MC4103 Python Programming UNIT-I

python programming (Anna University)

MC4103 PYTHON PROGRAMMING

UNIT I BASICS OF PYTHON 9

Introduction to Python Programming – Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements. Operators – Boolean Values – Operator Precedence – Expression – Conditionals: If-Else Constructs – Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement-Continue statement – Function Call and Returning Values – Parameter Passing – Local and Global Scope – Recursive Functions

Introduction:

Python is a general purpose interpreted, interactive, object-oriented and high-level programming language. Python was created by Guido van Rossum in the late eighties and early nineties. Like Perl, Python source code is now available under the GNU General Public License (GPL).Python was designed to be highly readable which uses English keywords frequently where as other languages use punctuation and it has fewer syntactical constructions than other languages.

- **Python is interpreted:** This means that it is processed at runtime by the interpreter and you do not need to compile your program before executing it. This is similar to PERL and PHP.

- **Python is Interactive:** This means that you can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

- **Python is Object-Oriented:** This means that Python supports Object-Oriented style or technique of programming that encapsulates code within objects.

- **Python is Beginner's Language:** Python is a great language for the beginner programmers and supports the development of a wide range of applications, from simple text processing to WWW browsers to games.

Syntax and Style:

Statements and Syntax

Some rules and certain symbols are used with regard to statements in Python:

Symbol Description

Hash mark (#) Indicates Python comments

NEWLINE (\n) The standard line separator (one statement per line) Backslash (\ ) Continues a line

Semicolon (;) Joins two statements on a line Colon (:) Separates a header line from its suite

Comments:

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 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.

Continuation (\ ):

In Python you normally have one instruction per line. Long instructions can span several lines using the line-continuation character "\". Some instructions, as triple quoted strings, list, tuple and dictionary constructors or statements grouped by parentheses do not need a line-continuation character. It is possible to write several statements on the same line, provided they are separated by semi-colons.

check conditions

if (weather_is_hot == 1) and \ (shark_warnings == 0) :

send_goto_beach_mesg_to_pager()

Multiple Statement Groups as Suites (:)

Groups of individual statements making up 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.

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:

Example:

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

Module:

A module allows you to logically organize your Python code. Grouping related code into a module makes the code easier to understand and use.

A module is a Python object with arbitrarily named attributes that you can bind and reference.Simply, a module is a file consisting of Python code. A module can define functions, classes, and variables. A module can also include runnable code.

Variable Assignment

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 following result:

Values and types

A **value** is one of the fundamental things — like a letter or a number — that a program manipulates. The values we have seen so far are 2 (the result when we added 1 + 1), and 'Hello, World!'.

These values belong to different **types**: 2 is an integer, and 'Hello, World!' is a **string**, so-called because it contains a "string" of letters. You (and the interpreter) can identify strings because they are enclosed in quotation marks.

The print statement also works for integers.

```
>>> print 4
4
```

If you are not sure what type a value has, the interpreter can tell you.

```
>>> type('Hello, World!')
<type 'str'>
>>> type(17)
<type 'int'>
```

Not surprisingly, strings belong to the type str and integers belong to the type int. Less obviously, numbers with a decimal point belong to a type called float, because these numbers are represented in a format called **floating-point**.

```
>>> type(3.2)
<type 'float'>
```

What about values like '17' and '3.2'? They look like numbers, but they are in quotation marks like strings.

```
>>> type('17')
<type 'str'>
```

```
>>> type('3.2')
<type 'str'>
```

They're strings.

When you type a large integer, you might be tempted to use commas between groups of three digits, as in 1,000,000. This is not a legal integer in Python, but it is a legal expression:

```
>>> print 1,000,000
1 0 0
```

Well, that's not what we expected at all! Python interprets 1,000,000 as a comma-separated list of three integers, which it prints consecutively. This is the first example we have seen of a semantic error: the code runs without producing an error message, but it doesn't do the "right" thing.

2.2 Variables

One of the most powerful features of a programming language is the ability to manipulate **variables**. A variable is a name that refers to a value.

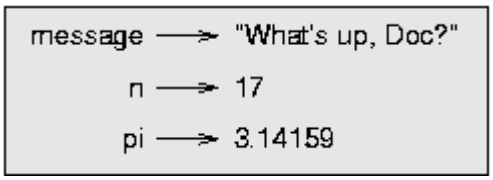
The **assignment statement** creates new variables and gives them values:

```
>>> message = "What's up, Doc?"
>>> n = 17
>>> pi = 3.14159
```

This example makes three assignments. The first assigns the string "What's up, Doc?" to a new variable named message. The second gives the integer 17 to n, and the third gives the floating-point number 3.14159 to pi.

