function");
```

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

```
I'm first call to user defined function!
Again second call to the same function
```

Pass by reference vs value

All parameters (arguments) in the Python language are passed by reference. It means if you change what a parameter refers to within a function, the change also reflects back in the calling function. For example:

```
#!/usr/bin/python

# Function definition is here
def changeme( mylist ):
   "This changes a passed list into this function"
   mylist.append([1,2,3,4]);
   print "Values inside the function: ", mylist
   return

# Now you can call changeme function
mylist = [10,20,30];
changeme( mylist );
print "Values outside the function: ", mylist
```

Here, we are maintaining reference of the passed object and appending values in the same object. So, this would produce the following result:

```
Values inside the function:  [10, 20, 30, [1, 2, 3, 4]]
Values outside the function:  [10, 20, 30, [1, 2, 3, 4]]
```

There is one more example where argument is being passed by reference and the reference is being overwritten inside the called function

```
#!/usr/bin/python

# Function definition is here
def changeme( mylist ):
   "This changes a passed list into this function"
   mylist = [1,2,3,4]; # This would assign new reference in mylist
   print "Values inside the function: ", mylist
   return

# Now you can call changeme function
mylist = [10,20,30];
changeme( mylist );
print "Values outside the function: ", mylist
```

The parameter mylist is local to the function changeme. Changing mylist within the function does not affect mylist. The function accomplishes nothing and finally this would produce the following result:

```
Values inside the function:  [1, 2, 3, 4]
Values outside the function:  [10, 20, 30]
```

Function Arguments:

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

- Required arguments
- Keyword arguments
- Default arguments
- Variable-length arguments

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 would give a syntax error as follows:

```
#!/usr/bin/python

# 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)
```

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. You can also make keyword calls to the *printme()* function in the following ways:

```
#!/usr/bin/python

# 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( str = "My string");
```

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

```
My string
```

Following example gives more clear picture. Note, here order of the parameter does not matter.

```
#!/usr/bin/python

# Function definition is here
def printinfo( name, age ):
   "This prints a passed info into this function"
   print "Name: ", name;
   print "Age ", age;
   return;

# Now you can call printinfo function
printinfo( age=50, name="miki" );
```

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

```
Name:  miki
Age  50
```

Default arguments:

A default argument is an argument that assumes a default value if a value is not provided in the function call for that argument. Following example gives an idea on default arguments, it would print default age if it is not passed:

```
#!/usr/bin/python

# 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 you can call printinfo function
printinfo( age=50, name="miki" );
printinfo( name="miki" );
```

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

```
Name:  miki
Age  50
Name:  miki
Age  35
```

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.

The general syntax for a function with non-keyword variable arguments is this:

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

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

```
#!/usr/bin/python

# 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 you can call printinfo function
printinfo( 10 );
printinfo( 70, 60, 50 );
```

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

```
Output is:
10
Output is:
70
60
50
```

The *Anonymous* Functions:

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

- 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.

- Although it appears that lambda's are a one-line version of a function, they are not equivalent to *inline* statements in C or C++, whose purpose is by passing function stack allocation during invocation for performance reasons.

Syntax:

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

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

Following is the example to show how *lambda* form of function works:

```
#!/usr/bin/python

# 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 )
```

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

```
Value of total :  30
Value of total :  40
```

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, but if you like you can return a value from a function as follows:

```
#!/usr/bin/python

# 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 you can call sum function
total = sum( 10, 20 );
print "Outside the function : ", total
```

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

```
Inside the function :  30
Outside the function :  30
```

Scope of Variables:

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 two basic scopes of variables in Python:

- Global variables
- Local variables

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

```
#!/usr/bin/python

total = 0; # This is global variable.
# Function definition is here
def sum( arg1, arg2 ):
   # Add both the parameters and return them."
   total = arg1 + arg2; # Here total is local variable.
   print "Inside the function local total : ", total
   return total;

# Now you can call sum function
sum( 10, 20 );
print "Outside the function global total : ", total
```

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

```
Inside the function local total :  30
Outside the function global total :  0
```