Python Basic Tutorial

Python Quick Guide

Previous Page Next

Python Overview

Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is be highly readable. It uses English keywords frequently where as other languages use punctua has fewer syntactical constructions than other languages.

- **Python is Interpreted** − Python is processed at runtime by the interpreter. You do compile your program before executing it. This is similar to PERL and PHP.
- **Python is Interactive** − You can actually sit at a Python prompt and interact with the directly to write your programs.
- **Python is Object-Oriented** − Python supports Object-Oriented style or technique of pr that encapsulates code within objects.
- **Python is a Beginner's Language** − Python is a great language for the be programmers and supports the development of a wide range of applications from processing to WWW browsers to games.

History of Python

Python was developed by Guido van Rossum in the late eighties and early nineties at th Research Institute for Mathematics and Computer Science in the Netherlands.

Python is derived from many other languages, including ABC, Modula-3, C, C++, Algol-68, Sm Unix shell and other scripting languages.

Python is copyrighted. Like Perl, Python source code is now available under the GNU Ger License (GPL).

Python is now maintained by a core development team at the institute, although Guido van R holds a vital role in directing its progress.

Python Features

Python's features include −

- **Easy-to-learn** − Python has few keywords, simple structure, and a clearly defined s allows the student to pick up the language quickly.
- **Easy-to-read** − Python code is more clearly defined and visible to the eyes.
- **Easy-to-maintain** − Python's source code is fairly easy-to-maintain.
- **A broad standard library** − Python's bulk of the library is very portable and cro compatible on UNIX, Windows, and Macintosh.
- **Interactive Mode** − Python has support for an interactive mode which allows interac and debugging of snippets of code.
- **Portable** − Python can run on a wide variety of hardware platforms and has the same i all platforms.
- **Extendable** − You can add low-level modules to the Python interpreter. These modu programmers to add to or customize their tools to be more efficient.
- **Databases** − Python provides interfaces to all major commercial databases.
- **GUI Programming** − Python supports GUI applications that can be created and port system calls, libraries and windows systems, such as Windows MFC, Macintosh, Window system of Unix.
- **Scalable** − Python provides a better structure and support for large programs than shell

Apart from the above-mentioned features, Python has a big list of good features, few are listed be

- It supports functional and structured programming methods as well as OOP.
- It can be used as a scripting language or can be compiled to byte-code for bu applications.
- It provides very high-level dynamic data types and supports dynamic type checking.
- It supports automatic garbage collection.
- It can be easily integrated with C, C++, COM, ActiveX, CORBA, and Java.

Python - Environment Setup

Python is available on a wide variety of platforms including Linux and Mac OS X. Let's underst set up our Python environment.

Local Environment Setup

Open a terminal window and type "python" to find out if it is already installed and which version is

- Unix (Solaris, Linux, FreeBSD, AIX, HP/UX, SunOS, IRIX, etc.)
- Win 9x/NT/2000
- Macintosh (Intel, PPC, 68K)
- OS/2
- DOS (multiple versions)
- PalmOS
- Nokia mobile phones
- Windows CE
- Acorn/RISC OS
- BeOS
- Amiga
- VMS/OpenVMS
- QNX
- VxWorks
- Psion
- Python has also been ported to the Java and .NET virtual machines

Getting Python

The most up-to-date and current source code, binaries, documentation, news, etc., is availa official website of Python https://www.python.org/

You can download Python documentation from https://www.python.org/doc/. The docum available in HTML, PDF, and PostScript formats.

Installing Python

Python distribution is available for a wide variety of platforms. You need to download only the applicable for your platform and install Python.

If the binary code for your platform is not available, you need a C compiler to compile the s manually. Compiling the source code offers more flexibility in terms of choice of features that yo your installation.

Here is a quick overview of installing Python on various platforms −

Unix and Linux Installation

Here are the simple steps to install Python on Unix/Linux machine.

- Open a Web browser and go to https://www.python.org/downloads/ .

- Follow the link to download zipped source code available for Unix/Linux.
- Download and extract files.
- Editing the *Modules/Setup* file if you want to customize some options.
- run ./configure script
- make
- make install

This installs Python at standard location */usr/local/bin* and its libraries at */usr/local/lib/pythonXX* \
the version of Python.

Windows Installation

Here are the steps to install Python on Windows machine.

- Open a Web browser and go to https://www.python.org/downloads/ .
- Follow the link for the Windows installer *python-XYZ.msi* file where XYZ is the version \
install.
- To use this installer *python-XYZ.msi*, the Windows system must support Microsoft I\
Save the installer file to your local machine and then run it to find out if your machine su
- Run the downloaded file. This brings up the Python install wizard, which is really easy \
accept the default settings, wait until the install is finished, and you are done.

Macintosh Installation

Recent Macs come with Python installed, but it may be several years out of \
http://www.python.org/download/mac/ for instructions on getting the current version along with\
to support development on the Mac. For older Mac OS's before Mac OS X 10.3 (release\
MacPython is available.

Jack Jansen maintains it and you can have full access to the entire documentation at his\
http://www.cwi.nl/~jack/macpython.html . You can find complete installation details fo\
installation.

Setting up PATH

Programs and other executable files can be in many directories, so operating systems provic\
path that lists the directories that the OS searches for executables.

The path is stored in an environment variable, which is a named string maintained by the operat\
This variable contains information available to the command shell and other programs.

The **path** variable is named as PATH in Unix or Path in Windows (Unix is case sensitive; Windo\

In Mac OS, the installer handles the path details. To invoke the Python interpreter from an directory, you must add the Python directory to your path.

Setting path at Unix/Linux

To add the Python directory to the path for a particular session in Unix −

- **In the csh shell** − type setenv PATH "$PATH:/usr/local/bin/python" and press Enter.
- **In the bash shell (Linux)** − type export PATH="$PATH:/usr/local/bin/python" and press
- **In the sh or ksh shell** − type PATH="$PATH:/usr/local/bin/python" and press Enter.
- **Note** − /usr/local/bin/python is the path of the Python directory

Setting path at Windows

To add the Python directory to the path for a particular session in Windows −

At the command prompt − type path %path%;C:\Python and press Enter.

Note − C:\Python is the path of the Python directory

Python Environment Variables

Here are important environment variables, which can be recognized by Python −

Sr.No.	Variable & Description
1	**PYTHONPATH** It has a role similar to PATH. This variable tells the Python interpreter where to module files imported into a program. It should include the Python source library dire the directories containing Python source code. PYTHONPATH is sometimes pres Python installer.
2	**PYTHONSTARTUP** It contains the path of an initialization file containing Python source code. It is execu time you start the interpreter. It is named as .pythonrc.py in Unix and it contains comn load utilities or modify PYTHONPATH.
3	**PYTHONCASEOK** It is used in Windows to instruct Python to find the first case-insensitive match in statement. Set this variable to any value to activate it.

4	**PYTHONHOME** It is an alternative module search path. It is usually embedded in the PYTHONST/ PYTHONPATH directories to make switching module libraries easy.

Running Python

There are three different ways to start Python −

Interactive Interpreter

You can start Python from Unix, DOS, or any other system that provides you a command-line ir shell window.

Enter **python** the command line.

Start coding right away in the interactive interpreter.

```
$python # Unix/Linux
or
python% # Unix/Linux
or
C:> python # Windows/DOS
```

Here is the list of all the available command line options −

Sr.No.	Option & Description
1	**-d** It provides debug output.
2	**-O** It generates optimized bytecode (resulting in .pyo files).
3	**-S** Do not run import site to look for Python paths on startup.
4	**-v** verbose output (detailed trace on import statements).
5	**-X**

	disable class-based built-in exceptions (just use strings); obsolete starting with versio
6	**-c cmd** run Python script sent in as cmd string
7	**file** run Python script from given file

Script from the Command-line

A Python script can be executed at command line by invoking the interpreter on your applicatio following −

```
$python script.py # Unix/Linux

or

python% script.py # Unix/Linux

or

C: >python script.py # Windows/DOS
```

Note − Be sure the file permission mode allows execution.

Integrated Development Environment

You can run Python from a Graphical User Interface (GUI) environment as well, if you h application on your system that supports Python.

- **Unix** − IDLE is the very first Unix IDE for Python.
- **Windows** − PythonWin is the first Windows interface for Python and is an IDE with a GU
- **Macintosh** − The Macintosh version of Python along with the IDLE IDE is available fro website, downloadable as either MacBinary or BinHex'd files.

If you are not able to set up the environment properly, then you can take help from your sys Make sure the Python environment is properly set up and working perfectly fine.

Note − All the examples given in subsequent chapters are executed with Python 2.4.3 version a CentOS flavor of Linux.

We already have set up Python Programming environment online, so that you can execute all th

examples online at the same time when you are learning theory. Feel free to modify any ex execute it online.

Python - Basic Syntax

The Python language has many similarities to Perl, C, and Java. However, there are so differences between the languages.

First Python Program

Let us execute programs in different modes of programming.

Interactive Mode Programming

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

```
$ 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 at the Python prompt and press the Enter −

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

If you are running new version of Python, then you would need to use print statement with paren **print ("Hello, Python!");**. However in Python version 2.4.3, this produces the following result −

```
Hello, Python!
```

Script Mode Programming

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

Let us write a simple Python program in a script. Python files have extension **.py**. Type the follo code in a test.py file −

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

We assume that you have Python interpreter set in PATH variable. Now, try to run this program a

```
$ python test.py
```

This produces the following result −

```
Hello, Python!
```

Let us try another way to execute a Python script. Here is the modified test.py file −

```
#!/usr/bin/python

print "Hello, Python!"
```

We assume that you have Python interpreter available in /usr/bin directory. Now, try to run this follows −

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

This produces the following result −

```
Hello, Python!
```

Python Identifiers

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

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

Here are naming conventions for Python identifiers −

- Class names start with an uppercase letter. All other identifiers start with a lowercase let
- Starting an identifier with a single leading underscore indicates that the identifier is priva
- 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-defi name.

Reserved Words

The following list shows the Python keywords. These are reserved words and you cannot us constant or variable or any other identifier names. All the Python keywords contain lowercase lett

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

Python provides no braces to indicate blocks of code for class and function definitions or fl
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 i
same amount. For example −

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

However, the following block generates an error −

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

Thus, in Python all the continuous lines indented with same number of spaces would form a
following example has various statement blocks −

Note − Do not try to understand the logic at this point of time. Just make sure you understo
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 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 ch example −

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

Quotation in Python

Python accepts single ('), double (") and triple ('' or """) quotes to denote string literals, as long a type of quote starts and ends the string.

The triple quotes are used to span the string across multiple lines. For example, all the following

```
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 # ar 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.
```

Using Blank Lines

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

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

Waiting for the User

The following line of the program displays the prompt, the statement saying “Press the enter k 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 press the program ends. This is a nice trick to keep a console window open until the user is do application.

Multiple Statements on a Single Line

The semicolon (;) allows multiple statements on the single line given that neither statement s 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. C 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 follo 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 sho 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. Com Arguments is an advanced topic and should be studied a bit later once you have gone thro the Python concepts.

Python - Variable Types

Variables are nothing but reserved memory locations to store values. This means that when y variable you reserve some space in memory.

Based on the data type of a variable, the interpreter allocates memory and decides what can b the reserved memory. Therefore, by assigning different data types to variables, you can sto decimals or characters in these variables.

Assigning Values to Variables

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

The operand to the left of the = operator is the name of the variable and the operand to the ri 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, r This produces 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 sa 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 respectively, an 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 nu and his or her address is stored as alphanumeric characters. Python has various standard data 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. Number objects are created when you assign a value t
example −

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

You can also delete the reference to a number object by using the del statement. The syntax
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, they 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	co
10	51924361L	0.0	3
100	-0x19323L	15.20	
-786	0122L	-21.9	9.32
080	0xDEFABCECBDAECBFBAEl	32.3+e18	.

-0490	535633629843L	-90.	-.65
-0x260	-052318172735L	-32.54e100	3e
0x69	-4721885298529L	70.2-E12	4.5

- Python allows you to use a lowercase l with long, but it is recommended that you u uppercase L to avoid confusion with the number 1. Python displays long intege uppercase L.
- A complex number consists of an ordered pair of real floating-point numbers denote where x and y are the real numbers and j is the imaginary unit.

Python Strings

Strings in Python are identified as a contiguous set of characters represented in the quota Python allows for either pairs of single or double quotes. Subsets of strings can be taken usi operator ([ ] and [:]) with indexes starting at 0 in the beginning of the string and working their wa the end.

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

and enclosed within square brackets ([]). To some extent, lists are similar to arrays in C. One 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 sta the beginning of the list and working their way to end -1. The plus (+) sign is the list concatenati 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 produce the following result −

```
['abcd', 786, 2.23, 'john', 70.2]
abcd
[786, 2.23]
[2.23, 'john', 70.2]
[123, 'john', 123, 'john']
['abcd', 786, 2.23, 'john', 70.2, 123, 'john']
```

Python Tuples

A tuple is another sequence data type that is similar to the list. A tuple consists of a numbe 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 the and size can be changed, while tuples are enclosed in parentheses (( )) and cannot be upda 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 produce the following result −

```
('abcd', 786, 2.23, 'john', 70.2)
abcd
(786, 2.23)
(2.23, 'john', 70.2)
(123, 'john', 123, 'john')
('abcd', 786, 2.23, 'john', 70.2, 123, 'john')
```

The following code is invalid with tuple, because we attempted to update a tuple, which is r
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 fo
and consist of key-value pairs. A dictionary key can be almost any Python type, but are usually
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 us
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 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

order"; they are simply unordered.

Data Type Conversion

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

There are several built-in functions to perform conversion from one data type to another. Thes return a new object representing the converted value.

Sr.No.	Function & Description
1	**int(x [,base])** Converts x to an integer. base specifies the base if x is a string.
2	**long(x [,base])** Converts x to a long integer. base specifies the base if x is a string.
3	**float(x)** Converts x to a floating-point number.
4	**complex(real [,imag])** Creates a complex number.
5	**str(x)** Converts object x to a string representation.
6	**repr(x)** Converts object x to an expression string.
7	**eval(str)** Evaluates a string and returns an object.
8	**tuple(s)** Converts s to a tuple.

9	**list(s)** Converts s to a list.
10	**set(s)** Converts s to a set.
11	**dict(d)** Creates a dictionary. d must be a sequence of (key,value) tuples.
12	**frozenset(s)** Converts s to a frozen set.
13	**chr(x)** Converts an integer to a character.
14	**unichr(x)** Converts an integer to a Unicode character.
15	**ord(x)** Converts a single character to its integer value.
16	**hex(x)** Converts an integer to a hexadecimal string.
17	**oct(x)** Converts an integer to an octal string.

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 −

[Show Example]

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
* Multiplication	Multiplies values on either side of the operator	a * b = 200
/ 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
//	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, -1 -11.0//3 = -4.0

Python Comparison Operators

These operators compare the values on either sides of them and decide the relation among ther also called Relational operators.

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

[Show Example]

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 !=
>	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 −

[Show Example]

Operator	Description	Example
=	Assigns values from right side operands to left side operand	c = a + b assigns value of a + b int

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

Python Bitwise Operators

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

a = 0011 1100

b = 0000 1101

---

a&b = 0000 1100

a|b = 0011 1101

a^b = 0011 0001

~a = 1100 0011

There are following Bitwise operators supported by Python language

[Show Example]

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 i complement form due to a sign 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 000
>> 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 ho variable b holds 20 then

[Show Example]

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.

Used to reverse the logical state of its operand.

Python Membership Operators

Python’s membership operators test for membership in a sequence, such as strings, lists, or tu are two membership operators as explained below −

[Show Example]

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 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 a member of sequence y.

Python Identity Operators

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

[Show Example]

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) ec
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 not equal to id(y).

Python Operators Precedence

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

[Show Example]

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	*** / % //**

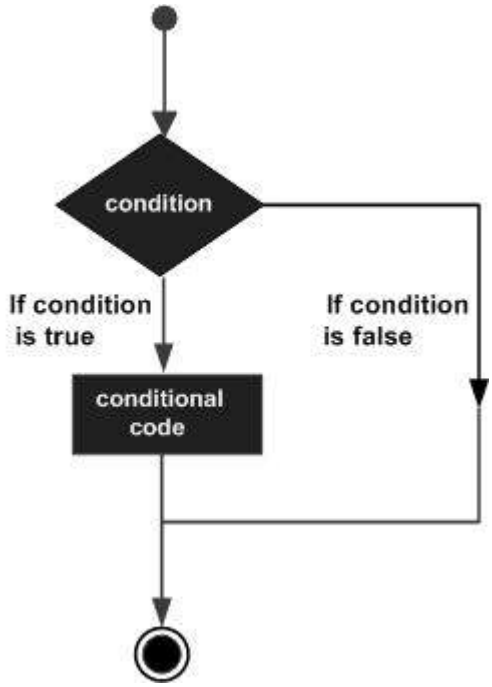
	Multiply, divide, modulo and floor division
4	**+ -** Addition and subtraction
5	**>> <<** Right and left bitwise shift
6	**&** Bitwise 'AND'
7	**^ |** Bitwise exclusive `OR' and regular `OR'
8	**<= < > >=** Comparison operators
9	**<> == !=** Equality operators
10	**= %= /= //= -= += *= **=** Assignment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

Python - Decision Making

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

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

Following is the general form of a typical decision making structure found in most of the pr languages −



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

Python programming language provides following types of decision making statements. Click th 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 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).

Let us go through each decision making briefly −

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

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 −

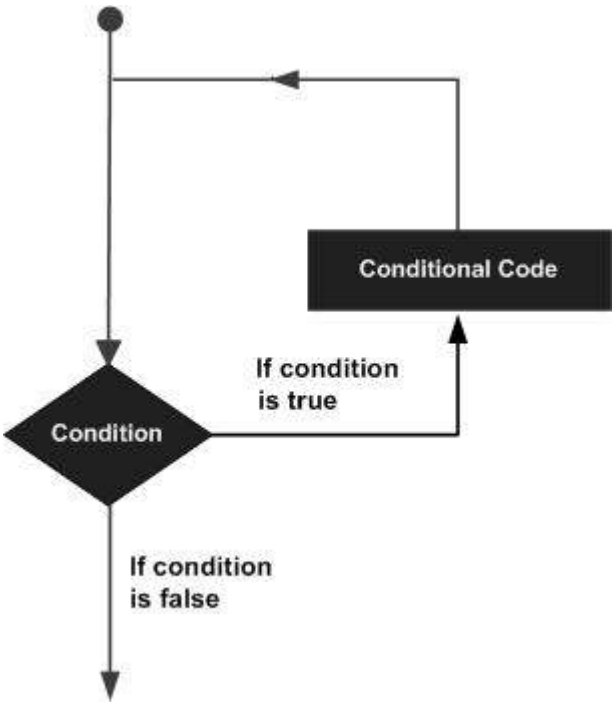
```
Value of expression is 100
Good bye!
```

Python - Loops

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

Programming languages provide various control structures that allow for more complicated execu

A loop statement allows us to execute a statement or group of statements multiple times. Th
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 condition before executing the loop body.
2	**for loop** Executes a sequence of statements multiple times and abbreviates the code that ma 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 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 immediatel the loop.
2	**continue statement** Causes the loop to skip the remainder of its body and immediately retest its conditi reiterating.
3	**pass statement** The pass statement in Python is used when a statement is required syntactically but want any command or code to execute.

Python - Numbers

Number data types store numeric values. They are immutable data types, means that changing 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 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)** − They are often called just integers or ints, are positive or neg numbers with no decimal point.
- **long (long integers)** − Also called longs, they are integers of unlimited size, written l and followed by an uppercase or lowercase L.
- **float (floating point real values)** − Also called floats, they represent real numbers and with a decimal point dividing the integer and fractional parts. Floats may also be notation, with E or e indicating the power of 10 (2.5e2 = 2.5 x 10^2 = 250).
- **complex (complex numbers)** − are of the form a + bJ, where a and b are floats represents the square root of -1 (which is an imaginary number). The real part of the n and the imaginary part is b. Complex numbers are not used much in Python programmi

Examples

Here are some examples of numbers

int	long	float	co
10	51924361L	0.0	3
100	-0x19323L	15.20	
-786	0122L	-21.9	9.3
080	0xDEFABCECBDAECBFBAEL	32.3+e18	.
-0490	535633629843L	-90.	-.6
-0x260	-052318172735L	-32.54e100	3e

0x69	-4721885298529L	70.2-E12	4.!

- Python allows you to use a lowercase L with long, but it is recommended that you u uppercase L to avoid confusion with the number 1. Python displays long intege uppercase L.
- A complex number consists of an ordered pair of real floating point numbers denote where a is the real part and b is the imaginary part of the complex number.

Number Type Conversion

Python converts numbers internally in an expression containing mixed types to a comm evaluation. But sometimes, you need to coerce a number explicitly from one type to another to requirements of an operator or function parameter.

- Type **int(x)** to convert x to a plain integer.
- Type **long(x)** to convert x to a long integer.
- Type **float(x)** to convert x to a floating-point number.
- Type **complex(x)** to convert x to a complex number with real part x and imaginary part z
- Type **complex(x, y)** to convert x and y to a complex number with real part x and imagin and y are numeric expressions

Mathematical Functions

Python includes following functions that perform mathematical calculations.

Sr.No.	Function & Returns (description)
1	**abs(x)** The absolute value of x: the (positive) distance between x and zero.
2	**ceil(x)** The ceiling of x: the smallest integer not less than x
3	**cmp(x, y)** -1 if x < y, 0 if x == y, or 1 if x > y
4	**exp(x)** The exponential of x: e^x

5	**fabs(x)** The absolute value of x.
6	**floor(x)** The floor of x: the largest integer not greater than x
7	**log(x)** The natural logarithm of x, for x> 0
8	**log10(x)** The base-10 logarithm of x for x> 0.
9	**max(x1, x2,...)** The largest of its arguments: the value closest to positive infinity
10	**min(x1, x2,...)** The smallest of its arguments: the value closest to negative infinity
11	**modf(x)** The fractional and integer parts of x in a two-item tuple. Both parts have the same The integer part is returned as a float.
12	**pow(x, y)** The value of x**y.
13	**round(x [,n])** **x** rounded to n digits from the decimal point. Python rounds away from zero as a ti round(0.5) is 1.0 and round(-0.5) is -1.0.
14	**sqrt(x)** The square root of x for x > 0

Random Number Functions

Random numbers are used for games, simulations, testing, security, and privacy applicatic includes following functions that are commonly used.

Sr.No.	Function & Description

1	**choice(seq)** A random item from a list, tuple, or string.
2	**randrange ([start,] stop [,step])** A randomly selected element from range(start, stop, step)
3	**random()** A random float r, such that 0 is less than or equal to r and r is less than 1
4	**seed([x])** Sets the integer starting value used in generating random numbers. Call this funct calling any other random module function. Returns None.
5	**shuffle(lst)** Randomizes the items of a list in place. Returns None.
6	**uniform(x, y)** A random float r, such that x is less than or equal to r and r is less than y

Trigonometric Functions

Python includes following functions that perform trigonometric calculations.

Sr.No.	Function & Description
1	**acos(x)** Return the arc cosine of x, in radians.
2	**asin(x)** Return the arc sine of x, in radians.
3	**atan(x)** Return the arc tangent of x, in radians.
4	**atan2(y, x)** Return atan(y / x), in radians.
5	**cos(x)** Return the cosine of x radians.

6	**hypot(x, y)** Return the Euclidean norm, sqrt(x*x + y*y).
7	**sin(x)** Return the sine of x radians.
8	**tan(x)** Return the tangent of x radians.
9	**degrees(x)** Converts angle x from radians to degrees.
10	**radians(x)** Converts angle x from degrees to radians.

Mathematical Constants

The module also defines two mathematical constants −

Sr.No.	Constants & Description
1	**pi** The mathematical constant pi.
2	**e** The mathematical constant e.

Python - Strings

Strings are amongst the most popular types in Python. We can create them simply by enclosing in quotes. Python treats single quotes the same as double quotes. Creating strings is as assigning a value to a variable. For example −