Notice that the first statement uses double quotes to enclose the string. In general, single and double quotes do the same thing, but if the string contains a single quote (or an apostrophe, which is the same character), you have to use double quotes to enclose it.

A common way to represent variables on paper is to write the name with an arrow pointing to the variable's value. This kind of figure is called a **state diagram** because it shows what state each of the variables is in (think of it as the variable's state of mind). This diagram shows the result of the assignment statements:



The print statement also works with variables.

```
>>> print message
What's up, Doc?
>>> print n
17
>>> print pi
3.14159
```

In each case the result is the value of the variable. Variables also have types; again, we can ask the interpreter what they are.

```
>>> type(message)
<type 'str'>
>>> type(n)
<type 'int'>
>>> type(pi)
<type 'float'>
```

The type of a variable is the type of the value it refers to.

2.3 Variable names and keywords

Programmers generally choose names for their variables that are meaningful — they document what the variable is used for.

Variable names can be arbitrarily long. They can contain both letters and numbers, but they have to begin with a letter. Although it is legal to use uppercase letters, by convention we don't. If you do, remember that case matters. Bruce and bruce are different variables.

The underscore character (_) can appear in a name. It is often used in names with multiple words, such as my_name or price_of_tea_in_china.

If you give a variable an illegal name, you get a syntax error:

```
>>> 76trombones = 'big parade'
SyntaxError: invalid syntax
>>> more$ = 1000000
SyntaxError: invalid syntax
>>> class = 'Computer Science 101'
SyntaxError: invalid syntax
```

76trombones is illegal because it does not begin with a letter. more$ is illegal because it contains an illegal character, the dollar sign. But what's wrong with class?

It turns out that class is one of the Python **keywords**. Keywords define the language's rules and structure, and they cannot be used as variable names.

Python has twenty-nine keywords:

```
and       def       exec      if        not       return
assert    del       finally   import    or        try
break     elif      for       in        pass      while
class     else      from      is        print     yield
continue  except    global    lambda    raise
```

You might want to keep this list handy. If the interpreter complains about one of your variable names and you don't know why, see if it is on this list.

2.4 Statements

A statement is an instruction that the Python interpreter can execute. We have seen two kinds of statements: print and assignment.

When you type a statement on the command line, Python executes it and displays the result, if there is one. The result of a print statement is a value. Assignment statements don't produce a result.

A script usually contains a sequence of statements. If there is more than one statement, the results appear one at a time as the statements execute.

For example, the script

```
print 1
x = 2
print x
```

produces the output

```
1
2
```

Again, the assignment statement produces no output.

2.5 Evaluating expressions

An expression is a combination of values, variables, and operators. If you type an expression on the command line, the interpreter **evaluates** it and displays the result:

```
>>> 1 + 1
2
```

Although expressions contain values, variables, and operators, not every expression contains all of these elements. A value all by itself is considered an expression, and so is a variable.

```
>>> 17
17
>>> x
2
```

Confusingly, evaluating an expression is not quite the same thing as printing a value.

```
>>> message = 'Hello, World!'
>>> message
'Hello, World!'
>>> print message
Hello, World!
```

When the Python interpreter displays the value of an expression, it uses the same format you would use to enter a value. In the case of strings, that means that it includes the quotation marks. But if you use a print statement, Python displays the contents of the string without the quotation marks.

In a script, an expression all by itself is a legal statement, but it doesn't do anything. The script

```
17
3.2
'Hello, World!'
1 + 1
```

produces no output at all. How would you change the script to display the values of these four expressions?

2.6 Operators and operands

Operators are special symbols that represent computations like addition and multiplication. The values the operator uses are called **operands**.

The following are all legal Python expressions whose meaning is more or less clear:

20+32 hour-1 hour*60+minute minute/60 5**2 (5+9)*(15-7)

The symbols +, -, and /, and the use of parenthesis for grouping, mean in Python what they mean in mathematics. The asterisk (*) is the symbol for multiplication, and ** is the symbol for exponentiation.

When a variable name appears in the place of an operand, it is replaced with its value before the operation is performed.

Addition, subtraction, multiplication, and exponentiation all do what you expect, but you might be surprised by division. The following operation has an unexpected result:

```
>>> minute = 59
>>> minute/60
0
```

The value of minute is 59, and in conventional arithmetic 59 divided by 60 is 0.98333, not 0. The reason for the discrepancy is that Python is performing **integer division**.

When both of the operands are integers, the result must also be an integer, and by convention, integer division always rounds *down*, even in cases like this where the next integer is very close.

A possible solution to this problem is to calculate a percentage rather than a fraction:

```
>>> minute*100/60
98
```

Again the result is rounded down, but at least now the answer is approximately correct. Another alternative is to use floating-point division, which we get to in Chapter 3.

2.7 Order of operations

When more than one operator appears in an expression, the order of evaluation depends on the **rules of precedence**. Python follows the same precedence rules for its mathematical operators that mathematics does. The acronym **PEMDAS** is a useful way to remember the order of operations:

- **P**arentheses have the highest precedence and can be used to force an expression to evaluate in the order you want. Since expressions in parentheses are evaluated first, 2 * (3-1) is 4, and (1+1)**(5-2) is 8. You can also use parentheses to make an expression easier to read, as in (minute * 100) / 60, even though it doesn't change the result.
- **E**xponentiation has the next highest precedence, so 2**1+1 is 3 and not 4, and 3*1**3 is 3 and not 27.
- **M**ultiplication and **D**ivision have the same precedence, which is higher than **A**ddition and **S**ubtraction, which also have the same precedence. So 2*3-1 yields 5 rather than 4, and 2/3-1 is -1, not 1 (remember that in integer division, 2/3=0).
- Operators with the same precedence are evaluated from left to right. So in the expression minute*100/60, the multiplication happens first, yielding 5900/60, which in turn yields 98. If the operations had been evaluated from right to left, the result would have been 59*1, which is 59, which is wrong.

2.8 Operations on strings

In general, you cannot perform mathematical operations on strings, even if the strings look like numbers. The following are illegal (assuming that message has type string):

message-1 'Hello'/123 message*'Hello' '15'+2

Interestingly, the + operator does work with strings, although it does not do exactly what you might expect. For strings, the + operator represents **concatenation**, which means joining the two operands by linking them end-to-end. For example:

```
fruit = 'banana'
bakedGood = ' nut bread'
print fruit + bakedGood
```

The output of this program is banana nut bread. The space before the word nut is part of the string, and is necessary to produce the space between the concatenated strings.

The * operator also works on strings; it performs repetition. For example, 'Fun'*3 is 'FunFunFun'. One of the operands has to be a string; the other has to be an integer.

On one hand, this interpretation of + and * makes sense by analogy with addition and multiplication. Just as 4*3 is equivalent to 4+4+4, we expect 'Fun'*3 to be the same as 'Fun'+'Fun'+'Fun', and it is. On the other hand, there is a significant way in which string concatenation and repetition are different from integer addition and multiplication. Can you think of a property that addition and multiplication have that string concatenation and repetition do not?

2.9 Composition

So far, we have looked at the elements of a program — variables, expressions, and statements — in isolation, without talking about how to combine them.

One of the most useful features of programming languages is their ability to take small building blocks and **compose** them. For example, we know how to add numbers and we know how to print; it turns out we can do both at the same time:

```
>>> print 17 + 3
20
```

In reality, the addition has to happen before the printing, so the actions aren't actually happening at the same time. The point is that any expression involving numbers, strings, and variables can be used inside a print statement. You've already seen an example of this:

```
print 'Number of minutes since midnight: ', hour*60+minute
```

You can also put arbitrary expressions on the right-hand side of an assignment statement:

```
percentage = (minute * 100) / 60
```

This ability may not seem impressive now, but you will see other examples where composition makes it possible to express complex computations neatly and concisely.

Warning: There are limits on where you can use certain expressions. For example, the left-hand side of an assignment statement has to be a *variable* name, not an expression. So, the following is illegal: minute+1 = hour.

2.10 Comments

As programs get bigger and more complicated, they get more difficult to read. Formal languages are dense, and it is often difficult to look at a piece of code and figure out what it is doing, or why.