```
var1 = 'Hello World!'
var2 = "Python Programming"
```

Accessing Values in Strings

Python does not support a character type; these are treated as strings of length one, thus also c

substring.

To access substrings, use the square brackets for slicing along with the index or indices to substring. For example −

```
#!/usr/bin/python

var1 = 'Hello World!'
var2 = "Python Programming"

print "var1[0]: ", var1[0]
print "var2[1:5]: ", var2[1:5]
```

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

```
var1[0]:  H
var2[1:5]:  ytho
```

Updating Strings

You can "update" an existing string by (re)assigning a variable to another string. The new va related to its previous value or to a completely different string altogether. For example −

```
#!/usr/bin/python

var1 = 'Hello World!'
print "Updated String :- ", var1[:6] + 'Python'
```

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

```
Updated String :-  Hello Python
```

Escape Characters

Following table is a list of escape or non-printable characters that can be represented with notation.

An escape character gets interpreted; in a single quoted as well as double quoted strings.

Backslash notation	Hexadecimal character	Description
\a	0x07	Bell or alert
\b	0x08	Backspace
\cx		Control-x
\C-x		Control-x

\e	0x1b	Escape
\f	0x0c	Formfeed
\M-\C-x		Meta-Control-x
\n	0x0a	Newline
\nnn		Octal notation, where n is in the range
\r	0x0d	Carriage return
\s	0x20	Space
\t	0x09	Tab
\v	0x0b	Vertical tab
\x		Character x
\xnn		Hexadecimal notation, where n is in the range A.F

String Special Operators

Assume string variable **a** holds 'Hello' and variable **b** holds 'Python', then −

Operator	Description	Example
+	Concatenation - Adds values on either side of the operator	a + b will give HelloPytho
*	Repetition - Creates new strings, concatenating multiple copies of the same string	a*2 will give -HelloHello
[]	Slice - Gives the character from the given index	a[1] will give e
[:]	Range Slice - Gives the characters from the given range	a[1:4] will give ell
in	Membership - Returns true if a character exists in the given string	H in a will give 1
not in	Membership - Returns true if a character does not exist in the given string	M not in a will give 1

r/R	Raw String - Suppresses actual meaning of Escape characters. The syntax for raw strings is exactly the same as for normal strings with the exception of the raw string operator, the letter "r," which precedes the quotation marks. The "r" can be lowercase (r) or uppercase (R) and must be placed immediately preceding the first quote mark.	print r'\n' prints \n and print R'\n'
%	Format - Performs String formatting	See at next section

String Formatting Operator

One of Python's coolest features is the string format operator %. This operator is unique to makes up for the pack of having functions from C's printf() family. Following is a simple example -

```
#!/usr/bin/python

print "My name is %s and weight is %d kg!" % ('Zara', 21)
```

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

```
My name is Zara and weight is 21 kg!
```

Here is the list of complete set of symbols which can be used along with % −

Format Symbol	Conversion
%c	character
%s	string conversion via str() prior to formatting
%i	signed decimal integer
%d	signed decimal integer
%u	unsigned decimal integer
%o	octal integer
%x	hexadecimal integer (lowercase letters)
%X	hexadecimal integer (UPPERcase letters)
%e	exponential notation (with lowercase 'e')
%E	exponential notation (with UPPERcase 'E')

%f	floating point real number
%g	the shorter of %f and %e
%G	the shorter of %f and %E

Other supported symbols and functionality are listed in the following table −

Symbol	Functionality
*	argument specifies width or precision
-	left justification
+	display the sign
<sp>	leave a blank space before a positive number
#	add the octal leading zero ('0') or hexadecimal leading '0x' or ' depending on whether 'x' or 'X' were used.
0	pad from left with zeros (instead of spaces)
%	'%%' leaves you with a single literal '%'
(var)	mapping variable (dictionary arguments)
m.n.	m is the minimum total width and n is the number of digits to dis the decimal point (if appl.)

Triple Quotes

Python's triple quotes comes to the rescue by allowing strings to span multiple lines, includi NEWLINEs, TABs, and any other special characters.

The syntax for triple quotes consists of three consecutive **single or double** quotes.

```
#!/usr/bin/python

para_str = """this is a long string that is made up of
several lines and non-printable characters such as
TAB ( \t ) and they will show up that way when displayed.
NEWLINEs within the string, whether explicitly given like
this within the brackets [ \n ], or just a NEWLINE within
the variable assignment will also show up.
"""
print para_str
```

When the above code is executed, it produces the following result. Note how every single speci has been converted to its printed form, right down to the last NEWLINE at the end of the string b "up." and closing triple quotes. Also note that NEWLINEs occur either with an explicit carriage r end of a line or its escape code (\n) −

```
this is a long string that is made up of
several lines and non-printable characters such as
TAB (    ) and they will show up that way when displayed.
NEWLINEs within the string, whether explicitly given like
this within the brackets [
 ], or just a NEWLINE within
the variable assignment will also show up.
```

Raw strings do not treat the backslash as a special character at all. Every character you put into stays the way you wrote it −

```
#!/usr/bin/python

print 'C:\\nowhere'
```

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

```
C:\nowhere
```

Now let's make use of raw string. We would put expression in **r'expression'** as follows −

```
#!/usr/bin/python

print r'C:\\nowhere'
```

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

```
C:\\nowhere
```

Unicode String

Normal strings in Python are stored internally as 8-bit ASCII, while Unicode strings are store Unicode. This allows for a more varied set of characters, including special characters from mos in the world. I'll restrict my treatment of Unicode strings to the following −

```
#!/usr/bin/python

print u'Hello, world!'
```

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

```
Hello, world!
```

As you can see, Unicode strings use the prefix u, just as raw strings use the prefix r.

Built-in String Methods

Python includes the following built-in methods to manipulate strings −

Sr.No.	Methods with Description
1	**capitalize()** Capitalizes first letter of string
2	**center(width, fillchar)** Returns a space-padded string with the original string centered to a total of width col
3	**count(str, beg= 0,end=len(string))** Counts how many times str occurs in string or in a substring of string if starting inde ending index end are given.
4	**decode(encoding='UTF-8',errors='strict')** Decodes the string using the codec registered for encoding. encoding defaults to t string encoding.
5	**encode(encoding='UTF-8',errors='strict')** Returns encoded string version of string; on error, default is to raise a ValueError unl is given with 'ignore' or 'replace'.
6	**endswith(suffix, beg=0, end=len(string))** Determines if string or a substring of string (if starting index beg and ending inde given) ends with suffix; returns true if so and false otherwise.
7	**expandtabs(tabsize=8)** Expands tabs in string to multiple spaces; defaults to 8 spaces per tab if tabsize not
8	**find(str, beg=0 end=len(string))** Determine if str occurs in string or in a substring of string if starting index beg a index end are given returns index if found and -1 otherwise.
9	**index(str, beg=0, end=len(string))** Same as find(), but raises an exception if str not found.

10	**isalnum()** Returns true if string has at least 1 character and all characters are alphanumeric otherwise.
11	**isalpha()** Returns true if string has at least 1 character and all characters are alphabetic otherwise.
12	**isdigit()** Returns true if string contains only digits and false otherwise.
13	**islower()** Returns true if string has at least 1 cased character and all cased characters are in and false otherwise.
14	**isnumeric()** Returns true if a unicode string contains only numeric characters and false otherwise
15	**isspace()** Returns true if string contains only whitespace characters and false otherwise.
16	**istitle()** Returns true if string is properly "titlecased" and false otherwise.
17	**isupper()** Returns true if string has at least one cased character and all cased characte uppercase and false otherwise.
18	**join(seq)** Merges (concatenates) the string representations of elements in sequence seq int with separator string.
19	**len(string)** Returns the length of the string
20	**ljust(width[, fillchar])** Returns a space-padded string with the original string left-justified to a total of width

21	**lower()** Converts all uppercase letters in string to lowercase.
22	**lstrip()** Removes all leading whitespace in string.
23	**maketrans()** Returns a translation table to be used in translate function.
24	**max(str)** Returns the max alphabetical character from the string str.
25	**min(str)** Returns the min alphabetical character from the string str.
26	**replace(old, new [, max])** Replaces all occurrences of old in string with new or at most max occurrences if max
27	**rfind(str, beg=0,end=len(string))** Same as find(), but search backwards in string.
28	**rindex(str, beg=0, end=len(string))** Same as index(), but search backwards in string.
29	**rjust(width,[, fillchar])** Returns a space-padded string with the original string right-justified to a total of width
30	**rstrip()** Removes all trailing whitespace of string.
31	**split(str="", num=string.count(str))** Splits string according to delimiter str (space if not provided) and returns list of substr into at most num substrings if given.
32	**splitlines(num=string.count('\n'))** Splits string at all (or num) NEWLINEs and returns a list of each line with N removed.

33	**startswith(str, beg=0,end=len(string))** Determines if string or a substring of string (if starting index beg and ending inde given) starts with substring str; returns true if so and false otherwise.
34	**strip([chars])** Performs both lstrip() and rstrip() on string.
35	**swapcase()** Inverts case for all letters in string.
36	**title()** Returns "titlecased" version of string, that is, all words begin with uppercase and th lowercase.
37	**translate(table, deletechars="")** Translates string according to translation table str(256 chars), removing those in the
38	**upper()** Converts lowercase letters in string to uppercase.
39	**zfill (width)** Returns original string leftpadded with zeros to a total of width characters; int numbers, zfill() retains any sign given (less one zero).
40	**isdecimal()** Returns true if a unicode string contains only decimal characters and false otherwise

Python - Lists

The most basic data structure in Python is the **sequence**. Each element of a sequence is number - its position or index. The first index is zero, the second index is one, and so forth.

Python has six built-in types of sequences, but the most common ones are lists and tuples, whic see in this tutorial.

There are certain things you can do with all sequence types. These operations include index adding, multiplying, and checking for membership. In addition, Python has built-in functions for length of a sequence and for finding its largest and smallest elements.

Python Lists

The list is a most versatile datatype available in Python which can be written as a list of comma values (items) between square brackets. Important thing about a list is that items in a list need n same type.

Creating a list is as simple as putting different comma-separated values between square br example −

```
list1 = ['physics', 'chemistry', 1997, 2000];
list2 = [1, 2, 3, 4, 5 ];
list3 = ["a", "b", "c", "d"]
```

Similar to string indices, list indices start at 0, and lists can be sliced, concatenated and so on.

Accessing Values in Lists

To access values in lists, use the square brackets for slicing along with the index or indices to c available at that index. For example −

```
#!/usr/bin/python

list1 = ['physics', 'chemistry', 1997, 2000];
list2 = [1, 2, 3, 4, 5, 6, 7 ];
print "list1[0]: ", list1[0]
print "list2[1:5]: ", list2[1:5]
```

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

```
list1[0]:  physics
list2[1:5]:  [2, 3, 4, 5]
```

Updating Lists

You can update single or multiple elements of lists by giving the slice on the left-hand side of the operator, and you can add to elements in a list with the append() method. For example −

```
#!/usr/bin/python

list = ['physics', 'chemistry', 1997, 2000];
print "Value available at index 2 : "
print list[2]
list[2] = 2001;
print "New value available at index 2 : "
print list[2]
```

Note − append() method is discussed in subsequent section.

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

```
Value available at index 2 :
```

```
1997
New value available at index 2 :
2001
```

Delete List Elements

To remove a list element, you can use either the del statement if you know exactly which elemen deleting or the remove() method if you do not know. For example −

```
#!/usr/bin/python

list1 = ['physics', 'chemistry', 1997, 2000];
print list1
del list1[2];
print "After deleting value at index 2 : "
print list1
```

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

```
['physics', 'chemistry', 1997, 2000]
After deleting value at index 2 :
['physics', 'chemistry', 2000]
```

Note − remove() method is discussed in subsequent section.

Basic List Operations

Lists respond to the + and * operators much like strings; they mean concatenation and repetitic except that the result is a new list, not a string.

In fact, lists respond to all of the general sequence operations we used on strings in the prior cha

Python Expression	Results	Description
len([1, 2, 3])	3	Length
[1, 2, 3] + [4, 5, 6]	[1, 2, 3, 4, 5, 6]	Concatenatio
['Hi!'] * 4	['Hi!', 'Hi!', 'Hi!', 'Hi!']	Repetition
3 in [1, 2, 3]	True	Membership
for x in [1, 2, 3]: print x,	1 2 3	Iteration

Indexing, Slicing, and Matrixes

Because lists are sequences, indexing and slicing work the same way for lists as they do for strin

Assuming following input −

```
L = ['spam', 'Spam', 'SPAM!']
```

Python Expression	Results	Description
L[2]	SPAM!	Offsets start at z
L[-2]	Spam	Negative: count from
L[1:]	['Spam', 'SPAM!']	Slicing fetches se

Built-in List Functions & Methods

Python includes the following list functions −

Sr.No.	Function with Description
1	**cmp(list1, list2)** Compares elements of both lists.
2	**len(list)** Gives the total length of the list.
3	**max(list)** Returns item from the list with max value.
4	**min(list)** Returns item from the list with min value.
5	**list(seq)** Converts a tuple into list.

Python includes following list methods

Sr.No.	Methods with Description
1	**list.append(obj)** Appends object obj to list
2	**list.count(obj)** Returns count of how many times obj occurs in list

Python - Tuples

A tuple is a sequence of immutable Python objects. Tuples are sequences, just like lists. The between tuples and lists are, the tuples cannot be changed unlike lists and tuples use p whereas lists use square brackets.

Creating a tuple is as simple as putting different comma-separated values. Optionally you ca comma-separated values between parentheses also. For example −

```
tup1 = ('physics', 'chemistry', 1997, 2000);
tup2 = (1, 2, 3, 4, 5 );
tup3 = "a", "b", "c", "d";
```

The empty tuple is written as two parentheses containing nothing −

```
tup1 = ();
```

To write a tuple containing a single value you have to include a comma, even though there is onl −

```
tup1 = (50,);
```

Like string indices, tuple indices start at 0, and they can be sliced, concatenated, and so on.

Accessing Values in Tuples

To access values in tuple, use the square brackets for slicing along with the index or indices to c available at that index. For example −

```
#!/usr/bin/python

tup1 = ('physics', 'chemistry', 1997, 2000);
tup2 = (1, 2, 3, 4, 5, 6, 7 );
print "tup1[0]: ", tup1[0];
print "tup2[1:5]: ", tup2[1:5];
```

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

```
tup1[0]:  physics
tup2[1:5]:  [2, 3, 4, 5]
```

Updating Tuples

Tuples are immutable which means you cannot update or change the values of tuple elements. Y to take portions of existing tuples to create new tuples as the following example demonstrates −

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

```
tup1 = (12, 34.56);
tup2 = ('abc', 'xyz');

# Following action is not valid for tuples
# tup1[0] = 100;

# So let's create a new tuple as follows
tup3 = tup1 + tup2;
print tup3;
```

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

```
(12, 34.56, 'abc', 'xyz')
```

Delete Tuple Elements

Removing individual tuple elements is not possible. There is, of course, nothing wrong with putti another tuple with the undesired elements discarded.

To explicitly remove an entire tuple, just use the **del** statement. For example −

```
#!/usr/bin/python

tup = ('physics', 'chemistry', 1997, 2000);
print tup;
del tup;
print "After deleting tup : ";
print tup;
```

This produces the following result. Note an exception raised, this is because after **del tup** tup exist any more −

```
('physics', 'chemistry', 1997, 2000)
After deleting tup :
Traceback (most recent call last):
   File "test.py", line 9, in <module>
      print tup;
NameError: name 'tup' is not defined
```

Basic Tuples Operations

Tuples respond to the + and * operators much like strings; they mean concatenation and repetiti except that the result is a new tuple, not a string.

In fact, tuples respond to all of the general sequence operations we used on strings in the prior c

Python Expression	Results	Descrip
len((1, 2, 3))	3	Lengt

(1, 2, 3) + (4, 5, 6)	(1, 2, 3, 4, 5, 6)	Concaten
('Hi!',) * 4	('Hi!', 'Hi!', 'Hi!', 'Hi!')	Repetit
3 in (1, 2, 3)	True	Member
for x in (1, 2, 3): print x,	1 2 3	Iteratic

Indexing, Slicing, and Matrixes

Because tuples are sequences, indexing and slicing work the same way for tuples as they do Assuming following input −

```
L = ('spam', 'Spam', 'SPAM!')
```

Python Expression	Results	Description
L[2]	'SPAM!'	Offsets start at z
L[-2]	'Spam'	Negative: count from
L[1:]	['Spam', 'SPAM!']	Slicing fetches se

No Enclosing Delimiters

Any set of multiple objects, comma-separated, written without identifying symbols, i.e., bracke parentheses for tuples, etc., default to tuples, as indicated in these short examples −

```
#!/usr/bin/python

print 'abc', -4.24e93, 18+6.6j, 'xyz';
x, y = 1, 2;
print "Value of x , y : ", x,y;
```

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