For this reason, it is a good idea to add notes to your programs to explain in natural language what the program is doing. These notes are called **comments**, and they are marked with the # symbol:

```
# compute the percentage of the hour that has elapsed
percentage = (minute * 100) / 60
```

In this case, the comment appears on a line by itself. You can also put comments at the end of a line:

```
percentage = (minute * 100) / 60     # caution: integer division
```

Everything from the # to the end of the line is ignored — it has no effect on the program. The message is intended for the programmer or for future programmers who might use this code. In this case, it reminds the reader about the ever-surprising behavior of integer division.

This sort of comment is less necessary if you use the integer division operation, //. It has the same effect as the division operator * Note, but it signals that the effect is deliberate.

percentage = (minute * 100) // 60

The integer division operator is like a comment that says, "I know this is integer division, and I like it that way!"

Python - Basic Operators

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

Consider the expression 4 + 5 = 9. Here, 4 and 5 are called operands and + is called operator.

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

Let us 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 = 30
- Subtraction	Subtracts right hand operand from left hand operand.	a – b = -10
*	Multiplies values on either side of the	a * b = 200

Multiplication	operator	
/ Division	Divides left hand operand by right hand operand	b / a = 2
% Modulus	Divides left hand operand by right hand operand and returns remainder	b % a = 0
** 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 sides of them and decide the relation among them. They are also called Relational operators.

Assume variable a holds 10 and variable b holds 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 values of two operands are not equal, then condition becomes true.	(a <> b) is true. This is similar to != operator.

>	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 10 and variable b holds 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	It divides left operand with the right	c /= a is equivalent to c = c / a

AND	operand and assign the result to left operand	
%= 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 the binary format their values will be 0011 1100 and 0000 1101 respectively. Following table lists out the bitwise operators supported by Python language with an example each in those, we use the above two variables (a and b) as operands −

a = 0011 1100

b = 0000 1101

---

a&b = 0000 1100

a|b = 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) (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 operands value is moved left by the number of bits specified by the right operand.	a << 2 = 240 (means 1111 0000)
>> Binary Right Shift	The left operands value is moved right by the number of bits specified by the right operand.	a >> 2 = 15 (means 0000 1111)

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 Logical AND	If both the operands are true then condition becomes true.	(a and b) is true.
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 false.

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	x in y, here in results in a 1 if x is a

	the specified sequence and false otherwise.	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 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 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	**<= < > >=** 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

Comments in Python

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

```
#!/usr/bin/python

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

This produces the following result −

```
Hello, Python!
```

You can type a comment 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.
```

Following triple-quoted string is also ignored by Python interpreter and can be used as a multiline comments:

```
'''
This is a multiline
comment.
'''
```

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, the statement saying “Press the enter key to exit”, and waits for the user to take action −

```
#!/usr/bin/python

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

Here, "\n\n" is 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 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

Many programs can be run to 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. Command Line Arguments is an advanced topic and should be studied a bit later once you have gone through rest of the Python concepts.

DEBUGGING

The Python Debugger (pdb)

PythonProgrammingServer Side Programming

In software development jargon, 'debugging' term is popularly used to process of locating and rectifying errors in a program. Python's standard library contains pdb module which is a set of utilities for debugging of Python programs.

The debugging functionality is defined in a Pdb class. The module internally makes used of bdb and cmd modules.

The pdb module has a very convenient command line interface. It is imported at the time of execution of Python script by using –m switch

python –m pdb script.py

In order to find more about how the debugger works, let us first write a Python module (fact.py) as follows −

```
def fact(x):
   f = 1
   for i in range(1,x+1):
      print (i)
      f = f * i
   return f
if __name__=="__main__":
   print ("factorial of 3=",fact(3))
```

Start debugging this module from command line. In this case the execution halts at first line in the code by showing arrow (->) to its left, and producing debugger prompt (Pdb)

```
C:\python36>python -m pdb fact.py
> c:\python36\fact.py(1)<module>()
```

-> def fact(x):

(Pdb)

Python - 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.

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

The following 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 assig 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 gives 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
```

The following example gives more clear picture. Note that the order of parameters 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. The following example gives an idea on default arguments, it prints 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.