```
abc -4.24e+93 (18+6.6j) xyz
Value of x , y : 1 2
```

Built-in Tuple Functions

Python includes the following tuple functions −

Sr.No.	Function with Description
1	**cmp(tuple1, tuple2)** Compares elements of both tuples.
2	**len(tuple)** Gives the total length of the tuple.
3	**max(tuple)** Returns item from the tuple with max value.
4	**min(tuple)** Returns item from the tuple with min value.
5	**tuple(seq)** Converts a list into tuple.

Python - Dictionary

Each key is separated from its value by a colon (:), the items are separated by commas, and the is enclosed in curly braces. An empty dictionary without any items is written with just two curly this: {}.

Keys are unique within a dictionary while values may not be. The values of a dictionary can be but the keys must be of an immutable data type such as strings, numbers, or tuples.

Accessing Values in Dictionary

To access dictionary elements, you can use the familiar square brackets along with the key t value. Following is a simple example −

```
#!/usr/bin/python

dict = {'Name': 'Zara', 'Age': 7, 'Class': 'First'}
print "dict['Name']: ", dict['Name']
print "dict['Age']: ", dict['Age']
```

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

```
dict['Name']:  Zara
dict['Age']:  7
```

If we attempt to access a data item with a key, which is not part of the dictionary, we get an erro −

```
#!/usr/bin/python

dict = {'Name': 'Zara', 'Age': 7, 'Class': 'First'}
print "dict['Alice']: ", dict['Alice']
```

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

```
dict['Alice']:
Traceback (most recent call last):
   File "test.py", line 4, in <module>
      print "dict['Alice']: ", dict['Alice'];
KeyError: 'Alice'
```

Updating Dictionary

You can update a dictionary by adding a new entry or a key-value pair, modifying an existi deleting an existing entry as shown below in the simple example −

```
#!/usr/bin/python

dict = {'Name': 'Zara', 'Age': 7, 'Class': 'First'}
dict['Age'] = 8; # update existing entry
dict['School'] = "DPS School"; # Add new entry

print "dict['Age']: ", dict['Age']
print "dict['School']: ", dict['School']
```

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

```
dict['Age']:  8
dict['School']:  DPS School
```

Delete Dictionary Elements

You can either remove individual dictionary elements or clear the entire contents of a dictiona also delete entire dictionary in a single operation.

To explicitly remove an entire dictionary, just use the **del** statement. Following is a simple exampl

```
#!/usr/bin/python

dict = {'Name': 'Zara', 'Age': 7, 'Class': 'First'}
del dict['Name']; # remove entry with key 'Name'
dict.clear();     # remove all entries in dict
del dict ;        # delete entire dictionary

print "dict['Age']: ", dict['Age']
print "dict['School']: ", dict['School']
```

This produces the following result. Note that an exception is raised because after **del dict** dict

not exist any more −

```
dict['Age']:
Traceback (most recent call last):
   File "test.py", line 8, in <module>
      print "dict['Age']: ", dict['Age'];
TypeError: 'type' object is unsubscriptable
```

Note − del() method is discussed in subsequent section.

Properties of Dictionary Keys

Dictionary values have no restrictions. They can be any arbitrary Python object, either standar user-defined objects. However, same is not true for the keys.

There are two important points to remember about dictionary keys −

(a) More than one entry per key not allowed. Which means no duplicate key is allowed. Whe keys encountered during assignment, the last assignment wins. For example −

```
#!/usr/bin/python

dict = {'Name': 'Zara', 'Age': 7, 'Name': 'Manni'}
print "dict['Name']: ", dict['Name']
```

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

```
dict['Name']:  Manni
```

(b) Keys must be immutable. Which means you can use strings, numbers or tuples as dictiona something like ['key'] is not allowed. Following is a simple example −

```
#!/usr/bin/python

dict = {['Name']: 'Zara', 'Age': 7}
print "dict['Name']: ", dict['Name']
```

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

```
Traceback (most recent call last):
   File "test.py", line 3, in <module>
      dict = {['Name']: 'Zara', 'Age': 7};
TypeError: unhashable type: 'list'
```

Built-in Dictionary Functions & Methods

Python includes the following dictionary functions −

Sr.No.	Function with Description
1	**cmp(dict1, dict2)** Compares elements of both dict.
2	**len(dict)** Gives the total length of the dictionary. This would be equal to the number of ite dictionary.
3	**str(dict)** Produces a printable string representation of a dictionary
4	**type(variable)** Returns the type of the passed variable. If passed variable is dictionary, then it woul dictionary type.

Python includes following dictionary methods −

Sr.No.	Methods with Description
1	**dict.clear()** Removes all elements of dictionary *dict*
2	**dict.copy()** Returns a shallow copy of dictionary *dict*
3	**dict.fromkeys()** Create a new dictionary with keys from seq and values *set* to *value*.
4	**dict.get(key, default=None)** For *key* key, returns value or default if key not in dictionary
5	**dict.has_key(key)** Returns *true* if key in dictionary *dict*, *false* otherwise
6	**dict.items()** Returns a list of *dict*'s (key, value) tuple pairs
7	**dict.keys()** Returns list of dictionary dict's keys

Python - Date & Time

A Python program can handle date and time in several ways. Converting between date fo common chore for computers. Python's time and calendar modules help track dates and times.

What is Tick?

Time intervals are floating-point numbers in units of seconds. Particular instants in time are e seconds since 12:00am, January 1, 1970(epoch).

There is a popular **time** module available in Python which provides functions for working with tin converting between representations. The function *time.time()* returns the current system time in 12:00am, January 1, 1970(epoch).

Example

```
#!/usr/bin/python
import time;  # This is required to include time module.

ticks = time.time()
print "Number of ticks since 12:00am, January 1, 1970:", ticks
```

This would produce a result something as follows −

```
Number of ticks since 12:00am, January 1, 1970: 7186862.73399
```

Date arithmetic is easy to do with ticks. However, dates before the epoch cannot be represe form. Dates in the far future also cannot be represented this way - the cutoff point is sometime UNIX and Windows.

What is TimeTuple?

Many of Python's time functions handle time as a tuple of 9 numbers, as shown below −

Index	Field	Values
0	4-digit year	2008
1	Month	1 to 12
2	Day	1 to 31
3	Hour	0 to 23
4	Minute	0 to 59
5	Second	0 to 61 (60 or 61 are leap-seconds)

6	Day of Week	0 to 6 (0 is Monday)
7	Day of year	1 to 366 (Julian day)
8	Daylight savings	-1, 0, 1, -1 means library determines DST

The above tuple is equivalent to **struct_time** structure. This structure has following attributes −

Index	Attributes	Values
0	tm_year	2008
1	tm_mon	1 to 12
2	tm_mday	1 to 31
3	tm_hour	0 to 23
4	tm_min	0 to 59
5	tm_sec	0 to 61 (60 or 61 are leap-seconds)
6	tm_wday	0 to 6 (0 is Monday)
7	tm_yday	1 to 366 (Julian day)
8	tm_isdst	-1, 0, 1, -1 means library determines DST

Getting current time

To translate a time instant from a *seconds since the epoch* floating-point value into a time-tupl floating-point value to a function (e.g., localtime) that returns a time-tuple with all nine items valid.

```
#!/usr/bin/python
import time;

localtime = time.localtime(time.time())
print "Local current time :", localtime
```

This would produce the following result, which could be formatted in any other presentable form -

```
Local current time : time.struct_time(tm_year=2013, tm_mon=7,
tm_mday=17, tm_hour=21, tm_min=26, tm_sec=3, tm_wday=2, tm_yday=198, tm_isdst=0)
```

Getting formatted time

You can format any time as per your requirement, but simple method to get time in readabl

asctime() −

```
#!/usr/bin/python
import time;

localtime = time.asctime( time.localtime(time.time()) )
print "Local current time :", localtime
```

This would produce the following result −

```
Local current time : Tue Jan 13 10:17:09 2009
```

Getting calendar for a month

The calendar module gives a wide range of methods to play with yearly and monthly calendar print a calendar for a given month (Jan 2008) −

```
#!/usr/bin/python
import calendar

cal = calendar.month(2008, 1)
print "Here is the calendar:"
print cal
```

This would produce the following result −

```
Here is the calendar:
   January 2008
Mo Tu We Th Fr Sa Su
    1  2  3  4  5  6
 7  8  9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31
```

The *time* Module

There is a popular **time** module available in Python which provides functions for working with ti converting between representations. Here is the list of all available methods −

Sr.No.	Function with Description
1	**time.altzone** The offset of the local DST timezone, in seconds west of UTC, if one is defined. This i if the local DST timezone is east of UTC (as in Western Europe, including the UK). On if daylight is nonzero.

2	**time.asctime([tupletime])** Accepts a time-tuple and returns a readable 24-character string such as 'Tue Dec 1 2008'.
3	**time.clock( )** Returns the current CPU time as a floating-point number of seconds. To measure com costs of different approaches, the value of time.clock is more useful than that of time.ti
4	**time.ctime([secs])** Like asctime(localtime(secs)) and without arguments is like asctime( )
5	**time.gmtime([secs])** Accepts an instant expressed in seconds since the epoch and returns a time-tuple UTC time. Note : t.tm_isdst is always 0
6	**time.localtime([secs])** Accepts an instant expressed in seconds since the epoch and returns a time-tuple local time (t.tm_isdst is 0 or 1, depending on whether DST applies to instant sec rules).
7	**time.mktime(tupletime)** Accepts an instant expressed as a time-tuple in local time and returns a floating-point the instant expressed in seconds since the epoch.
8	**time.sleep(secs)** Suspends the calling thread for secs seconds.
9	**time.strftime(fmt[,tupletime])** Accepts an instant expressed as a time-tuple in local time and returns a string repres instant as specified by string fmt.
10	**time.strptime(str,fmt='%a %b %d %H:%M:%S %Y')** Parses str according to format string fmt and returns the instant in time-tuple format.
11	**time.time( )** Returns the current time instant, a floating-point number of seconds since the epoch.
12	**time.tzset()** Resets the time conversion rules used by the library routines. The environment v

	specifies how this is done.

Let us go through the functions briefly −

There are following two important attributes available with time module −

Sr.No.	Attribute with Description
1	**time.timezone** Attribute time.timezone is the offset in seconds of the local time zone (without DST) (>0 in the Americas; <=0 in most of Europe, Asia, Africa).
2	**time.tzname** Attribute time.tzname is a pair of locale-dependent strings, which are the names o time zone without and with DST, respectively.

The *calendar* Module

The calendar module supplies calendar-related functions, including functions to print a text cal given month or year.

By default, calendar takes Monday as the first day of the week and Sunday as the last one. To c call calendar.setfirstweekday() function.

Here is a list of functions available with the *calendar* module −

Sr.No.	Function with Description
1	**calendar.calendar(year,w=2,l=1,c=6)** Returns a multiline string with a calendar for year year formatted into three columns by c spaces. w is the width in characters of each date; each line has length 21*w+1 the number of lines for each week.
2	**calendar.firstweekday( )** Returns the current setting for the weekday that starts each week. By default, when c first imported, this is 0, meaning Monday.
3	**calendar.isleap(year)**

	Returns True if year is a leap year; otherwise, False.
4	**calendar.leapdays(y1,y2)** Returns the total number of leap days in the years within range(y1,y2).
5	**calendar.month(year,month,w=2,l=1)** Returns a multiline string with a calendar for month month of year year, one line per two header lines. w is the width in characters of each date; each line has length 7*w- number of lines for each week.
6	**calendar.monthcalendar(year,month)** Returns a list of lists of ints. Each sublist denotes a week. Days outside month mor year are set to 0; days within the month are set to their day-of-month, 1 and up.
7	**calendar.monthrange(year,month)** Returns two integers. The first one is the code of the weekday for the first day of month in year year; the second one is the number of days in the month. Weekday cc (Monday) to 6 (Sunday); month numbers are 1 to 12.
8	**calendar.prcal(year,w=2,l=1,c=6)** Like print calendar.calendar(year,w,l,c).
9	**calendar.prmonth(year,month,w=2,l=1)** Like print calendar.month(year,month,w,l).
10	**calendar.setfirstweekday(weekday)** Sets the first day of each week to weekday code weekday. Weekday codes are 0 (Mo (Sunday).
11	**calendar.timegm(tupletime)** The inverse of time.gmtime: accepts a time instant in time-tuple form and returns instant as a floating-point number of seconds since the epoch.
12	**calendar.weekday(year,month,day)**

	Returns the weekday code for the given date. Weekday codes are 0 (Monday) to 6 month numbers are 1 (January) to 12 (December).

Other Modules & Functions

If you are interested, then here you would find a list of other important modules and functions date & time in Python −

- The *datetime* Module
- The *pytz* Module
- The *dateutil* Module

Python - Functions

A function is a block of organized, reusable code that is used to perform a single, related actior 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 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 Python.

- Function blocks begin with the keyword **def** followed by the function name and parenthe
- Any input parameters or arguments should be placed within these parentheses. Yc define parameters inside these parentheses.
- The first statement of a function can be an optional statement - the documentation s 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 expres 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 ord
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 f
structures the blocks of code.

Once the basic structure of a function is finalized, you can execute it by calling it from another
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 cha
parameter refers to within a function, the change also reflects back in the calling function. For exa

```
#!/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 obj 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 referen 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 doe *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

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 syn 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 fu 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 the keywords provided to match the values with parameters. You can also make keyword *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 matt

```
#!/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 f
for that argument. The following example gives an idea on default arguments, it prints default ag
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 tl
These arguments are called *variable-length* arguments and are not named in the function defin
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 nonkeywo arguments. This tuple remains empty if no additional arguments are specified during the fu 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

These functions are called anonymous because they are not declared in the standard manner b *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 expression. They cannot contain commands or multiple expressions.
- An anonymous function cannot be a direct call to print because lambda requires an exp
- Lambda functions have their own local namespace and cannot access variables other 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 e inline statements in C or C++, whose purpose is by passing function stack alloca 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 t 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 foll

```
#!/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 depend

you have declared a variable.

The scope of a variable determines the portion of the program where you can access a particul
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 outs
global scope.

This means that local variables can be accessed only inside the function in which they ar
whereas global variables can be accessed throughout the program body by all functions. Whe
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 - Modules

A module allows you to logically organize your Python code. Grouping related code into a mo
the code easier to understand and use. A module is a Python object with arbitrarily named att
you can bind and reference.

Simply, a module is a file consisting of Python code. A module can define functions, classes an
A module can also include runnable code.

Example

The Python code for a module named *aname* normally resides in a file named *aname.py*.

example of a simple module, support.py

```
def print_func( par ):
   print "Hello : ", par
   return
```

The *import* Statement

You can use any Python source file as a module by executing an import statement in some o source file. The *import* has the following syntax −

```
import module1[, module2[,... moduleN]
```

When the interpreter encounters an import statement, it imports the module if the module is pr search path. A search path is a list of directories that the interpreter searches before importing For example, to import the module support.py, you need to put the following command at the script −

```
#!/usr/bin/python

# Import module support
import support

# Now you can call defined function that module as follows
support.print_func("Zara")
```

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

```
Hello : Zara
```

A module is loaded only once, regardless of the number of times it is imported. This prevents execution from happening over and over again if multiple imports occur.

The *from...import* Statement

Python's *from* statement lets you import specific attributes from a module into the current name *from...import* has the following syntax −

```
from modname import name1[, name2[, ... nameN]]
```

For example, to import the function fibonacci from the module fib, use the following statement −

```
from fib import fibonacci
```

This statement does not import the entire module fib into the current namespace; it just introduc fibonacci from the module fib into the global symbol table of the importing module.

The *from...import* * Statement

It is also possible to import all names from a module into the current namespace by using th import statement −

```
from modname import *
```

This provides an easy way to import all the items from a module into the current namespace; ho statement should be used sparingly.

Locating Modules

When you import a module, the Python interpreter searches for the module in the following seque

- The current directory.
- If the module isn't found, Python then searches each directory in the shell variable PYTH
- If all else fails, Python checks the default path. On UNIX, this default path is normal /lib/python/.

The module search path is stored in the system module sys as the **sys.path** variable. The sys.p contains the current directory, PYTHONPATH, and the installation-dependent default.

The *PYTHONPATH* Variable

The PYTHONPATH is an environment variable, consisting of a list of directories. The PYTHONPATH is the same as that of the shell variable PATH.

Here is a typical PYTHONPATH from a Windows system −

```
set PYTHONPATH = c:\python20\lib;
```

And here is a typical PYTHONPATH from a UNIX system −

```
set PYTHONPATH = /usr/local/lib/python
```

Namespaces and Scoping

Variables are names (identifiers) that map to objects. A *namespace* is a dictionary of variable na and their corresponding objects (values).

A Python statement can access variables in a *local namespace* and in the *global namespace*. If a global variable have the same name, the local variable shadows the global variable.

Each function has its own local namespace. Class methods follow the same scoping rule functions.

Python makes educated guesses on whether variables are local or global. It assumes that a assigned a value in a function is local.

Therefore, in order to assign a value to a global variable within a function, you must first use statement.

The statement *global VarName* tells Python that VarName is a global variable. Python stops se local namespace for the variable.

For example, we define a variable *Money* in the global namespace. Within the function *Money* *Money* a value, therefore Python assumes *Money* as a local variable. However, we accessed t the local variable *Money* before setting it, so an UnboundLocalError is the result. Uncommentin statement fixes the problem.

```
#!/usr/bin/python

Money = 2000
def AddMoney():
   # Uncomment the following line to fix the code:
   # global Money
   Money = Money + 1

print Money
AddMoney()
print Money
```

The dir( ) Function

The dir() built-in function returns a sorted list of strings containing the names defined by a module

The list contains the names of all the modules, variables and functions that are defined in Following is a simple example −

```
#!/usr/bin/python

# Import built-in module math
import math

content = dir(math)
print content
```

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

```
['__doc__', '__file__', '__name__', 'acos', 'asin', 'atan',
'atan2', 'ceil', 'cos', 'cosh', 'degrees', 'e', 'exp',
'fabs', 'floor', 'fmod', 'frexp', 'hypot', 'ldexp', 'log',
'log10', 'modf', 'pi', 'pow', 'radians', 'sin', 'sinh',
'sqrt', 'tan', 'tanh']
```

Here, the special string variable *__name__* is the module's name, and *__file__* is the filename the module was loaded.

The *globals()* and *locals()* Functions

The *globals()* and *locals()* functions can be used to return the names in the global and local n depending on the location from where they are called.

If locals() is called from within a function, it will return all the names that can be accessed local function.

If globals() is called from within a function, it will return all the names that can be accessed globa function.

The return type of both these functions is dictionary. Therefore, names can be extracted using function.

The *reload()* Function

When the module is imported into a script, the code in the top-level portion of a module is ex once.

Therefore, if you want to reexecute the top-level code in a module, you can use the *reload()* fu reload() function imports a previously imported module again. The syntax of the reload() function

```
reload(module_name)
```

Here, *module_name* is the name of the module you want to reload and not the string containing name. For example, to reload *hello* module, do the following −

```
reload(hello)
```

Packages in Python

A package is a hierarchical file directory structure that defines a single Python application envir consists of modules and subpackages and sub-subpackages, and so on.

Consider a file *Pots.py* available in *Phone* directory. This file has following line of source code −

```
#!/usr/bin/python

def Pots():
   print "I'm Pots Phone"
```

Similar way, we have another two files having different functions with the same name as above −

- *Phone/Isdn.py* file having function Isdn()
- *Phone/G3.py* file having function G3()

Now, create one more file __init__.py in *Phone* directory −

- Phone/__init__.py

To make all of your functions available when you've imported Phone, you need to put ex| statements in __init__.py as follows −

```
from Pots import Pots
from Isdn import Isdn
from G3 import G3
```

After you add these lines to __init__.py, you have all of these classes available when you impor package.

```
#!/usr/bin/python

# Now import your Phone Package.
import Phone

Phone.Pots()
Phone.Isdn()
Phone.G3()
```

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

```
I'm Pots Phone
I'm 3G Phone
I'm ISDN Phone
```

In the above example, we have taken example of a single functions in each file, but you can k functions in your files. You can also define different Python classes in those files and then you your packages out of those classes.

Python - Files I/O

This chapter covers all the basic I/O functions available in Python. For more functions, plea standard Python documentation.