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 holds 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
```

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.
- 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. 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 −

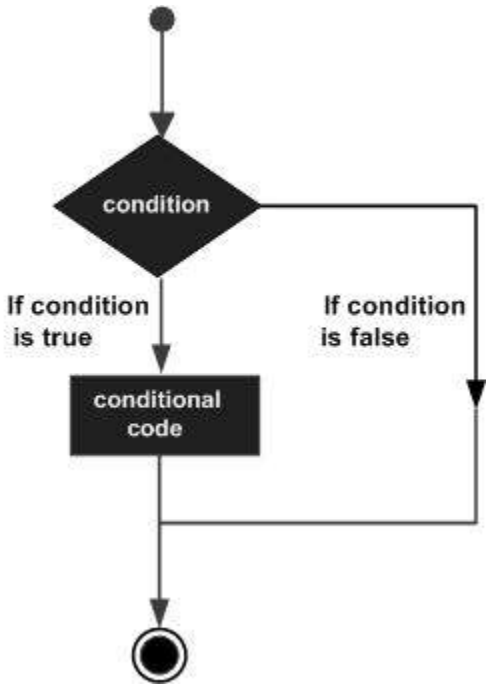
```
Inside the function local total :  30
Outside the function global total :  0
```

Python – Conditional (Decision Making)

Decision making is anticipation of conditions occurring while execution of the program and specifying actions taken according to the conditions.

Decision structures evaluate multiple expressions which produce TRUE or FALSE as outcome. You need to determine which action to take and which statements to execute if outcome is TRUE or FALSE otherwise.

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.

Sr.No.	Statement & Description
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	nested if statements You can use one **if** or **else if** statement inside another **if** or **else if** statement(s).

Python - if, elif, else Conditions

By default, statements in the script are executed sequentially from the first to the last. If the processing logic requires so, the sequential flow can be altered in two ways:

Python uses the if keyword to implement decision control. Python's syntax for executing a block conditionally is as below:

Syntax:

```
if [boolean expression]:
   statement1
   statement2
   ...
   statementN
```

Any Boolean expression evaluating to True or False appears after the if keyword. Use the : symbol and press Enter after the expression to start a block with an increased indent. One or

more statements written with the same level of indent will be executed if the Boolean expression evaluates to True.

To end the block, decrease the indentation. Subsequent statements after the block will be executed out of the if condition. The following example demonstrates the if condition.

Example: if Condition

```
price = 50


if price < 100:
    print("price is less than 100")
```

Output

```
price is less than 100
```

In the above example, the expression price < 100 evaluates to True, so it will execute the block. The if block starts from the new line after : and all the statements under the if condition starts with an increased indentation, either space or tab. Above, the if block contains only one statement. The following example has multiple statements in the if condition.

Example: Multiple Statements in the if Block

```
price = 50
quantity = 5
if price*quantity < 500:
    print("price*quantity is less than 500")
    print("price = ", price)
    print("quantity = ", quantity)
```

Output

```
price*quantity is less than 500
price = 50
quantity = 5
```

Above, the if condition contains multiple statements with the same indentation. If all the statements are not in the same indentation, either space or a tab then it will raise an IdentationError.

Example: Invalid Indentation in the Block

```
price = 50
quantity = 5
if price*quantity < 500:
    print("price is less than 500")
    print("price = ", price)
     print("quantity = ", quantity)
```

Output

```
  print("quantity = ", quantity)
 ^
IdentationError: unexpected indent
```

The statements with the same indentation level as if condition will not consider in the if block. They will consider out of the if condition.

Example: Out of Block Statements

```
price = 50
quantity = 5
if price*quantity < 100:
    print("price is less than 500")
    print("price = ", price)
    print("quantity = ", quantity)
print("No if block executed.")
```

Output

```
No if block executed.
```

The following example demonstrates multiple if conditions.

Example: Multiple if Conditions

```
price = 100

if price > 100:
 print("price is greater than 100")

if price == 100:
  print("price is 100")

if price < 100:
    print("price is less than 100")
```

Output

```
price is 100
```

Notice that each if block contains a statement in a different indentation, and that's valid because they are different from each other.

Note

It is recommended to use 4 spaces or a tab as the default indentation level for more readability.

else Condition

Along with the if statement, the else condition can be optionally used to define an alternate block of statements to be executed if the boolean expression in the if condition evaluates to False.

Syntax:

```
if [boolean expression]:
    statement1
    statement2
    ...
```

```
    statementN
else:
    statement1
    statement2
    ...
    statementN
```

As mentioned before, the indented block starts after the : symbol, after the boolean expression. It will get executed when the condition is True. We have another block that should be executed when the if condition is False. First, complete the if block by a backspace and write else, put add the : symbol in front of the new block to begin it, and add the required statements in the block.

Example: else Condition