Printing to the Screen

The simplest way to produce output is using the *print* statement where you can pass ze expressions separated by commas. This function converts the expressions you pass into a strin the result to standard output as follows −

```
#!/usr/bin/python

print "Python is really a great language,", "isn't it?"
```

This produces the following result on your standard screen −

```
Python is really a great language, isn't it?
```

Reading Keyboard Input

Python provides two built-in functions to read a line of text from standard input, which by default
the keyboard. These functions are −

- raw_input
- input

The *raw_input* Function

The *raw_input([prompt])* function reads one line from standard input and returns it as a string (re
trailing newline).

```
#!/usr/bin/python

str = raw_input("Enter your input: ")
print "Received input is : ", str
```

This prompts you to enter any string and it would display same string on the screen. When I t
Python!", its output is like this −

```
Enter your input: Hello Python
Received input is :  Hello Python
```

The *input* Function

The *input([prompt])* function is equivalent to raw_input, except that it assumes the input is a v
expression and returns the evaluated result to you.

```
#!/usr/bin/python

str = input("Enter your input: ")
print "Received input is : ", str
```

This would produce the following result against the entered input −

```
Enter your input: [x*5 for x in range(2,10,2)]
Recieved input is :  [10, 20, 30, 40]
```

Opening and Closing Files

Until now, you have been reading and writing to the standard input and output. Now, we will see
actual data files.

Python provides basic functions and methods necessary to manipulate files by default. You can the file manipulation using a **file** object.

The *open* Function

Before you can read or write a file, you have to open it using Python's built-in *open()* function. T creates a **file** object, which would be utilized to call other support methods associated with it.

Syntax

```
file object = open(file_name [, access_mode][, buffering])
```

Here are parameter details −

- **file_name** − The file_name argument is a string value that contains the name of the f want to access.
- **access_mode** − The access_mode determines the mode in which the file has to be c read, write, append, etc. A complete list of possible values is given below in the ta optional parameter and the default file access mode is read (r).
- **buffering** − If the buffering value is set to 0, no buffering takes place. If the buffering val buffering is performed while accessing a file. If you specify the buffering value as an inte than 1, then buffering action is performed with the indicated buffer size. If negative, the is the system default(default behavior).

Here is a list of the different modes of opening a file −

Sr.No.	Modes & Description
1	**r** Opens a file for reading only. The file pointer is placed at the beginning of the file. T default mode.
2	**rb** Opens a file for reading only in binary format. The file pointer is placed at the beginr file. This is the default mode.
3	**r+** Opens a file for both reading and writing. The file pointer placed at the beginning of the
4	**rb+**

	Opens a file for both reading and writing in binary format. The file pointer plac beginning of the file.
5	**w** Opens a file for writing only. Overwrites the file if the file exists. If the file does not exi a new file for writing.
6	**wb** Opens a file for writing only in binary format. Overwrites the file if the file exists. If th not exist, creates a new file for writing.
7	**w+** Opens a file for both writing and reading. Overwrites the existing file if the file exists does not exist, creates a new file for reading and writing.
8	**wb+** Opens a file for both writing and reading in binary format. Overwrites the existing file exists. If the file does not exist, creates a new file for reading and writing.
9	**a** Opens a file for appending. The file pointer is at the end of the file if the file exists. T file is in the append mode. If the file does not exist, it creates a new file for writing.
10	**ab** Opens a file for appending in binary format. The file pointer is at the end of the file exists. That is, the file is in the append mode. If the file does not exist, it creates a n writing.
11	**a+** Opens a file for both appending and reading. The file pointer is at the end of the file exists. The file opens in the append mode. If the file does not exist, it creates a n reading and writing.
12	**ab+**

	Opens a file for both appending and reading in binary format. The file pointer is at the file if the file exists. The file opens in the append mode. If the file does not exist, it crea file for reading and writing.

The *file* Object Attributes

Once a file is opened and you have one *file* object, you can get various information related to tha

Here is a list of all attributes related to file object −

Sr.No.	Attribute & Description
1	**file.closed** Returns true if file is closed, false otherwise.
2	**file.mode** Returns access mode with which file was opened.
3	**file.name** Returns name of the file.
4	**file.softspace** Returns false if space explicitly required with print, true otherwise.

Example

```
#!/usr/bin/python

# Open a file
fo = open("foo.txt", "wb")
print "Name of the file: ", fo.name
print "Closed or not : ", fo.closed
print "Opening mode : ", fo.mode
print "Softspace flag : ", fo.softspace
```

This produces the following result −

```
Name of the file:  foo.txt
Closed or not :  False
Opening mode :  wb
```

```
Softspace flag :  0
```

The *close()* Method

The close() method of a *file* object flushes any unwritten information and closes the file object, no more writing can be done.

Python automatically closes a file when the reference object of a file is reassigned to another good practice to use the close() method to close a file.

Syntax

```
fileObject.close()
```

Example

```
#!/usr/bin/python

# Open a file
fo = open("foo.txt", "wb")
print "Name of the file: ", fo.name

# Close opend file
fo.close()
```

This produces the following result −

```
Name of the file:  foo.txt
```

Reading and Writing Files

The *file* object provides a set of access methods to make our lives easier. We would see how to and *write()* methods to read and write files.

The *write()* Method

The *write()* method writes any string to an open file. It is important to note that Python string binary data and not just text.

The write() method does not add a newline character ('\n') to the end of the string −

Syntax

```
fileObject.write(string)
```

Here, passed parameter is the content to be written into the opened file.

Example

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

```
# Open a file
fo = open("foo.txt", "wb")
fo.write( "Python is a great language.\nYeah its great!!\n")

# Close opend file
fo.close()
```

The above method would create *foo.txt* file and would write given content in that file and fina close that file. If you would open this file, it would have following content.

```
Python is a great language.
Yeah its great!!
```

The *read()* Method

The *read()* method reads a string from an open file. It is important to note that Python string binary data. apart from text data.

Syntax

```
fileObject.read([count])
```

Here, passed parameter is the number of bytes to be read from the opened file. This method sta from the beginning of the file and if *count* is missing, then it tries to read as much as possible, the end of file.

Example

Let's take a file *foo.txt*, which we created above.

```
#!/usr/bin/python

# Open a file
fo = open("foo.txt", "r+")
str = fo.read(10);
print "Read String is : ", str
# Close opend file
fo.close()
```

This produces the following result −

```
Read String is :  Python is
```

File Positions

The *tell()* method tells you the current position within the file; in other words, the next read or wri at that many bytes from the beginning of the file.

The *seek(offset[, from])* method changes the current file position. The *offset* argument indicates of bytes to be moved. The *from* argument specifies the reference position from where the byte

moved.

If *from* is set to 0, it means use the beginning of the file as the reference position and 1 mea current position as the reference position and if it is set to 2 then the end of the file would be ta reference position.

Example

Let us take a file *foo.txt*, which we created above.

```
#!/usr/bin/python

# Open a file
fo = open("foo.txt", "r+")
str = fo.read(10)
print "Read String is : ", str

# Check current position
position = fo.tell()
print "Current file position : ", position

# Reposition pointer at the beginning once again
position = fo.seek(0, 0);
str = fo.read(10)
print "Again read String is : ", str
# Close opend file
fo.close()
```

This produces the following result −

```
Read String is :  Python is
Current file position :  10
Again read String is :  Python is
```

Renaming and Deleting Files

Python **os** module provides methods that help you perform file-processing operations, such a and deleting files.

To use this module you need to import it first and then you can call any related functions.

The rename() Method

The *rename()* method takes two arguments, the current filename and the new filename.

Syntax

```
os.rename(current_file_name, new_file_name)
```

Example

Following is the example to rename an existing file *test1.txt* −

```
#!/usr/bin/python
import os

# Rename a file from test1.txt to test2.txt
os.rename( "test1.txt", "test2.txt" )
```

The *remove()* Method

You can use the *remove()* method to delete files by supplying the name of the file to be del argument.

Syntax

```
os.remove(file_name)
```

Example

Following is the example to delete an existing file *test2.txt* −

```
#!/usr/bin/python
import os

# Delete file test2.txt
os.remove("text2.txt")
```

Directories in Python

All files are contained within various directories, and Python has no problem handling these t module has several methods that help you create, remove, and change directories.

The *mkdir()* Method

You can use the *mkdir()* method of the **os** module to create directories in the current directory. supply an argument to this method which contains the name of the directory to be created.

Syntax

```
os.mkdir("newdir")
```

Example

Following is the example to create a directory *test* in the current directory −

```
#!/usr/bin/python
import os

# Create a directory "test"
os.mkdir("test")
```

The *chdir()* Method

You can use the *chdir()* method to change the current directory. The chdir() method takes ar which is the name of the directory that you want to make the current directory.

Syntax

```
os.chdir("newdir")
```

Example

Following is the example to go into "/home/newdir" directory −

```
#!/usr/bin/python
import os

# Changing a directory to "/home/newdir"
os.chdir("/home/newdir")
```

The *getcwd()* Method

The *getcwd()* method displays the current working directory.

Syntax

```
os.getcwd()
```

Example

Following is the example to give current directory −

```
#!/usr/bin/python
import os

# This would give location of the current directory
os.getcwd()
```

The *rmdir()* Method

The *rmdir()* method deletes the directory, which is passed as an argument in the method.

Before removing a directory, all the contents in it should be removed.

Syntax

```
os.rmdir('dirname')
```

Example

Following is the example to remove "/tmp/test" directory. It is required to give fully qualified r

directory, otherwise it would search for that directory in the current directory.

```
#!/usr/bin/python
import os

# This would  remove "/tmp/test"  directory.
os.rmdir( "/tmp/test"  )
```

File & Directory Related Methods

There are three important sources, which provide a wide range of utility methods to handle and files & directories on Windows and Unix operating systems. They are as follows −

- File Object Methods : The *file* object provides functions to manipulate files.
- OS Object Methods : This provides methods to process files as well as directories.

Python - Exceptions Handling

Python provides two very important features to handle any unexpected error in your Python pr to add debugging capabilities in them −

- **Exception Handling** − This would be covered in this tutorial. Here is a list standard available in Python: Standard Exceptions .
- **Assertions** − This would be covered in Assertions in Python tutorial.

List of Standard Exceptions −

Sr.No.	Exception Name & Description
1	**Exception** Base class for all exceptions
2	**StopIteration** Raised when the next() method of an iterator does not point to any object.
3	**SystemExit** Raised by the sys.exit() function.
4	**StandardError** Base class for all built-in exceptions except StopIteration and SystemExit.

5	**ArithmeticError** Base class for all errors that occur for numeric calculation.
6	**OverflowError** Raised when a calculation exceeds maximum limit for a numeric type.
7	**FloatingPointError** Raised when a floating point calculation fails.
8	**ZeroDivisionError** Raised when division or modulo by zero takes place for all numeric types.
9	**AssertionError** Raised in case of failure of the Assert statement.
10	**AttributeError** Raised in case of failure of attribute reference or assignment.
11	**EOFError** Raised when there is no input from either the raw_input() or input() function and the er reached.
12	**ImportError** Raised when an import statement fails.
13	**KeyboardInterrupt** Raised when the user interrupts program execution, usually by pressing Ctrl+c.
14	**LookupError** Base class for all lookup errors.
15	**IndexError** Raised when an index is not found in a sequence.

16	**KeyError** Raised when the specified key is not found in the dictionary.
17	**NameError** Raised when an identifier is not found in the local or global namespace.
18	**UnboundLocalError** Raised when trying to access a local variable in a function or method but no value assigned to it.
19	**EnvironmentError** Base class for all exceptions that occur outside the Python environment.
20	**IOError** Raised when an input/ output operation fails, such as the print statement or the open when trying to open a file that does not exist.
21	**IOError** Raised for operating system-related errors.
22	**SyntaxError** Raised when there is an error in Python syntax.
23	**IndentationError** Raised when indentation is not specified properly.
24	**SystemError** Raised when the interpreter finds an internal problem, but when this error is encou Python interpreter does not exit.
25	**SystemExit** Raised when Python interpreter is quit by using the sys.exit() function. If not hand code, causes the interpreter to exit.

26	**TypeError** Raised when an operation or function is attempted that is invalid for the specified data
27	**ValueError** Raised when the built-in function for a data type has the valid type of argument arguments have invalid values specified.
28	**RuntimeError** Raised when a generated error does not fall into any category.
29	**NotImplementedError** Raised when an abstract method that needs to be implemented in an inherited cl actually implemented.

Assertions in Python

An assertion is a sanity-check that you can turn on or turn off when you are done with your te program.

The easiest way to think of an assertion is to liken it to a **raise-if** statement (or to be more accur if-not statement). An expression is tested, and if the result comes up false, an exception is raised

Assertions are carried out by the assert statement, the newest keyword to Python, introduced in

Programmers often place assertions at the start of a function to check for valid input, and afte call to check for valid output.

The *assert* Statement

When it encounters an assert statement, Python evaluates the accompanying expression, which true. If the expression is false, Python raises an *AssertionError* exception.

The syntax for assert is −

```
assert Expression[, Arguments]
```

If the assertion fails, Python uses ArgumentExpression as the argument for the Ass AssertionError exceptions can be caught and handled like any other exception using the statement, but if not handled, they will terminate the program and produce a traceback.

Example

Here is a function that converts a temperature from degrees Kelvin to degrees Fahrenheit.

degrees Kelvin is as cold as it gets, the function bails out if it sees a negative temperature −

```
#!/usr/bin/python
def KelvinToFahrenheit(Temperature):
   assert (Temperature >= 0),"Colder than absolute zero!"
   return ((Temperature-273)*1.8)+32
print KelvinToFahrenheit(273)
print int(KelvinToFahrenheit(505.78))
print KelvinToFahrenheit(-5)
```

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

```
32.0
451
Traceback (most recent call last):
File "test.py", line 9, in <module>
print KelvinToFahrenheit(-5)
File "test.py", line 4, in KelvinToFahrenheit
assert (Temperature >= 0),"Colder than absolute zero!"
AssertionError: Colder than absolute zero!
```

What is Exception?

An exception is an event, which occurs during the execution of a program that disrupts the nor the program's instructions. In general, when a Python script encounters a situation that it canno it raises an exception. An exception is a Python object that represents an error.

When a Python script raises an exception, it must either handle the exception immediately terminates and quits.

Handling an exception

If you have some *suspicious* code that may raise an exception, you can defend your program by suspicious code in a **try:** block. After the try: block, include an **except:** statement, followed by code which handles the problem as elegantly as possible.

Syntax

Here is simple syntax of *try....except...else* blocks −

```
try:
   You do your operations here;
   ......................
except ExceptionI:
   If there is ExceptionI, then execute this block.
except ExceptionII:
   If there is ExceptionII, then execute this block.
```

```
   ......................
else:
   If there is no exception then execute this block.
```

Here are few important points about the above-mentioned syntax −

- A single try statement can have multiple except statements. This is useful when th contains statements that may throw different types of exceptions.
- You can also provide a generic except clause, which handles any exception.
- After the except clause(s), you can include an else-clause. The code in the else-block the code in the try: block does not raise an exception.
- The else-block is a good place for code that does not need the try: block's protection.

Example

This example opens a file, writes content in the, file and comes out gracefully because there is at all −

```
#!/usr/bin/python

try:
   fh = open("testfile", "w")
   fh.write("This is my test file for exception handling!!")
except IOError:
   print "Error: can\'t find file or read data"
else:
   print "Written content in the file successfully"
   fh.close()
```

This produces the following result −

```
Written content in the file successfully
```

Example

This example tries to open a file where you do not have write permission, so it raises an exceptio

```
#!/usr/bin/python

try:
   fh = open("testfile", "r")
   fh.write("This is my test file for exception handling!!")
except IOError:
   print "Error: can\'t find file or read data"
else:
   print "Written content in the file successfully"
```

This produces the following result −

```
Error: can't find file or read data
```

The *except* Clause with No Exceptions

You can also use the except statement with no exceptions defined as follows −

```
try:
   You do your operations here;
   ......................
except:
   If there is any exception, then execute this block.
   ......................
else:
   If there is no exception then execute this block.
```

This kind of a **try-except** statement catches all the exceptions that occur. Using this kind o statement is not considered a good programming practice though, because it catches all exc does not make the programmer identify the root cause of the problem that may occur.

The *except* Clause with Multiple Exceptions

You can also use the same *except* statement to handle multiple exceptions as follows −

```
try:
   You do your operations here;
   ......................
except(Exception1[, Exception2[,...ExceptionN]]):
   If there is any exception from the given exception list,
   then execute this block.
   ......................
else:
   If there is no exception then execute this block.
```

The try-finally Clause

You can use a **finally:** block along with a **try:** block. The finally block is a place to put any cod execute, whether the try-block raised an exception or not. The syntax of the try-finally statement i

```
try:
   You do your operations here;
   ......................
   Due to any exception, this may be skipped.
finally:
   This would always be executed.
   ......................
```

You cannot use *else* clause as well along with a finally clause.

Example

```
#!/usr/bin/python

try:
   fh = open("testfile", "w")
   fh.write("This is my test file for exception handling!!")
finally:
   print "Error: can\'t find file or read data"
```

If you do not have permission to open the file in writing mode, then this will produce the following

```
Error: can't find file or read data
```

Same example can be written more cleanly as follows −

```
#!/usr/bin/python

try:
   fh = open("testfile", "w")
   try:
      fh.write("This is my test file for exception handling!!")
   finally:
      print "Going to close the file"
      fh.close()
except IOError:
   print "Error: can\'t find file or read data"
```

When an exception is thrown in the *try* block, the execution immediately passes to the *finally* blo the statements in the *finally* block are executed, the exception is raised again and is handled in statements if present in the next higher layer of the *try-except* statement.

Argument of an Exception

An exception can have an *argument*, which is a value that gives additional information about th The contents of the argument vary by exception. You capture an exception's argument by variable in the except clause as follows −

```
try:
   You do your operations here;
   ......................
except ExceptionType, Argument:
   You can print value of Argument here...
```

If you write the code to handle a single exception, you can have a variable follow the name of th in the except statement. If you are trapping multiple exceptions, you can have a variable follow the exception.

This variable receives the value of the exception mostly containing the cause of the exception. T can receive a single value or multiple values in the form of a tuple. This tuple usually contai

string, the error number, and an error location.

Example

Following is an example for a single exception −

```
#!/usr/bin/python

# Define a function here.
def temp_convert(var):
   try:
      return int(var)
   except ValueError, Argument:
      print "The argument does not contain numbers\n", Argument

# Call above function here.
temp_convert("xyz");
```

This produces the following result −

```
The argument does not contain numbers
invalid literal for int() with base 10: 'xyz'
```

Raising an Exceptions

You can raise exceptions in several ways by using the raise statement. The general syntax fo statement is as follows.

Syntax

```
raise [Exception [, args [, traceback]]]
```

Here, *Exception* is the type of exception (for example, NameError) and *argument* is a va exception argument. The argument is optional; if not supplied, the exception argument is None.

The final argument, traceback, is also optional (and rarely used in practice), and if present, is th object used for the exception.

Example

An exception can be a string, a class or an object. Most of the exceptions that the Python core classes, with an argument that is an instance of the class. Defining new exceptions is quite easy done as follows −

```
def functionName( level ):
   if level < 1:
      raise "Invalid level!", level
      # The code below to this would not be executed
      # if we raise the exception
```

Note: In order to catch an exception, an "except" clause must refer to the same exception th

class object or simple string. For example, to capture above exception, we must write the excep follows −

```
try:
   Business Logic here...
except "Invalid level!":
   Exception handling here...
else:
   Rest of the code here...
```

User-Defined Exceptions

Python also allows you to create your own exceptions by deriving classes from the stanc exceptions.

Here is an example related to *RuntimeError*. Here, a class is created that is subclassed from *Ru* This is useful when you need to display more specific information when an exception is caught.

In the try block, the user-defined exception is raised and caught in the except block. The variab to create an instance of the class *Networkerror*.

```
class Networkerror(RuntimeError):
   def __init__(self, arg):
      self.args = arg
```

So once you defined above class, you can raise the exception as follows −

```
try:
   raise Networkerror("Bad hostname")
except Networkerror,e:
   print e.args
```

Python - Object Oriented

Python has been an object-oriented language since it existed. Because of this, creating and us and objects are downright easy. This chapter helps you become an expert in using Python's obj programming support.

If you do not have any previous experience with object-oriented (OO) programming, you m consult an introductory course on it or at least a tutorial of some sort so that you have a grasp concepts.

However, here is small introduction of Object-Oriented Programming (OOP) to bring you at speed

Overview of OOP Terminology

- **Class** − A user-defined prototype for an object that defines a set of attributes that chara object of the class. The attributes are data members (class variables and instance va

methods, accessed via dot notation.

- **Class variable** − A variable that is shared by all instances of a class. Class variables within a class but outside any of the class's methods. Class variables are not used as fr instance variables are.
- **Data member** − A class variable or instance variable that holds data associated with its objects.
- **Function overloading** − The assignment of more than one behavior to a particular fu operation performed varies by the types of objects or arguments involved.
- **Instance variable** − A variable that is defined inside a method and belongs only to instance of a class.
- **Inheritance** − The transfer of the characteristics of a class to other classes that are deri
- **Instance** − An individual object of a certain class. An object obj that belongs to a clas example, is an instance of the class Circle.
- **Instantiation** − The creation of an instance of a class.
- **Method** − A special kind of function that is defined in a class definition.
- **Object** − A unique instance of a data structure that's defined by its class. An object com data members (class variables and instance variables) and methods.
- **Operator overloading** − The assignment of more than one function to a particular oper

Creating Classes

The *class* statement creates a new class definition. The name of the class immediately follows t *class* followed by a colon as follows −

```
class ClassName:
   'Optional class documentation string'
   class_suite
```

- The class has a documentation string, which can be accessed via *ClassName.__doc__*
- The *class_suite* consists of all the component statements defining class members, dat and functions.

Example

Following is the example of a simple Python class −

```
class Employee:
   'Common base class for all employees'
```

```
   empCount = 0

   def __init__(self, name, salary):
      self.name = name
      self.salary = salary
      Employee.empCount += 1

   def displayCount(self):
     print "Total Employee %d" % Employee.empCount

   def displayEmployee(self):
      print "Name : ", self.name,  ", Salary: ", self.salary
```

- The variable *empCount* is a class variable whose value is shared among all instanc class. This can be accessed as *Employee.empCount* from inside the class or outside th
- The first method *__init__()* is a special method, which is called class constructor or method that Python calls when you create a new instance of this class.
- You declare other class methods like normal functions with the exception that the first a each method is *self*. Python adds the *self* argument to the list for you; you do not need when you call the methods.

Creating Instance Objects

To create instances of a class, you call the class using class name and pass in whatever ar *__init__* method accepts.

```
"This would create first object of Employee class"
emp1 = Employee("Zara", 2000)
"This would create second object of Employee class"
emp2 = Employee("Manni", 5000)
```

Accessing Attributes

You access the object's attributes using the dot operator with object. Class variable would b using class name as follows −

```
emp1.displayEmployee()
emp2.displayEmployee()
print "Total Employee %d" % Employee.empCount
```

Now, putting all the concepts together −

```
#!/usr/bin/python

class Employee:
   'Common base class for all employees'
   empCount = 0
```

```
   def __init__(self, name, salary):
      self.name = name
      self.salary = salary
      Employee.empCount += 1

   def displayCount(self):
     print "Total Employee %d" % Employee.empCount

   def displayEmployee(self):
      print "Name : ", self.name,  ", Salary: ", self.salary

"This would create first object of Employee class"
emp1 = Employee("Zara", 2000)
"This would create second object of Employee class"
emp2 = Employee("Manni", 5000)
emp1.displayEmployee()
emp2.displayEmployee()
print "Total Employee %d" % Employee.empCount
```

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

```
Name :  Zara ,Salary:  2000
Name :  Manni ,Salary:  5000
Total Employee 2
```

You can add, remove, or modify attributes of classes and objects at any time −

```
emp1.age = 7  # Add an 'age' attribute.
emp1.age = 8  # Modify 'age' attribute.
del emp1.age  # Delete 'age' attribute.
```

Instead of using the normal statements to access attributes, you can use the following functions -

- The **getattr(obj, name[, default])** − to access the attribute of object.
- The **hasattr(obj,name)** − to check if an attribute exists or not.
- The **setattr(obj,name,value)** − to set an attribute. If attribute does not exist, then created.
- The **delattr(obj, name)** − to delete an attribute.

```
hasattr(emp1, 'age')    # Returns true if 'age' attribute exists
getattr(emp1, 'age')    # Returns value of 'age' attribute
setattr(emp1, 'age', 8) # Set attribute 'age' at 8
delattr(empl, 'age')    # Delete attribute 'age'
```

Built-In Class Attributes

Every Python class keeps following built-in attributes and they can be accessed using dot opera other attribute −

- **__dict__** − Dictionary containing the class's namespace.
- **__doc__** − Class documentation string or none, if undefined.
- **__name__** − Class name.
- **__module__** − Module name in which the class is defined. This attribute is "__ interactive mode.
- **__bases__** − A possibly empty tuple containing the base classes, in the order of their in the base class list.

For the above class let us try to access all these attributes −

```
#!/usr/bin/python

class Employee:
   'Common base class for all employees'
   empCount = 0

   def __init__(self, name, salary):
      self.name = name
      self.salary = salary
      Employee.empCount += 1

   def displayCount(self):
     print "Total Employee %d" % Employee.empCount

   def displayEmployee(self):
      print "Name : ", self.name,  ", Salary: ", self.salary

print "Employee.__doc__:", Employee.__doc__
print "Employee.__name__:", Employee.__name__
print "Employee.__module__:", Employee.__module__
print "Employee.__bases__:", Employee.__bases__
print "Employee.__dict__:", Employee.__dict__
```

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

```
Employee.__doc__: Common base class for all employees
Employee.__name__: Employee
Employee.__module__: __main__
Employee.__bases__: ()
Employee.__dict__: {'__module__': '__main__', 'displayCount':
<function displayCount at 0xb7c84994>, 'empCount': 2,
'displayEmployee': <function displayEmployee at 0xb7c8441c>,
'__doc__': 'Common base class for all employees',
'__init__': <function __init__ at 0xb7c846bc>}
```

Destroying Objects (Garbage Collection)

Python deletes unneeded objects (built-in types or class instances) automatically to free the mer
The process by which Python periodically reclaims blocks of memory that no longer are in us
Garbage Collection.

Python's garbage collector runs during program execution and is triggered when an object's refe
reaches zero. An object's reference count changes as the number of aliases that point to it chang

An object's reference count increases when it is assigned a new name or placed in a container (l
dictionary). The object's reference count decreases when it's deleted with *del*, its reference is rea
its reference goes out of scope. When an object's reference count reaches zero, Pythor
automatically.

```
a = 40      # Create object <40>
b = a       # Increase ref. count  of <40>
c = [b]     # Increase ref. count  of <40>

del a       # Decrease ref. count  of <40>
b = 100     # Decrease ref. count  of <40>
c[0] = -1   # Decrease ref. count  of <40>
```

You normally will not notice when the garbage collector destroys an orphaned instance and
space. But a class can implement the special method *__del__()*, called a destructor, that is inv
the instance is about to be destroyed. This method might be used to clean up any non memor
used by an instance.

Example

This __del__() destructor prints the class name of an instance that is about to be destroyed −

```
#!/usr/bin/python

class Point:
   def __init__( self, x=0, y=0):
      self.x = x
      self.y = y
   def __del__(self):
      class_name = self.__class__.__name__
      print class_name, "destroyed"

pt1 = Point()
pt2 = pt1
pt3 = pt1
print id(pt1), id(pt2), id(pt3) # prints the ids of the obejcts
del pt1
del pt2
del pt3
```

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

```
3083401324 3083401324 3083401324
```

```
Point destroyed
```

Note − Ideally, you should define your classes in separate file, then you should import them ir program file using *import* statement.

Class Inheritance

Instead of starting from scratch, you can create a class by deriving it from a preexisting class b parent class in parentheses after the new class name.

The child class inherits the attributes of its parent class, and you can use those attributes as i defined in the child class. A child class can also override data members and methods from the pa

Syntax

Derived classes are declared much like their parent class; however, a list of base classes to inl given after the class name −

```
class SubClassName (ParentClass1[, ParentClass2, ...]):
   'Optional class documentation string'
   class_suite
```

Example

```
#!/usr/bin/python

class Parent:        # define parent class
   parentAttr = 100
   def __init__(self):
      print "Calling parent constructor"

   def parentMethod(self):
      print 'Calling parent method'

   def setAttr(self, attr):
      Parent.parentAttr = attr

   def getAttr(self):
      print "Parent attribute :", Parent.parentAttr

class Child(Parent): # define child class
   def __init__(self):
      print "Calling child constructor"

   def childMethod(self):
      print 'Calling child method'

c = Child()          # instance of child
c.childMethod()      # child calls its method
c.parentMethod()     # calls parent's method
c.setAttr(200)       # again call parent's method
c.getAttr()          # again call parent's method
```

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

```
Calling child constructor
Calling child method
Calling parent method
Parent attribute : 200
```

Similar way, you can drive a class from multiple parent classes as follows −

```
class A:        # define your class A
.....

class B:         # define your class B
.....

class C(A, B):   # subclass of A and B
.....
```

You can use issubclass() or isinstance() functions to check a relationships of two classes and ins

- The **issubclass(sub, sup)** boolean function returns true if the given subclass **sub** subclass of the superclass **sup**.
- The **isinstance(obj, Class)** boolean function returns true if *obj* is an instance of class an instance of a subclass of Class

Overriding Methods

You can always override your parent class methods. One reason for overriding parent's methods you may want special or different functionality in your subclass.

Example

```
#!/usr/bin/python

class Parent:        # define parent class
   def myMethod(self):
      print 'Calling parent method'

class Child(Parent): # define child class
   def myMethod(self):
      print 'Calling child method'

c = Child()          # instance of child
c.myMethod()         # child calls overridden method
```

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

```
Calling child method
```

Base Overloading Methods

Following table lists some generic functionality that you can override in your own classes −

Sr.No.	Method, Description & Sample Call
1	**__init__ (self [,args...])** Constructor (with any optional arguments) Sample Call : *obj = className(args)*
2	**__del__(self)** Destructor, deletes an object Sample Call : *del obj*
3	**__repr__(self)** Evaluable string representation Sample Call : *repr(obj)*
4	**__str__(self)** Printable string representation Sample Call : *str(obj)*
5	**__cmp__ (self, x)** Object comparison Sample Call : *cmp(obj, x)*

Overloading Operators

Suppose you have created a Vector class to represent two-dimensional vectors, what happens use the plus operator to add them? Most likely Python will yell at you.

You could, however, define the *__add__* method in your class to perform vector addition and th operator would behave as per expectation −

Example

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

```
class Vector:
   def __init__(self, a, b):
      self.a = a
      self.b = b

   def __str__(self):
      return 'Vector (%d, %d)' % (self.a, self.b)

   def __add__(self,other):
      return Vector(self.a + other.a, self.b + other.b)

v1 = Vector(2,10)
v2 = Vector(5,-2)
print v1 + v2
```

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

```
Vector(7,8)
```

Data Hiding

An object's attributes may or may not be visible outside the class definition. You need to nam with a double underscore prefix, and those attributes then are not be directly visible to outsiders.

Example

```
#!/usr/bin/python

class JustCounter:
   __secretCount = 0

   def count(self):
      self.__secretCount += 1
      print self.__secretCount

counter = JustCounter()
counter.count()
counter.count()
print counter.__secretCount
```

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

```
1
2
Traceback (most recent call last):
   File "test.py", line 12, in <module>
      print counter.__secretCount
AttributeError: JustCounter instance has no attribute '__secretCount'
```

Python protects those members by internally changing the name to include the class name. You such attributes as *object._className__attrName*. If you would replace your last line as follov

works for you −

```
.........................
print counter._JustCounter__secretCount
```

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

```
1
2
2
```

Python - Regular Expressions

A *regular expression* is a special sequence of characters that helps you match or find other string strings, using a specialized syntax held in a pattern. Regular expressions are widely used in UNI

The module **re** provides full support for Perl-like regular expressions in Python. The re module exception re.error if an error occurs while compiling or using a regular expression.

We would cover two important functions, which would be used to handle regular expressions. thing first: There are various characters, which would have special meaning when they are use expression. To avoid any confusion while dealing with regular expressions, we would use Raw **r'expression'**.

The *match* Function

This function attempts to match RE *pattern* to *string* with optional *flags*.

Here is the syntax for this function −

```
re.match(pattern, string, flags=0)
```

Here is the description of the parameters −

Sr.No.	Parameter & Description
1	**pattern** This is the regular expression to be matched.
2	**string** This is the string, which would be searched to match the pattern at the beginning of s
3	**flags** You can specify different flags using bitwise OR (|). These are modifiers, which ar

	the table below.

The *re.match* function returns a **match** object on success, **None** on failure. We use*group(num)* function of **match** object to get matched expression.

Sr.No.	Match Object Method & Description
1	**group(num=0)** This method returns entire match (or specific subgroup num)
2	**groups()** This method returns all matching subgroups in a tuple (empty if there weren't any)

Example

```
#!/usr/bin/python
import re

line = "Cats are smarter than dogs"

matchObj = re.match( r'(.*) are (.*?) .*', line, re.M|re.I)

if matchObj:
   print "matchObj.group() : ", matchObj.group()
   print "matchObj.group(1) : ", matchObj.group(1)
   print "matchObj.group(2) : ", matchObj.group(2)
else:
   print "No match!!"
```

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

```
matchObj.group() :  Cats are smarter than dogs
matchObj.group(1) :  Cats
matchObj.group(2) :  smarter
```

The *search* Function

This function searches for first occurrence of RE *pattern* within *string* with optional *flags*.

Here is the syntax for this function −

```
re.search(pattern, string, flags=0)
```

Here is the description of the parameters −

Sr.No.	Parameter & Description
1	**pattern** This is the regular expression to be matched.
2	**string** This is the string, which would be searched to match the pattern anywhere in the stri
3	**flags** You can specify different flags using bitwise OR (|). These are modifiers, which ar the table below.

The *re.search* function returns a **match** object on success, **none** on failure. We use *group(num)* function of **match** object to get matched expression.

Sr.No.	Match Object Methods & Description
1	**group(num=0)** This method returns entire match (or specific subgroup num)
2	**groups()** This method returns all matching subgroups in a tuple (empty if there weren't any)

Example

```
#!/usr/bin/python
import re

line = "Cats are smarter than dogs";

searchObj = re.search( r'(.*) are (.*?) .*', line, re.M|re.I)

if searchObj:
   print "searchObj.group() : ", searchObj.group()
   print "searchObj.group(1) : ", searchObj.group(1)
   print "searchObj.group(2) : ", searchObj.group(2)
else:
   print "Nothing found!!"
```

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

```
searchObj.group() :  Cats are smarter than dogs
searchObj.group(1) :  Cats
searchObj.group(2) :  smarter
```

Matching Versus Searching

Python offers two different primitive operations based on regular expressions: **match** checks for a match only at the beginning of the string, while **search** checks for a match anywhere in the string (this is what Perl does by default).

Example

```
#!/usr/bin/python
import re

line = "Cats are smarter than dogs";

matchObj = re.match( r'dogs', line, re.M|re.I)
if matchObj:
   print "match --> matchObj.group() : ", matchObj.group()
else:
   print "No match!!"

searchObj = re.search( r'dogs', line, re.M|re.I)
if searchObj:
   print "search --> searchObj.group() : ", searchObj.group()
else:
   print "Nothing found!!"
```

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

```
No match!!
search --> matchObj.group() :  dogs
```

Search and Replace

One of the most important **re** methods that use regular expressions is **sub**.

Syntax

```
re.sub(pattern, repl, string, max=0)
```

This method replaces all occurrences of the RE *pattern* in *string* with *repl*, substituting all occurrences unless *max* provided. This method returns modified string.

Example

```
#!/usr/bin/python
import re
```

```
phone = "2004-959-559 # This is Phone Number"

# Delete Python-style comments
num = re.sub(r'#.*$', "", phone)
print "Phone Num : ", num

# Remove anything other than digits
num = re.sub(r'\D', "", phone)
print "Phone Num : ", num
```

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

```
Phone Num :  2004-959-559
Phone Num :  2004959559
```

Regular Expression Modifiers: Option Flags

Regular expression literals may include an optional modifier to control various aspects of ma
modifiers are specified as an optional flag. You can provide multiple modifiers using exclusive
shown previously and may be represented by one of these −

Sr.No.	Modifier & Description
1	**re.I** Performs case-insensitive matching.
2	**re.L** Interprets words according to the current locale. This interpretation affects the group (\w and \W), as well as word boundary behavior(\b and \B).
3	**re.M** Makes $ match the end of a line (not just the end of the string) and makes ^ match t any line (not just the start of the string).
4	**re.S** Makes a period (dot) match any character, including a newline.
5	**re.U** Interprets letters according to the Unicode character set. This flag affects the beha \W, \b, \B.

6	**re.X** Permits "cuter" regular expression syntax. It ignores whitespace (except inside a when escaped by a backslash) and treats unescaped # as a comment marker.

Regular Expression Patterns

Except for control characters, **(+ ? . * ^ $ ( ) [ ] { } | \)**, all characters match themselves. You ca control character by preceding it with a backslash.

Following table lists the regular expression syntax that is available in Python −

Sr.No.	Pattern & Description
1	**^** Matches beginning of line.
2	**$** Matches end of line.
3	**.** Matches any single character except newline. Using m option allows it to match r well.
4	**[...]** Matches any single character in brackets.
5	**[^...]** Matches any single character not in brackets
6	**re*** Matches 0 or more occurrences of preceding expression.
7	**re+** Matches 1 or more occurrence of preceding expression.

8	**re?** Matches 0 or 1 occurrence of preceding expression.
9	**re{ n}** Matches exactly n number of occurrences of preceding expression.
10	**re{ n,}** Matches n or more occurrences of preceding expression.
11	**re{ n, m}** Matches at least n and at most m occurrences of preceding expression.
12	**a| b** Matches either a or b.
13	**(re)** Groups regular expressions and remembers matched text.
14	**(?imx)** Temporarily toggles on i, m, or x options within a regular expression. If in parenth that area is affected.
15	**(?-imx)** Temporarily toggles off i, m, or x options within a regular expression. If in parenth that area is affected.
16	**(?: re)** Groups regular expressions without remembering matched text.
17	**(?imx: re)** Temporarily toggles on i, m, or x options within parentheses.
18	**(?-imx: re)**

	Temporarily toggles off i, m, or x options within parentheses.
19	**(?#...)** Comment.
20	**(?= re)** Specifies position using a pattern. Doesn't have a range.
21	**(?! re)** Specifies position using pattern negation. Doesn't have a range.
22	**(?> re)** Matches independent pattern without backtracking.
23	**\w** Matches word characters.
24	**\W** Matches nonword characters.
25	**\s** Matches whitespace. Equivalent to [\t\n\r\f].
26	**\S** Matches nonwhitespace.
27	**\d** Matches digits. Equivalent to [0-9].
28	**\D** Matches nondigits.
29	**\A**

	Matches beginning of string.
30	**\Z** Matches end of string. If a newline exists, it matches just before newline.
31	**\z** Matches end of string.
32	**\G** Matches point where last match finished.
33	**\b** Matches word boundaries when outside brackets. Matches backspace (0x08) wł brackets.
34	**\B** Matches nonword boundaries.
35	**\n, \t, etc.** Matches newlines, carriage returns, tabs, etc.
36	**\1...\9** Matches nth grouped subexpression.
37	**\10** Matches nth grouped subexpression if it matched already. Otherwise refers to representation of a character code.

Regular Expression Examples

Literal characters

Sr.No.	Example & Description

1	**python** Match "python".

Character classes

Sr.No.	Example & Description
1	**[Pp]ython** Match "Python" or "python"
2	**rub[ye]** Match "ruby" or "rube"
3	**[aeiou]** Match any one lowercase vowel
4	**[0-9]** Match any digit; same as [0123456789]
5	**[a-z]** Match any lowercase ASCII letter
6	**[A-Z]** Match any uppercase ASCII letter
7	**[a-zA-Z0-9]** Match any of the above
8	**[^aeiou]** Match anything other than a lowercase vowel
9	**[^0-9]** Match anything other than a digit

Special Character Classes

Sr.No.	Example & Description
1	**.** Match any character except newline
2	**\d** Match a digit: [0-9]
3	**\D** Match a nondigit: [^0-9]
4	**\s** Match a whitespace character: [\t\r\n\f]
5	**\S** Match nonwhitespace: [^ \t\r\n\f]
6	**\w** Match a single word character: [A-Za-z0-9_]
7	**\W** Match a nonword character: [^A-Za-z0-9_]

Repetition Cases

Sr.No.	Example & Description
1	**ruby?** Match "rub" or "ruby": the y is optional
2	**ruby*** Match "rub" plus 0 or more ys

3	**ruby+** Match "rub" plus 1 or more ys
4	**\d{3}** Match exactly 3 digits
5	**\d{3,}** Match 3 or more digits
6	**\d{3,5}** Match 3, 4, or 5 digits

Nongreedy repetition

This matches the smallest number of repetitions −

Sr.No.	Example & Description
1	**<.*>** Greedy repetition: matches "<python>perl>"
2	**<.*?>** Nongreedy: matches "<python>" in "<python>perl>"

Grouping with Parentheses

Sr.No.	Example & Description
1	**\D\d+** No group: + repeats \d
2	**(\D\d)+** Grouped: + repeats \D\d pair

3	**([Pp]ython(,)?)+** Match "Python", "Python, python, python", etc.