```
price = 50


if price >= 100:
    print("price is greater than 100")
else:
    print("price is less than 100")
```

Output

```
price is less than 100
```

In the above example, the if condition price >= 100 is False, so the else block will be executed. The else block can also contain multiple statements with the same indentation; otherwise, it will raise the IndentationError.

Note that you cannot have multiple else blocks, and it must be the last block.

elif Condition

Use the elif condition is used to include multiple conditional expressions after the if condition or between the if and else conditions.

Syntax:

```
if [boolean expression]:
   [statements]
elif [boolean expresion]:
   [statements]
elif [boolean expresion]:
   [statements]
else:
   [statements]
```

The elif block is executed if the specified condition evaluates to True.

Example: if-elif Conditions

```
price = 100


if price > 100:
   print("price is greater than 100")
elif price == 100:
   print("price is 100")
elif price < 100:
   print("price is less than 100")
```

Output

```
price is 100
```

In the above example, the elif conditions are applied after the if condition. Python will evalute the if condition and if it evaluates to False then it will evalute the elif blocks and execute the elif block whose expression evaluates to True. If multiple elif conditions become True, then the first elif block will be executed.

The following example demonstrates if, elif, and else conditions.

Example: if-elif-else Conditions

```
price = 50

if price > 100:
    print("price is greater than 100")
elif price == 100:
    print("price is 100")
else price < 100:
    print("price is less than 100")
```

Output

```
price is less than 100
```

All the if, elif, and else conditions must start from the same indentation level, otherwise it will raise the IndentationError.

Example: Invalid Indentation

```
price = 50

if price > 100:
    print("price is greater than 100")
 elif price == 100:
    print("price is 100")
  else price < 100:
    print("price is less than 100")
```

Output

```
  elif price == 100:
                ^
IdentationError: unindent does not match any outer indentation level
```

Nested if, elif, else Conditions

Python supports nested if, elif, and else condition. The inner condition must be with increased indentation than the outer condition, and all the statements under the one block should be with the same indentation.

Example: Nested if-elif-else Conditions