Backreferences

This matches a previously matched group again −

Sr.No.	Example & Description
1	**([Pp])ython&\1ails** Match python&pails or Python&Pails
2	**(['"])[^\1]*\1** Single or double-quoted string. \1 matches whatever the 1st group matched. \2 whatever the 2nd group matched, etc.

Alternatives

Sr.No.	Example & Description
1	**python|perl** Match "python" or "perl"
2	**rub(y|le))** Match "ruby" or "ruble"
3	**Python(!+|\?)** "Python" followed by one or more ! or one ?

Anchors

This needs to specify match position.

Sr.No.	Example & Description

1	**^Python** Match "Python" at the start of a string or internal line
2	**Python$** Match "Python" at the end of a string or line
3	**\APython** Match "Python" at the start of a string
4	**Python\Z** Match "Python" at the end of a string
5	**\bPython\b** Match "Python" at a word boundary
6	**\brub\B** \B is nonword boundary: match "rub" in "rube" and "ruby" but not alone
7	**Python(?=!)** Match "Python", if followed by an exclamation point.
8	**Python(?!!)** Match "Python", if not followed by an exclamation point.

Special Syntax with Parentheses

Sr.No.	Example & Description
1	**R(?#comment)** Matches "R". All the rest is a comment
2	**R(?i)uby** Case-insensitive while matching "uby"

3	**R(?i:uby)** Same as above
4	**rub(?:y|le))** Group only without creating \1 backreference

Python - CGI Programming

The Common Gateway Interface, or CGI, is a set of standards that define how information is between the web server and a custom script. The CGI specs are currently maintained by the NC

What is CGI?

- The Common Gateway Interface, or CGI, is a standard for external gateway programs with information servers such as HTTP servers.
- The current version is CGI/1.1 and CGI/1.2 is under progress.

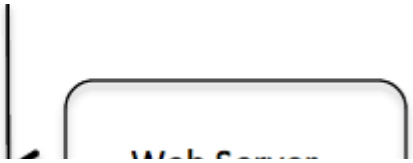
Web Browsing

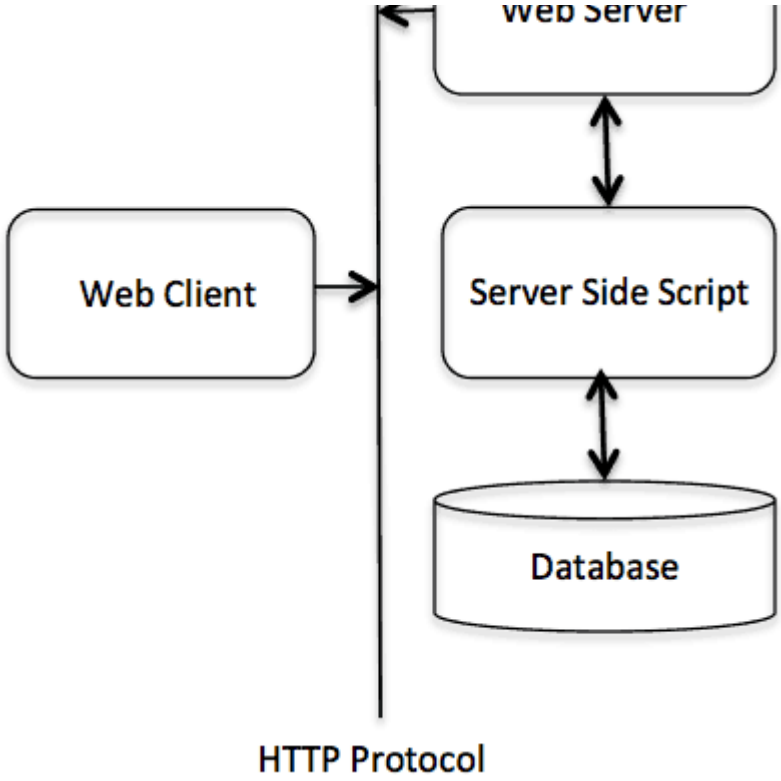
To understand the concept of CGI, let us see what happens when we click a hyper link t particular web page or URL.

- Your browser contacts the HTTP web server and demands for the URL, i.e., filename.
- Web Server parses the URL and looks for the filename. If it finds that file then sends it browser, otherwise sends an error message indicating that you requested a wrong file.
- Web browser takes response from web server and displays either the received f message.

However, it is possible to set up the HTTP server so that whenever a file in a certain directory i that file is not sent back; instead it is executed as a program, and whatever that program out back for your browser to display. This function is called the Common Gateway Interface or C programs are called CGI scripts. These CGI programs can be a Python Script, PERL Script, Sh or C++ program, etc.

CGI Architecture Diagram





Web Server Support and Configuration

Before you proceed with CGI Programming, make sure that your Web Server supports CG configured to handle CGI Programs. All the CGI Programs to be executed by the HTTP server a pre-configured directory. This directory is called CGI Directory and by convention it is named a /cgi-bin. By convention, CGI files have extension as. **cgi,** but you can keep your files with pytho **.py** as well.

By default, the Linux server is configured to run only the scripts in the cgi-bin directory in /var/ want to specify any other directory to run your CGI scripts, comment the following lines in the ht –

```
<Directory "/var/www/cgi-bin">
   AllowOverride None
   Options ExecCGI
   Order allow,deny
   Allow from all
</Directory>

<Directory "/var/www/cgi-bin">
Options All
</Directory>
```

Here, we assume that you have Web Server up and running successfully and you are able to ru CGI program like Perl or Shell, etc.

First CGI Program

Here is a simple link, which is linked to a CGI script called hello.py . This file is kept in /var/\ directory and it has following content. Before running your CGI program, make sure you have ch of file using **chmod 755 hello.py** UNIX command to make file executable.

```
#!/usr/bin/python

print "Content-type:text/html\r\n\r\n"
print '<html>'
print '<head>'
print '<title>Hello Word - First CGI Program</title>'
print '</head>'
print '<body>'
print '<h2>Hello Word! This is my first CGI program</h2>'
print '</body>'
print '</html>'
```

If you click hello.py, then this produces the following output −

Hello Word! This is my first CGI program

This hello.py script is a simple Python script, which writes its output on STDOUT file, i.e., scree one important and extra feature available which is first line to be printed **Content-type:text/h** This line is sent back to the browser and it specifies the content type to be displayed on the brow

By now you must have understood basic concept of CGI and you can write many comp programs using Python. This script can interact with any other external system also to exchange such as RDBMS.

HTTP Header

The line **Content-type:text/html\r\n\r\n** is part of HTTP header which is sent to the browser to the content. All the HTTP header will be in the following form −

```
HTTP Field Name: Field Content


For Example
Content-type: text/html\r\n\r\n
```

There are few other important HTTP headers, which you will use frequently in your CGI Program

Sr.No.	Header & Description
1	**Content-type:** A MIME string defining the format of the file being returned. Example is Content-type:t

2	**Expires: Date** The date the information becomes invalid. It is used by the browser to decide whe needs to be refreshed. A valid date string is in the format 01 Jan 1998 12:00:00 GMT.
3	**Location: URL** The URL that is returned instead of the URL requested. You can use this field to request to any file.
4	**Last-modified: Date** The date of last modification of the resource.
5	**Content-length: N** The length, in bytes, of the data being returned. The browser uses this value to estimated download time for a file.
6	**Set-Cookie: String** Set the cookie passed through the *string*

CGI Environment Variables

All the CGI programs have access to the following environment variables. These variables play a role while writing any CGI program.

Sr.No.	Variable Name & Description
1	**CONTENT_TYPE** The data type of the content. Used when the client is sending attached content to t For example, file upload.
2	**CONTENT_LENGTH** The length of the query information. It is available only for POST requests.
3	**HTTP_COOKIE** Returns the set cookies in the form of key & value pair.

4	**HTTP_USER_AGENT** The User-Agent request-header field contains information about the user agent origi request. It is name of the web browser.
5	**PATH_INFO** The path for the CGI script.
6	**QUERY_STRING** The URL-encoded information that is sent with GET method request.
7	**REMOTE_ADDR** The IP address of the remote host making the request. This is useful loggi authentication.
8	**REMOTE_HOST** The fully qualified name of the host making the request. If this information is not then REMOTE_ADDR can be used to get IR address.
9	**REQUEST_METHOD** The method used to make the request. The most common methods are GET and PC
10	**SCRIPT_FILENAME** The full path to the CGI script.
11	**SCRIPT_NAME** The name of the CGI script.
12	**SERVER_NAME** The server's hostname or IP Address
13	**SERVER_SOFTWARE** The name and version of the software the server is running.

Here is small CGI program to list out all the CGI variables. Click this link to see the Environment

```
#!/usr/bin/python

import os

print "Content-type: text/html\r\n\r\n";
print "<font size=+1>Environment</font><\br>";
for param in os.environ.keys():
   print "<b>%20s</b>: %s<\br>" % (param, os.environ[param])
```

GET and POST Methods

You must have come across many situations when you need to pass some information from your web server and ultimately to your CGI Program. Most frequently, browser uses two methods tw information to web server. These methods are GET Method and POST Method.

Passing Information using GET method

The GET method sends the encoded user information appended to the page request. The pa encoded information are separated by the ? character as follows −

```
http://www.test.com/cgi-bin/hello.py?key1=value1&key2=value2
```

The GET method is the default method to pass information from browser to web server and it long string that appears in your browser's Location:box. Never use GET method if you have p other sensitive information to pass to the server. The GET method has size limitation: only 1024 can be sent in a request string. The GET method sends information using QUERY_STRING hea be accessible in your CGI Program through QUERY_STRING environment variable.

You can pass information by simply concatenating key and value pairs along with any URL or y HTML <FORM> tags to pass information using GET method.

Simple URL Example:Get Method

Here is a simple URL, which passes two values to hello_get.py program using GET method.

/cgi-bin/hello_get.py?first_name=ZARA&last_name=ALI

Below is **hello_get.py** script to handle input given by web browser. We are going to use **cgi** mo makes it very easy to access passed information −

```
#!/usr/bin/python

# Import modules for CGI handling
import cgi, cgitb

# Create instance of FieldStorage
```

```
form = cgi.FieldStorage()

# Get data from fields
first_name = form.getvalue('first_name')
last_name  = form.getvalue('last_name')

print "Content-type:text/html\r\n\r\n"
print "<html>"
print "<head>"
print "<title>Hello - Second CGI Program</title>"
print "</head>"
print "<body>"
print "<h2>Hello %s %s</h2>" % (first_name, last_name)
print "</body>"
print "</html>"
```

This would generate the following result −

Hello ZARA ALI

Simple FORM Example:GET Method

This example passes two values using HTML FORM and submit button. We use same hello_get.py to handle this input.

```
<form action = "/cgi-bin/hello_get.py" method = "get">
First Name: <input type = "text" name = "first_name">  <br />

Last Name: <input type = "text" name = "last_name" />
<input type = "submit" value = "Submit" />
</form>
```

Here is the actual output of the above form, you enter First and Last Name and then click subn see the result.

First Name:

Last Name: Submit

Passing Information Using POST Method

A generally more reliable method of passing information to a CGI program is the POST m packages the information in exactly the same way as GET methods, but instead of sending it as after a ? in the URL it sends it as a separate message. This message comes into the CGI script of the standard input.

Below is same hello_get.py script which handles GET as well as POST method.

```
#!/usr/bin/python

# Import modules for CGI handling
import cgi, cgitb

# Create instance of FieldStorage
form = cgi.FieldStorage()

# Get data from fields
first_name = form.getvalue('first_name')
last_name  = form.getvalue('last_name')

print "Content-type:text/html\r\n\r\n"
print "<html>"
print "<head>"
print "<title>Hello - Second CGI Program</title>"
print "</head>"
print "<body>"
print "<h2>Hello %s %s</h2>" % (first_name, last_name)
print "</body>"
print "</html>"
```

Let us take again same example as above which passes two values using HTML FORM and su
We use same CGI script hello_get.py to handle this input.

```
<form action = "/cgi-bin/hello_get.py" method = "post">
First Name: <input type = "text" name = "first_name"><br />
Last Name: <input type = "text" name = "last_name" />

<input type = "submit" value = "Submit" />
</form>
```

Here is the actual output of the above form. You enter First and Last Name and then click subn
see the result.

First Name:

Last Name: Submit

Passing Checkbox Data to CGI Program

Checkboxes are used when more than one option is required to be selected.

Here is example HTML code for a form with two checkboxes −

```
<form action = "/cgi-bin/checkbox.cgi" method = "POST" target = "_blank">
<input type = "checkbox" name = "maths" value = "on" /> Maths
<input type = "checkbox" name = "physics" value = "on" /> Physics
<input type = "submit" value = "Select Subject" />
</form>
```

The result of this code is the following form −

Maths Physics Select Subject

Below is checkbox.cgi script to handle input given by web browser for checkbox button.

```
#!/usr/bin/python

# Import modules for CGI handling
import cgi, cgitb

# Create instance of FieldStorage
form = cgi.FieldStorage()

# Get data from fields
if form.getvalue('maths'):
   math_flag = "ON"
else:
   math_flag = "OFF"

if form.getvalue('physics'):
   physics_flag = "ON"
else:
   physics_flag = "OFF"

print "Content-type:text/html\r\n\r\n"
print "<html>"
print "<head>"
print "<title>Checkbox - Third CGI Program</title>"
print "</head>"
print "<body>"
print "<h2> CheckBox Maths is : %s</h2>" % math_flag
print "<h2> CheckBox Physics is : %s</h2>" % physics_flag
print "</body>"
print "</html>"
```

Passing Radio Button Data to CGI Program

Radio Buttons are used when only one option is required to be selected.

Here is example HTML code for a form with two radio buttons −

```
<form action = "/cgi-bin/radiobutton.py" method = "post" target = "_blank">
<input type = "radio" name = "subject" value = "maths" /> Maths
<input type = "radio" name = "subject" value = "physics" /> Physics
<input type = "submit" value = "Select Subject" />
</form>
```

The result of this code is the following form −

Maths Physics Select Subject

Below is radiobutton.py script to handle input given by web browser for radio button −

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

```
# Import modules for CGI handling
import cgi, cgitb

# Create instance of FieldStorage
form = cgi.FieldStorage()

# Get data from fields
if form.getvalue('subject'):
   subject = form.getvalue('subject')
else:
   subject = "Not set"

print "Content-type:text/html\r\n\r\n"
print "<html>"
print "<head>"
print "<title>Radio - Fourth CGI Program</title>"
print "</head>"
print "<body>"
print "<h2> Selected Subject is %s</h2>" % subject
print "</body>"
print "</html>"
```

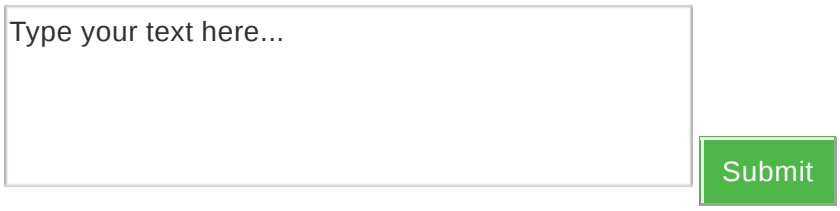
Passing Text Area Data to CGI Program

TEXTAREA element is used when multiline text has to be passed to the CGI Program.

Here is example HTML code for a form with a TEXTAREA box −

```
<form action = "/cgi-bin/textarea.py" method = "post" target = "_blank">
<textarea name = "textcontent" cols = "40" rows = "4">
Type your text here...
</textarea>
<input type = "submit" value = "Submit" />
</form>
```

The result of this code is the following form −



Below is textarea.cgi script to handle input given by web browser −

```
#!/usr/bin/python

# Import modules for CGI handling
import cgi, cgitb

# Create instance of FieldStorage
form = cgi.FieldStorage()

# Get data from fields
if form.getvalue('textcontent'):
```

```
   text_content = form.getvalue('textcontent')
else:
   text_content = "Not entered"

print "Content-type:text/html\r\n\r\n"
print "<html>"
print "<head>";
print "<title>Text Area - Fifth CGI Program</title>"
print "</head>"
print "<body>"
print "<h2> Entered Text Content is %s</h2>" % text_content
print "</body>"
```

Passing Drop Down Box Data to CGI Program

Drop Down Box is used when we have many options available but only one or two will be selecte

Here is example HTML code for a form with one drop down box −

```
<form action = "/cgi-bin/dropdown.py" method = "post" target = "_blank">
<select name = "dropdown">
<option value = "Maths" selected>Maths</option>
<option value = "Physics">Physics</option>
</select>
<input type = "submit" value = "Submit"/>
</form>
```

The result of this code is the following form −

Below is dropdown.py script to handle input given by web browser.

```
#!/usr/bin/python

# Import modules for CGI handling
import cgi, cgitb

# Create instance of FieldStorage
form = cgi.FieldStorage()

# Get data from fields
if form.getvalue('dropdown'):
   subject = form.getvalue('dropdown')
else:
   subject = "Not entered"

print "Content-type:text/html\r\n\r\n"
print "<html>"
print "<head>"
print "<title>Dropdown Box - Sixth CGI Program</title>"
print "</head>"
print "<body>"
print "<h2> Selected Subject is %s</h2>" % subject
print "</body>"
```

```
print "</html>"
```

Using Cookies in CGI

HTTP protocol is a stateless protocol. For a commercial website, it is required to maint information among different pages. For example, one user registration ends after completing m How to maintain user's session information across all the web pages?

In many situations, using cookies is the most efficient method of remembering and tracking p purchases, commissions, and other information required for better visitor experience or site statis

How It Works?

Your server sends some data to the visitor's browser in the form of a cookie. The browser may cookie. If it does, it is stored as a plain text record on the visitor's hard drive. Now, when the visit another page on your site, the cookie is available for retrieval. Once retrieved, y knows/remembers what was stored.

Cookies are a plain text data record of 5 variable-length fields −

- **Expires** − The date the cookie will expire. If this is blank, the cookie will expire whe quits the browser.
- **Domain** − The domain name of your site.
- **Path** − The path to the directory or web page that sets the cookie. This may be blank if retrieve the cookie from any directory or page.
- **Secure** − If this field contains the word "secure", then the cookie may only be retri secure server. If this field is blank, no such restriction exists.
- **Name=Value** − Cookies are set and retrieved in the form of key and value pairs.

Setting up Cookies

It is very easy to send cookies to browser. These cookies are sent along with HTTP Heade Content-type field. Assuming you want to set UserID and Password as cookies. Setting the cool as follows −

```
#!/usr/bin/python

print "Set-Cookie:UserID = XYZ;\r\n"
print "Set-Cookie:Password = XYZ123;\r\n"
print "Set-Cookie:Expires = Tuesday, 31-Dec-2007 23:12:40 GMT";\r\n"
print "Set-Cookie:Domain = www.tutorialspoint.com;\r\n"
print "Set-Cookie:Path = /perl;\n"
print "Content-type:text/html\r\n\r\n"
.....Rest of the HTML Content....
```

From this example, you must have understood how to set cookies. We use **Set-Cookie** HTTP h cookies.

It is optional to set cookies attributes like Expires, Domain, and Path. It is notable that cookies ar sending magic line **"Content-type:text/html\r\n\r\n**.

Retrieving Cookies

It is very easy to retrieve all the set cookies. Cookies are stored in CGI environme HTTP_COOKIE and they will have following form −

```
key1 = value1;key2 = value2;key3 = value3....
```

Here is an example of how to retrieve cookies.

```
#!/usr/bin/python

# Import modules for CGI handling
from os import environ
import cgi, cgitb

if environ.has_key('HTTP_COOKIE'):
   for cookie in map(strip, split(environ['HTTP_COOKIE'], ';')):
      (key, value ) = split(cookie, '=');
      if key == "UserID":
         user_id = value

      if key == "Password":
         password = value

print "User ID  = %s" % user_id
print "Password = %s" % password
```

This produces the following result for the cookies set by above script −

```
User ID = XYZ
Password = XYZ123
```

File Upload Example

To upload a file, the HTML form must have the enctype attribute set to **multipart/form-data**. Tl with the file type creates a "Browse" button.

```
<html>
<body>
   <form enctype = "multipart/form-data"
                     action = "save_file.py" method = "post">
   <p>File: <input type = "file" name = "filename" /></p>
   <p><input type = "submit" value = "Upload" /></p>
   </form>
</body>
```

```
</html>
```

The result of this code is the following form −

File: Browse... No file selected.

Upload

Above example has been disabled intentionally to save people uploading file on our server, but above code with your server.

Here is the script **save_file.py** to handle file upload −

```
#!/usr/bin/python

import cgi, os
import cgitb; cgitb.enable()

form = cgi.FieldStorage()

# Get filename here.
fileitem = form['filename']

# Test if the file was uploaded
if fileitem.filename:
   # strip leading path from file name to avoid
   # directory traversal attacks
   fn = os.path.basename(fileitem.filename)
   open('/tmp/' + fn, 'wb').write(fileitem.file.read())

   message = 'The file "' + fn + '" was uploaded successfully'

else:
   message = 'No file was uploaded'

print """\
Content-Type: text/html\n
<html>
<body>
   <p>%s</p>
</body>
</html>
""" % (message,)
```

If you run the above script on Unix/Linux, then you need to take care of replacing file separator otherwise on your windows machine above open() statement should work fine.

```
fn = os.path.basename(fileitem.filename.replace("\\", "/" ))
```

How To Raise a "File Download" Dialog Box?

Sometimes, it is desired that you want to give option where a user can click a link and it will po Download" dialogue box to the user instead of displaying actual content. This is very easy a

achieved through HTTP header. This HTTP header is be different from the header mentioned section.

For example, if you want make a **FileName** file downloadable from a given link, then its syntax i –

```
#!/usr/bin/python

# HTTP Header
print "Content-Type:application/octet-stream; name = \"FileName\"\r\n";
print "Content-Disposition: attachment; filename = \"FileName\"\r\n\n";

# Actual File Content will go here.
fo = open("foo.txt", "rb")

str = fo.read();
print str

# Close opend file
fo.close()
```

Hope you enjoyed this tutorial. If yes, please send me your feedback at: Contact Us

Python - MySQL Database Access

The Python standard for database interfaces is the Python DB-API. Most Python database adhere to this standard.

You can choose the right database for your application. Python Database API supports a wi database servers such as −

- GadFly
- mSQL
- MySQL
- PostgreSQL
- Microsoft SQL Server 2000
- Informix
- Interbase
- Oracle
- Sybase

Here is the list of available Python database interfaces: Python Database Interfaces and APIs download a separate DB API module for each database you need to access. For example, if access an Oracle database as well as a MySQL database, you must download both the Ora MySQL database modules.

The DB API provides a minimal standard for working with databases using Python structures wherever possible. This API includes the following −

- Importing the API module.
- Acquiring a connection with the database.
- Issuing SQL statements and stored procedures.
- Closing the connection

We would learn all the concepts using MySQL, so let us talk about MySQLdb module.

What is MySQLdb?

MySQLdb is an interface for connecting to a MySQL database server from Python. It implements Database API v2.0 and is built on top of the MySQL C API.

How do I Install MySQLdb?

Before proceeding, you make sure you have MySQLdb installed on your machine. Just type the your Python script and execute it −

```
#!/usr/bin/python

import MySQLdb
```

If it produces the following result, then it means MySQLdb module is not installed −

```
Traceback (most recent call last):
   File "test.py", line 3, in <module>
      import MySQLdb
ImportError: No module named MySQLdb
```

To install MySQLdb module, use the following command −

```
For Ubuntu, use the following command -
$ sudo apt-get install python-pip python-dev libmysqlclient-dev
For Fedora, use the following command -
$ sudo dnf install python python-devel mysql-devel redhat-rpm-config gcc
For Python command prompt, use the following command -
pip install MySQL-python
```

Note − Make sure you have root privilege to install above module.

Database Connection

Before connecting to a MySQL database, make sure of the followings −

- You have created a database TESTDB.
- You have created a table EMPLOYEE in TESTDB.
- This table has fields FIRST_NAME, LAST_NAME, AGE, SEX and INCOME.
- User ID "testuser" and password "test123" are set to access TESTDB.
- Python module MySQLdb is installed properly on your machine.
- You have gone through MySQL tutorial to understand MySQL Basics.

Example

Following is the example of connecting with MySQL database "TESTDB"

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

# execute SQL query using execute() method.
cursor.execute("SELECT VERSION()")

# Fetch a single row using fetchone() method.
data = cursor.fetchone()
print "Database version : %s " % data

# disconnect from server
db.close()
```

While running this script, it is producing the following result in my Linux machine.

```
Database version : 5.0.45
```

If a connection is established with the datasource, then a Connection Object is returned and sa for further use, otherwise **db** is set to None. Next, **db** object is used to create a **cursor** object, w is used to execute SQL queries. Finally, before coming out, it ensures that database connectic and resources are released.

Creating Database Table

Once a database connection is established, we are ready to create tables or records into th tables using **execute** method of the created cursor.

Example

Let us create Database table EMPLOYEE −

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

# Drop table if it already exist using execute() method.
cursor.execute("DROP TABLE IF EXISTS EMPLOYEE")

# Create table as per requirement
sql = """CREATE TABLE EMPLOYEE (
         FIRST_NAME  CHAR(20) NOT NULL,
         LAST_NAME  CHAR(20),
         AGE INT,
         SEX CHAR(1),
         INCOME FLOAT )"""

cursor.execute(sql)

# disconnect from server
db.close()
```

INSERT Operation

It is required when you want to create your records into a database table.

Example

The following example, executes SQL *INSERT* statement to create a record into EMPLOYEE tab

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

# Prepare SQL query to INSERT a record into the database.
sql = """INSERT INTO EMPLOYEE(FIRST_NAME,
         LAST_NAME, AGE, SEX, INCOME)
         VALUES ('Mac', 'Mohan', 20, 'M', 2000)"""
try:
   # Execute the SQL command
   cursor.execute(sql)
   # Commit your changes in the database
   db.commit()
except:
   # Rollback in case there is any error
   db.rollback()
```

```
# disconnect from server
db.close()
```

Above example can be written as follows to create SQL queries dynamically −

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

# Prepare SQL query to INSERT a record into the database.
sql = "INSERT INTO EMPLOYEE(FIRST_NAME, \
       LAST_NAME, AGE, SEX, INCOME) \
       VALUES ('%s', '%s', '%d', '%c', '%d' )" % \
       ('Mac', 'Mohan', 20, 'M', 2000)
try:
   # Execute the SQL command
   cursor.execute(sql)
   # Commit your changes in the database
   db.commit()
except:
   # Rollback in case there is any error
   db.rollback()

# disconnect from server
db.close()
```

Example

Following code segment is another form of execution where you can pass parameters directly −

```
.................................
user_id = "test123"
password = "password"

con.execute('insert into Login values("%s", "%s")' % \
            (user_id, password))
.................................
```

READ Operation

READ Operation on any database means to fetch some useful information from the database.

Once our database connection is established, you are ready to make a query into this databas use either **fetchone()** method to fetch single record or **fetchall()** method to fetech multiple va database table.

- **fetchone()** − It fetches the next row of a query result set. A result set is an object that when a cursor object is used to query a table.
- **fetchall()** − It fetches all the rows in a result set. If some rows have already been ext the result set, then it retrieves the remaining rows from the result set.
- **rowcount** − This is a read-only attribute and returns the number of rows that were aff execute() method.

Example

The following procedure queries all the records from EMPLOYEE table having salary more than

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

sql = "SELECT * FROM EMPLOYEE \
       WHERE INCOME > '%d'" % (1000)
try:
   # Execute the SQL command
   cursor.execute(sql)
   # Fetch all the rows in a list of lists.
   results = cursor.fetchall()
   for row in results:
      fname = row[0]
      lname = row[1]
      age = row[2]
      sex = row[3]
      income = row[4]
      # Now print fetched result
      print "fname=%s,lname=%s,age=%d,sex=%s,income=%d" % \
             (fname, lname, age, sex, income )
except:
   print "Error: unable to fecth data"

# disconnect from server
db.close()
```

This will produce the following result −

```
fname=Mac, lname=Mohan, age=20, sex=M, income=2000
```

Update Operation

UPDATE Operation on any database means to update one or more records, which are already the database.

The following procedure updates all the records having SEX as **'M'**. Here, we increase AGE of a by one year.

Example

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

# Prepare SQL query to UPDATE required records
sql = "UPDATE EMPLOYEE SET AGE = AGE + 1
                        WHERE SEX = '%c'" % ('M')
try:
   # Execute the SQL command
   cursor.execute(sql)
   # Commit your changes in the database
   db.commit()
except:
   # Rollback in case there is any error
   db.rollback()

# disconnect from server
db.close()
```

DELETE Operation

DELETE operation is required when you want to delete some records from your database. Follo procedure to delete all the records from EMPLOYEE where AGE is more than 20 −

Example

```
#!/usr/bin/python

import MySQLdb

# Open database connection
db = MySQLdb.connect("localhost","testuser","test123","TESTDB" )

# prepare a cursor object using cursor() method
cursor = db.cursor()

# Prepare SQL query to DELETE required records
sql = "DELETE FROM EMPLOYEE WHERE AGE > '%d'" % (20)
try:
   # Execute the SQL command
   cursor.execute(sql)
   # Commit your changes in the database
   db.commit()
```

```
except:
   # Rollback in case there is any error
   db.rollback()

# disconnect from server
db.close()
```

Performing Transactions

Transactions are a mechanism that ensures data consistency. Transactions have the fol properties −

- **Atomicity** − Either a transaction completes or nothing happens at all.
- **Consistency** − A transaction must start in a consistent state and leave the system in a state.
- **Isolation** − Intermediate results of a transaction are not visible outside the current trans
- **Durability** − Once a transaction was committed, the effects are persistent, even afte failure.

The Python DB API 2.0 provides two methods to either *commit* or *rollback* a transaction.

Example

You already know how to implement transactions. Here is again similar example −

```
# Prepare SQL query to DELETE required records
sql = "DELETE FROM EMPLOYEE WHERE AGE > '%d'" % (20)
try:
   # Execute the SQL command
   cursor.execute(sql)
   # Commit your changes in the database
   db.commit()
except:
   # Rollback in case there is any error
   db.rollback()
```

COMMIT Operation

Commit is the operation, which gives a green signal to database to finalize the changes, ar operation, no change can be reverted back.

Here is a simple example to call **commit** method.

```
db.commit()
```

ROLLBACK Operation

If you are not satisfied with one or more of the changes and you want to revert back thos

completely, then use **rollback()** method.

Here is a simple example to call **rollback()** method.

```
db.rollback()
```

Disconnecting Database

To disconnect Database connection, use close() method.

```
db.close()
```

If the connection to a database is closed by the user with the close() method, any outstanding t
are rolled back by the DB. However, instead of depending on any of DB lower level implementa
your application would be better off calling commit or rollback explicitly.

Handling Errors

There are many sources of errors. A few examples are a syntax error in an executed SQL s
connection failure, or calling the fetch method for an already canceled or finished statement hanc

The DB API defines a number of errors that must exist in each database module. The followin
these exceptions.

Sr.No.	Exception & Description
1	**Warning** Used for non-fatal issues. Must subclass StandardError.
2	**Error** Base class for errors. Must subclass StandardError.
3	**InterfaceError** Used for errors in the database module, not the database itself. Must subclass Error.
4	**DatabaseError** Used for errors in the database. Must subclass Error.
5	**DataError** Subclass of DatabaseError that refers to errors in the data.

6	**OperationalError** Subclass of DatabaseError that refers to errors such as the loss of a connecti database. These errors are generally outside of the control of the Python scripter.
7	**IntegrityError** Subclass of DatabaseError for situations that would damage the relational integrity uniqueness constraints or foreign keys.
8	**InternalError** Subclass of DatabaseError that refers to errors internal to the database module, cursor no longer being active.
9	**ProgrammingError** Subclass of DatabaseError that refers to errors such as a bad table name and ot that can safely be blamed on you.
10	**NotSupportedError** Subclass of DatabaseError that refers to trying to call unsupported functionality.

Your Python scripts should handle these errors, but before using any of the above exceptions, your MySQLdb has support for that exception. You can get more information about them by rea API 2.0 specification.

Python - Network Programming

Python provides two levels of access to network services. At a low level, you can access the b support in the underlying operating system, which allows you to implement clients and serve connection-oriented and connectionless protocols.

Python also has libraries that provide higher-level access to specific application-level networ such as FTP, HTTP, and so on.

This chapter gives you understanding on most famous concept in Networking - Socket Programm

What is Sockets?

Sockets are the endpoints of a bidirectional communications channel. Sockets may communic process, between processes on the same machine, or between processes on different continents

Sockets may be implemented over a number of different channel types: Unix domain sockets, and so on. The *socket* library provides specific classes for handling the common transports a generic interface for handling the rest.

Sockets have their own vocabulary −

Sr.No.	Term & Description
1	**Domain** The family of protocols that is used as the transport mechanism. These values are such as AF_INET, PF_INET, PF_UNIX, PF_X25, and so on.
2	**type** The type of communications between the two endpoints, typically SOCK_STI connection-oriented protocols and SOCK_DGRAM for connectionless protocols.
3	**protocol** Typically zero, this may be used to identify a variant of a protocol within a domain an
4	**hostname** The identifier of a network interface − A string, which can be a host name, a dotted-quad address, or an IPV6 a colon (and possibly dot) notation A string "<broadcast>", which specifies an INADDR_BROADCAST address A zero-length string, which specifies INADDR_ANY, or An Integer, interpreted as a binary address in host byte order.
5	**port** Each server listens for clients calling on one or more ports. A port may be a Fi number, a string containing a port number, or the name of a service.

The *socket* Module

To create a socket, you must use the *socket.socket()* function available in *socket* module, wh general syntax −

```
s = socket.socket (socket_family, socket_type, protocol=0)
```

Here is the description of the parameters −

- **socket_family** − This is either AF_UNIX or AF_INET, as explained earlier.
- **socket_type** − This is either SOCK_STREAM or SOCK_DGRAM.
- **protocol** − This is usually left out, defaulting to 0.

Once you have *socket* object, then you can use required functions to create your client or serv
Following is the list of functions required −

Server Socket Methods

Sr.No.	Method & Description
1	**s.bind()** This method binds address (hostname, port number pair) to socket.
2	**s.listen()** This method sets up and start TCP listener.
3	**s.accept()** This passively accept TCP client connection, waiting until connection arrives (blockin

Client Socket Methods

Sr.No.	Method & Description
1	**s.connect()** This method actively initiates TCP server connection.

General Socket Methods

Sr.No.	Method & Description
1	**s.recv()** This method receives TCP message

A Simple Server

To write Internet servers, we use the **socket** function available in socket module to create a sock
socket object is then used to call other functions to setup a socket server.

Now call **bind(hostname, port)** function to specify a *port* for your service on the given host.

Next, call the *accept* method of the returned object. This method waits until a client connects to t
specified, and then returns a *connection* object that represents the connection to that client.

```
#!/usr/bin/python           # This is server.py file

import socket               # Import socket module

s = socket.socket()         # Create a socket object
host = socket.gethostname() # Get local machine name
port = 12345                # Reserve a port for your service.
s.bind((host, port))        # Bind to the port

s.listen(5)                 # Now wait for client connection.
while True:
   c, addr = s.accept()     # Establish connection with client.
   print 'Got connection from', addr
   c.send('Thank you for connecting')
   c.close()                # Close the connection
```

A Simple Client

Let us write a very simple client program which opens a connection to a given port 12345 and
This is very simple to create a socket client using Python's *socket* module function.

The **socket.connect(hosname, port)** opens a TCP connection to *hostname* on the *port*. Once
socket open, you can read from it like any IO object. When done, remember to close it, as you
a file.

The following code is a very simple client that connects to a given host and port, reads any av
from the socket, and then exits −

```
#!/usr/bin/python           # This is client.py file

import socket               # Import socket module

s = socket.socket()         # Create a socket object
host = socket.gethostname() # Get local machine name
port = 12345                # Reserve a port for your service.

s.connect((host, port))
print s.recv(1024)
s.close()                  # Close the socket when done
```

Now run this server.py in background and then run above client.py to see the result.

```
# Following would start a server in background.
$ python server.py &

# Once server is started run client as follows:
$ python client.py
```

This would produce following result −

```
Got connection from ('127.0.0.1', 48437)
Thank you for connecting
```

Python Internet modules

A list of some important modules in Python Network/Internet programming.

Protocol	Common function	Port No	Python module
HTTP	Web pages	80	httplib, urllib, xmlrpclib
NNTP	Usenet news	119	nntplib
FTP	File transfers	20	ftplib, urllib
SMTP	Sending email	25	smtplib
POP3	Fetching email	110	poplib
IMAP4	Fetching email	143	imaplib
Telnet	Command lines	23	telnetlib
Gopher	Document transfers	70	gopherlib, urllib

Please check all the libraries mentioned above to work with FTP, SMTP, POP, and IMAP protocol

Further Readings

This was a quick start with Socket Programming. It is a vast subject. It is recommended to go following link to find more detail −

- Unix Socket Programming .
- Python Socket Library and Modules .

Python - Sending Email using SMTP

Simple Mail Transfer Protocol (SMTP) is a protocol, which handles sending e-mail and rou between mail servers.

Python provides **smtplib** module, which defines an SMTP client session object that can be us mail to any Internet machine with an SMTP or ESMTP listener daemon.

Here is a simple syntax to create one SMTP object, which can later be used to send an e-mail −

```
import smtplib

smtpObj = smtplib.SMTP( [host [, port [, local_hostname]]] )
```

Here is the detail of the parameters −

- **host** − This is the host running your SMTP server. You can specify IP address of th domain name like tutorialspoint.com. This is optional argument.
- **port** − If you are providing *host* argument, then you need to specify a port, where SM listening. Usually this port would be 25.
- **local_hostname** − If your SMTP server is running on your local machine, then you can *localhost* as of this option.

An SMTP object has an instance method called **sendmail**, which is typically used to do the wor a message. It takes three parameters −

- The *sender* − A string with the address of the sender.
- The *receivers* − A list of strings, one for each recipient.
- The *message* − A message as a string formatted as specified in the various RFCs.

Example

Here is a simple way to send one e-mail using Python script. Try it once −

```
#!/usr/bin/python

import smtplib

sender = 'from@fromdomain.com'
receivers = ['to@todomain.com']

message = """From: From Person <from@fromdomain.com>
To: To Person <to@todomain.com>
Subject: SMTP e-mail test

This is a test e-mail message.
"""

try:
   smtpObj = smtplib.SMTP('localhost')
   smtpObj.sendmail(sender, receivers, message)
   print "Successfully sent email"
```

```
except SMTPException:
   print "Error: unable to send email"
```

Here, you have placed a basic e-mail in message, using a triple quote, taking care to format t correctly. An e-mail requires a **From**, **To**, and **Subject** header, separated from the body of the e blank line.

To send the mail you use *smtpObj* to connect to the SMTP server on the local machine and th *sendmail* method along with the message, the from address, and the destination address as (even though the from and to addresses are within the e-mail itself, these aren't always used to r

If you are not running an SMTP server on your local machine, you can use *smtplib* client to co with a remote SMTP server. Unless you are using a webmail service (such as Hotmail or Yahoo e-mail provider must have provided you with outgoing mail server details that you can supp follows −

```
smtplib.SMTP('mail.your-domain.com', 25)
```

Sending an HTML e-mail using Python

When you send a text message using Python, then all the content are treated as simple text. include HTML tags in a text message, it is displayed as simple text and HTML tags will not b according to HTML syntax. But Python provides option to send an HTML message as a message.

While sending an e-mail message, you can specify a Mime version, content type and character an HTML e-mail.