```
price = 50
quantity = 5
amount = price*quantity

if amount > 100:
    if amount > 500:
        print("Amount is greater than 500")
    else:
        if amount < 500 and amount > 400:
            print("Amount is")
        elif amount < 500 and amount > 300:
            print("Amount is between 300 and 500")
        else:
            print("Amount is between 200 and 500")
elif amount == 100:
    print("Amount is 100")
else:
    print("Amount is less than 100")
```

Output

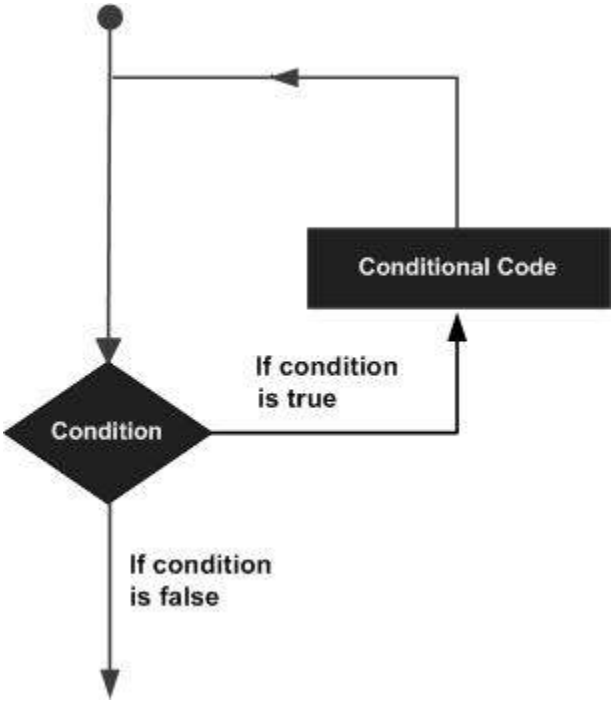
```
Amount is between 200 and 500
```

Python - Iterations (Loops)

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.

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. The following diagram illustrates a loop statement −



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

Sr.No.	Loop Type & Description
1	while loop

	Repeats a statement or group of statements while a given condition is TRUE. It tests the condition before executing the loop body.
2	for loop Executes a sequence of statements multiple times and abbreviates the code that manages the loop variable.
3	nested loops You can use one or more loop inside any another while, for or do..while loop.

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.

Let us go through the loop control statements briefly

Sr.No.	Control Statement & Description
1	break statement Terminates the loop statement and transfers execution to the statement immediately following the loop.
2	continue statement Causes the loop to skip the remainder of its body and immediately retest its condition prior to reiterating.
3	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.

Python while Loop Statements

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 −

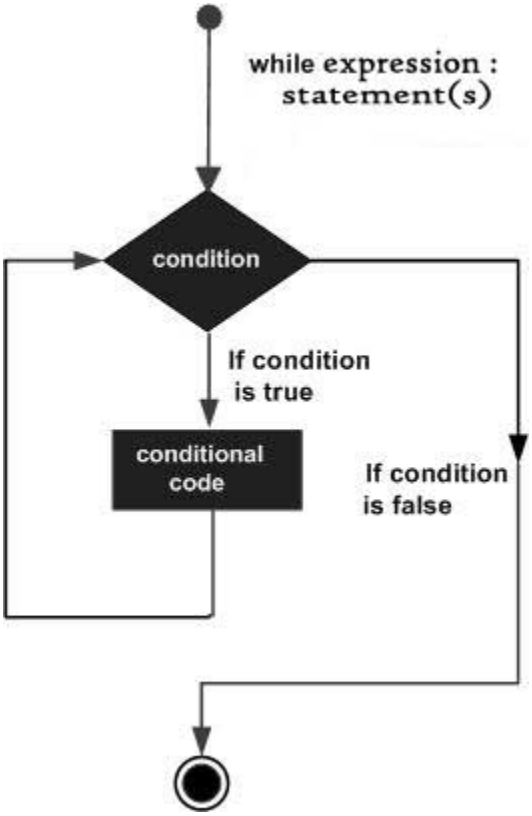
```
while expression:
   statement(s)
```

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 goes in an infinite loop and you need to use CTRL+C to exit the program.

Using else Statement with While Loop

Python supports to have an **else** statement associated with a loop statement.

- 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!"
```

It is better not try above example because it goes into infinite loop and you need to press CTRL+C keys to exit.

Python for Loop Statements

It has the ability to iterate over the items of any sequence, such as a list or a string.

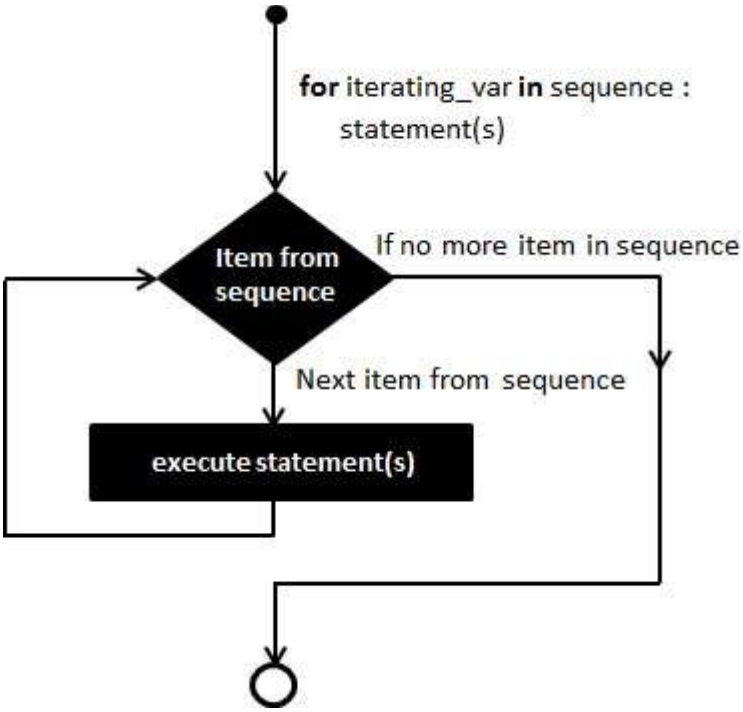
Syntax

```
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



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.

Using else Statement with For Loop

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.

The following example illustrates the combination of an else statement with a for statement that searches for prime numbers from 10 through 20.

Live Demo

```
#!/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'
                        break
```

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

Python nested loops

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

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)
```

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 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!