Example

Following is the example to send HTML content as an e-mail. Try it once −

```
#!/usr/bin/python

import smtplib

message = """From: From Person <from@fromdomain.com>
To: To Person <to@todomain.com>
MIME-Version: 1.0
Content-type: text/html
Subject: SMTP HTML e-mail test

This is an e-mail message to be sent in HTML format

<b>This is HTML message.</b>
<h1>This is headline.</h1>
"""

try:
   smtpObj = smtplib.SMTP('localhost')
```

```
   smtpObj.sendmail(sender, receivers, message)
   print "Successfully sent email"
except SMTPException:
   print "Error: unable to send email"
```

Sending Attachments as an E-mail

To send an e-mail with mixed content requires to set **Content-type** header to **multipart/mixed** and attachment sections can be specified within **boundaries**.

A boundary is started with two hyphens followed by a unique number, which cannot appear in th part of the e-mail. A final boundary denoting the e-mail's final section must also end with two hyp

Attached files should be encoded with the **pack("m")** function to have base64 encoc transmission.

Example

Following is the example, which sends a file **/tmp/test.txt** as an attachment. Try it once −

```
#!/usr/bin/python

import smtplib
import base64

filename = "/tmp/test.txt"

# Read a file and encode it into base64 format
fo = open(filename, "rb")
filecontent = fo.read()
encodedcontent = base64.b64encode(filecontent)  # base64

sender = 'webmaster@tutorialpoint.com'
reciever = 'amrood.admin@gmail.com'

marker = "AUNIQUEMARKER"

body ="""
This is a test email to send an attachement.
"""
# Define the main headers.
part1 = """From: From Person <me@fromdomain.net>
To: To Person <amrood.admin@gmail.com>
Subject: Sending Attachement
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary=%s
--%s
""" % (marker, marker)

# Define the message action
part2 = """Content-Type: text/plain
Content-Transfer-Encoding:8bit

%s
--%s
```

```
""" % (body,marker)

# Define the attachment section
part3 = """Content-Type: multipart/mixed; name=\"%s\"
Content-Transfer-Encoding:base64
Content-Disposition: attachment; filename=%s

%s
--%s--
""" %(filename, filename, encodedcontent, marker)
message = part1 + part2 + part3

try:
   smtpObj = smtplib.SMTP('localhost')
   smtpObj.sendmail(sender, reciever, message)
   print "Successfully sent email"
except Exception:
   print "Error: unable to send email"
```

Python - Multithreaded Programming

Running several threads is similar to running several different programs concurrently, but with tl benefits −

- Multiple threads within a process share the same data space with the main threa therefore share information or communicate with each other more easily than if they we processes.
- Threads sometimes called light-weight processes and they do not require much memor they are cheaper than processes.

A thread has a beginning, an execution sequence, and a conclusion. It has an instruction pointe track of where within its context it is currently running.

- It can be pre-empted (interrupted)
- It can temporarily be put on hold (also known as sleeping) while other threads are runr called yielding.

Starting a New Thread

To spawn another thread, you need to call following method available in *thread* module −

```
thread.start_new_thread ( function, args[, kwargs] )
```

This method call enables a fast and efficient way to create new threads in both Linux and Windov

The method call returns immediately and the child thread starts and calls function with the pa *args*. When function returns, the thread terminates.

Here, *args* is a tuple of arguments; use an empty tuple to call function without passing any

kwargs is an optional dictionary of keyword arguments.

Example

```
#!/usr/bin/python

import thread
import time

# Define a function for the thread
def print_time( threadName, delay):
   count = 0
   while count < 5:
      time.sleep(delay)
      count += 1
      print "%s: %s" % ( threadName, time.ctime(time.time()) )

# Create two threads as follows
try:
   thread.start_new_thread( print_time, ("Thread-1", 2, ) )
   thread.start_new_thread( print_time, ("Thread-2", 4, ) )
except:
   print "Error: unable to start thread"

while 1:
   pass
```

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

```
Thread-1: Thu Jan 22 15:42:17 2009
Thread-1: Thu Jan 22 15:42:19 2009
Thread-2: Thu Jan 22 15:42:19 2009
Thread-1: Thu Jan 22 15:42:21 2009
Thread-2: Thu Jan 22 15:42:23 2009
Thread-1: Thu Jan 22 15:42:23 2009
Thread-1: Thu Jan 22 15:42:25 2009
Thread-2: Thu Jan 22 15:42:27 2009
Thread-2: Thu Jan 22 15:42:31 2009
Thread-2: Thu Jan 22 15:42:35 2009
```

Although it is very effective for low-level threading, but the *thread* module is very limited comp newer threading module.

The *Threading* Module

The newer threading module included with Python 2.4 provides much more powerful, high-level threads than the thread module discussed in the previous section.

The *threading* module exposes all the methods of the *thread* module and provides some additior −

- **threading.activeCount()** − Returns the number of thread objects that are active.
- **threading.currentThread()** − Returns the number of thread objects in the caller's threa
- **threading.enumerate()** − Returns a list of all thread objects that are currently active.

In addition to the methods, the threading module has the *Thread* class that implements thre methods provided by the *Thread* class are as follows −

- **run()** − The run() method is the entry point for a thread.
- **start()** − The start() method starts a thread by calling the run method.
- **join([time])** − The join() waits for threads to terminate.
- **isAlive()** − The isAlive() method checks whether a thread is still executing.
- **getName()** − The getName() method returns the name of a thread.
- **setName()** − The setName() method sets the name of a thread.

Creating Thread Using *Threading* Module

To implement a new thread using the threading module, you have to do the following −

- Define a new subclass of the *Thread* class.
- Override the *__init__(self [,args])* method to add additional arguments.
- Then, override the run(self [,args]) method to implement what the thread should do whe

Once you have created the new *Thread* subclass, you can create an instance of it and then thread by invoking the *start()*, which in turn calls *run()* method.

Example

```
#!/usr/bin/python

import threading
import time

exitFlag = 0

class myThread (threading.Thread):
   def __init__(self, threadID, name, counter):
      threading.Thread.__init__(self)
      self.threadID = threadID
      self.name = name
      self.counter = counter
   def run(self):
      print "Starting " + self.name
      print_time(self.name, self.counter, 5)
      print "Exiting " + self.name
```

```
def print_time(threadName, counter, delay):
   while counter:
      if exitFlag:
         threadName.exit()
      time.sleep(delay)
      print "%s: %s" % (threadName, time.ctime(time.time()))
      counter -= 1

# Create new threads
thread1 = myThread(1, "Thread-1", 1)
thread2 = myThread(2, "Thread-2", 2)

# Start new Threads
thread1.start()
thread2.start()

print "Exiting Main Thread"
```

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

```
Starting Thread-1
Starting Thread-2
Exiting Main Thread
Thread-1: Thu Mar 21 09:10:03 2013
Thread-1: Thu Mar 21 09:10:04 2013
Thread-2: Thu Mar 21 09:10:04 2013
Thread-1: Thu Mar 21 09:10:05 2013
Thread-1: Thu Mar 21 09:10:06 2013
Thread-2: Thu Mar 21 09:10:06 2013
Thread-1: Thu Mar 21 09:10:07 2013
Exiting Thread-1
Thread-2: Thu Mar 21 09:10:08 2013
Thread-2: Thu Mar 21 09:10:10 2013
Thread-2: Thu Mar 21 09:10:12 2013
Exiting Thread-2
```

Synchronizing Threads

The threading module provided with Python includes a simple-to-implement locking mechanism you to synchronize threads. A new lock is created by calling the *Lock()* method, which returns the

The *acquire(blocking)* method of the new lock object is used to force threads to run synchro optional *blocking* parameter enables you to control whether the thread waits to acquire the lock.

If *blocking* is set to 0, the thread returns immediately with a 0 value if the lock cannot be acquire 1 if the lock was acquired. If blocking is set to 1, the thread blocks and wait for the lock to be rele

The *release()* method of the new lock object is used to release the lock when it is no longer requi

Example

```
#!/usr/bin/python

import threading
import time

class myThread (threading.Thread):
   def __init__(self, threadID, name, counter):
      threading.Thread.__init__(self)
      self.threadID = threadID
      self.name = name
      self.counter = counter
   def run(self):
      print "Starting " + self.name
      # Get lock to synchronize threads
      threadLock.acquire()
      print_time(self.name, self.counter, 3)
      # Free lock to release next thread
      threadLock.release()

def print_time(threadName, delay, counter):
   while counter:
      time.sleep(delay)
      print "%s: %s" % (threadName, time.ctime(time.time()))
      counter -= 1

threadLock = threading.Lock()
threads = []

# Create new threads
thread1 = myThread(1, "Thread-1", 1)
thread2 = myThread(2, "Thread-2", 2)

# Start new Threads
thread1.start()
thread2.start()

# Add threads to thread list
threads.append(thread1)
threads.append(thread2)

# Wait for all threads to complete
for t in threads:
    t.join()
print "Exiting Main Thread"
```

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

```
Starting Thread-1
Starting Thread-2
Thread-1: Thu Mar 21 09:11:28 2013
Thread-1: Thu Mar 21 09:11:29 2013
Thread-1: Thu Mar 21 09:11:30 2013
Thread-2: Thu Mar 21 09:11:32 2013
```

```
Thread-2: Thu Mar 21 09:11:34 2013
Thread-2: Thu Mar 21 09:11:36 2013
Exiting Main Thread
```

Multithreaded Priority Queue

The *Queue* module allows you to create a new queue object that can hold a specific number of it are following methods to control the Queue −

- **get()** − The get() removes and returns an item from the queue.
- **put()** − The put adds item to a queue.
- **qsize()** − The qsize() returns the number of items that are currently in the queue.
- **empty()** − The empty( ) returns True if queue is empty; otherwise, False.
- **full()** − the full() returns True if queue is full; otherwise, False.

Example

```
#!/usr/bin/python

import Queue
import threading
import time

exitFlag = 0

class myThread (threading.Thread):
   def __init__(self, threadID, name, q):
      threading.Thread.__init__(self)
      self.threadID = threadID
      self.name = name
      self.q = q
   def run(self):
      print "Starting " + self.name
      process_data(self.name, self.q)
      print "Exiting " + self.name

def process_data(threadName, q):
   while not exitFlag:
      queueLock.acquire()
         if not workQueue.empty():
            data = q.get()
            queueLock.release()
            print "%s processing %s" % (threadName, data)
         else:
            queueLock.release()
         time.sleep(1)

threadList = ["Thread-1", "Thread-2", "Thread-3"]
nameList = ["One", "Two", "Three", "Four", "Five"]
queueLock = threading.Lock()
```

```
workQueue = Queue.Queue(10)
threads = []
threadID = 1

# Create new threads
for tName in threadList:
   thread = myThread(threadID, tName, workQueue)
   thread.start()
   threads.append(thread)
   threadID += 1

# Fill the queue
queueLock.acquire()
for word in nameList:
   workQueue.put(word)
queueLock.release()

# Wait for queue to empty
while not workQueue.empty():
   pass

# Notify threads it's time to exit
exitFlag = 1

# Wait for all threads to complete
for t in threads:
   t.join()
print "Exiting Main Thread"
```

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

```
Starting Thread-1
Starting Thread-2
Starting Thread-3
Thread-1 processing One
Thread-2 processing Two
Thread-3 processing Three
Thread-1 processing Four
Thread-2 processing Five
Exiting Thread-3
Exiting Thread-1
Exiting Thread-2
Exiting Main Thread
```

Python - XML Processing

XML is a portable, open source language that allows programmers to develop applications that c
by other applications, regardless of operating system and/or developmental language.

What is XML?

The Extensible Markup Language (XML) is a markup language much like HTML or SGM recommended by the World Wide Web Consortium and available as an open standard.

XML is extremely useful for keeping track of small to medium amounts of data without requir based backbone.

XML Parser Architectures and APIs

The Python standard library provides a minimal but useful set of interfaces to work with XML.

The two most basic and broadly used APIs to XML data are the SAX and DOM interfaces.

- **Simple API for XML (SAX)** − Here, you register callbacks for events of interest and parser proceed through the document. This is useful when your documents are large memory limitations, it parses the file as it reads it from disk and the entire file is nev memory.
- **Document Object Model (DOM) API** − This is a World Wide Web Consortium recor wherein the entire file is read into memory and stored in a hierarchical (tree-base represent all the features of an XML document.

SAX obviously cannot process information as fast as DOM can when working with large files. C hand, using DOM exclusively can really kill your resources, especially if used on a lot of small file

SAX is read-only, while DOM allows changes to the XML file. Since these two different A complement each other, there is no reason why you cannot use them both for large projects.

For all our XML code examples, let's use a simple XML file *movies.xml* as an input −

```
<collection shelf="New Arrivals">
<movie title="Enemy Behind">
   <type>War, Thriller</type>
   <format>DVD</format>
   <year>2003</year>
   <rating>PG</rating>
   <stars>10</stars>
   <description>Talk about a US-Japan war</description>
</movie>
<movie title="Transformers">
   <type>Anime, Science Fiction</type>
   <format>DVD</format>
   <year>1989</year>
   <rating>R</rating>
   <stars>8</stars>
   <description>A schientific fiction</description>
</movie>
   <movie title="Trigun">
   <type>Anime, Action</type>
   <format>DVD</format>
   <episodes>4</episodes>
   <rating>PG</rating>
```

```
   <stars>10</stars>
   <description>Vash the Stampede!</description>
</movie>
<movie title="Ishtar">
   <type>Comedy</type>
   <format>VHS</format>
   <rating>PG</rating>
   <stars>2</stars>
   <description>Viewable boredom</description>
</movie>
</collection>
```

Parsing XML with SAX APIs

SAX is a standard interface for event-driven XML parsing. Parsing XML with SAX generally req create your own ContentHandler by subclassing xml.sax.ContentHandler.

Your *ContentHandler* handles the particular tags and attributes of your flavor(s) of XML. A Con object provides methods to handle various parsing events. Its owning parser calls ContentHandl as it parses the XML file.

The methods *startDocument* and *endDocument* are called at the start and the end of the XM method *characters(text)* is passed character data of the XML file via the parameter text.

The ContentHandler is called at the start and end of each element. If the parser is not in names the methods *startElement(tag, attributes)* and *endElement(tag)* are called; otherwise, the co methods *startElementNS* and *endElementNS* are called. Here, tag is the element tag, and attr Attributes object.

Here are other important methods to understand before proceeding −

The *make_parser* Method

Following method creates a new parser object and returns it. The parser object created will be parser type the system finds.

```
xml.sax.make_parser( [parser_list] )
```

Here is the detail of the parameters −

- **parser_list** − The optional argument consisting of a list of parsers to use which must al the make_parser method.

The *parse* Method

Following method creates a SAX parser and uses it to parse a document.

```
xml.sax.parse( xmlfile, contenthandler[, errorhandler])
```

Here is the detail of the parameters −

- **xmlfile** − This is the name of the XML file to read from.
- **contenthandler** − This must be a ContentHandler object.
- **errorhandler** − If specified, errorhandler must be a SAX ErrorHandler object.

The *parseString* Method

There is one more method to create a SAX parser and to parse the specified **XML string**.

```
xml.sax.parseString(xmlstring, contenthandler[, errorhandler])
```

Here is the detail of the parameters −

- **xmlstring** − This is the name of the XML string to read from.
- **contenthandler** − This must be a ContentHandler object.
- **errorhandler** − If specified, errorhandler must be a SAX ErrorHandler object.

Example

```
#!/usr/bin/python

import xml.sax

class MovieHandler( xml.sax.ContentHandler ):
   def __init__(self):
      self.CurrentData = ""
      self.type = ""
      self.format = ""
      self.year = ""
      self.rating = ""
      self.stars = ""
      self.description = ""

   # Call when an element starts
   def startElement(self, tag, attributes):
      self.CurrentData = tag
      if tag == "movie":
         print "*****Movie*****"
         title = attributes["title"]
         print "Title:", title

   # Call when an elements ends
   def endElement(self, tag):
      if self.CurrentData == "type":
         print "Type:", self.type
      elif self.CurrentData == "format":
         print "Format:", self.format
      elif self.CurrentData == "year":
         print "Year:", self.year
```

```
      elif self.CurrentData == "rating":
         print "Rating:", self.rating
      elif self.CurrentData == "stars":
         print "Stars:", self.stars
      elif self.CurrentData == "description":
         print "Description:", self.description
      self.CurrentData = ""

   # Call when a character is read
   def characters(self, content):
      if self.CurrentData == "type":
         self.type = content
      elif self.CurrentData == "format":
         self.format = content
      elif self.CurrentData == "year":
         self.year = content
      elif self.CurrentData == "rating":
         self.rating = content
      elif self.CurrentData == "stars":
         self.stars = content
      elif self.CurrentData == "description":
         self.description = content

if ( __name__ == "__main__"):

   # create an XMLReader
   parser = xml.sax.make_parser()
   # turn off namepsaces
   parser.setFeature(xml.sax.handler.feature_namespaces, 0)

   # override the default ContextHandler
   Handler = MovieHandler()
   parser.setContentHandler( Handler )

   parser.parse("movies.xml")
```

This would produce following result −

```
*****Movie*****
Title: Enemy Behind
Type: War, Thriller
Format: DVD
Year: 2003
Rating: PG
Stars: 10
Description: Talk about a US-Japan war
*****Movie*****
Title: Transformers
Type: Anime, Science Fiction
Format: DVD
Year: 1989
Rating: R
```

```
Stars: 8
Description: A schientific fiction
*****Movie*****
Title: Trigun
Type: Anime, Action
Format: DVD
Rating: PG
Stars: 10
Description: Vash the Stampede!
*****Movie*****
Title: Ishtar
Type: Comedy
Format: VHS
Rating: PG
Stars: 2
Description: Viewable boredom
```

For a complete detail on SAX API documentation, please refer to standard Python SAX APIs .

Parsing XML with DOM APIs

The Document Object Model ("DOM") is a cross-language API from the World Wide Web Consor for accessing and modifying XML documents.

The DOM is extremely useful for random-access applications. SAX only allows you a view of or document at a time. If you are looking at one SAX element, you have no access to another.

Here is the easiest way to quickly load an XML document and to create a minidom object using t module. The minidom object provides a simple parser method that quickly creates a DOM tr XML file.

The sample phrase calls the parse(file [,parser]) function of the minidom object to parse tl designated by file into a DOM tree object.

```
#!/usr/bin/python

from xml.dom.minidom import parse
import xml.dom.minidom

# Open XML document using minidom parser
DOMTree = xml.dom.minidom.parse("movies.xml")
collection = DOMTree.documentElement
if collection.hasAttribute("shelf"):
   print "Root element : %s" % collection.getAttribute("shelf")

# Get all the movies in the collection
movies = collection.getElementsByTagName("movie")
```

```
# Print detail of each movie.
for movie in movies:
   print "*****Movie*****"
   if movie.hasAttribute("title"):
      print "Title: %s" % movie.getAttribute("title")

   type = movie.getElementsByTagName('type')[0]
   print "Type: %s" % type.childNodes[0].data
   format = movie.getElementsByTagName('format')[0]
   print "Format: %s" % format.childNodes[0].data
   rating = movie.getElementsByTagName('rating')[0]
   print "Rating: %s" % rating.childNodes[0].data
   description = movie.getElementsByTagName('description')[0]
   print "Description: %s" % description.childNodes[0].data
```

This would produce the following result −

```
Root element : New Arrivals
*****Movie*****
Title: Enemy Behind
Type: War, Thriller
Format: DVD
Rating: PG
Description: Talk about a US-Japan war
*****Movie*****
Title: Transformers
Type: Anime, Science Fiction
Format: DVD
Rating: R
Description: A schientific fiction
*****Movie*****
Title: Trigun
Type: Anime, Action
Format: DVD
Rating: PG
Description: Vash the Stampede!
*****Movie*****
Title: Ishtar
Type: Comedy
Format: VHS
Rating: PG
Description: Viewable boredom
```

For a complete detail on DOM API documentation, please refer to standard Python DOM APIs

Python - GUI Programming (Tkinter)

Python provides various options for developing graphical user interfaces (GUIs). Most importa

below.

- **Tkinter** − Tkinter is the Python interface to the Tk GUI toolkit shipped with Python. We this option in this chapter.
- **wxPython** − This is an open-source Python interface for wxWindows http://wxpython.or
- **JPython** − JPython is a Python port for Java which gives Python scripts seamless acc class libraries on the local machine http://www.jython.org .

There are many other interfaces available, which you can find them on the net.

Tkinter Programming

Tkinter is the standard GUI library for Python. Python when combined with Tkinter provides a fa way to create GUI applications. Tkinter provides a powerful object-oriented interface to the Tk GU

Creating a GUI application using Tkinter is an easy task. All you need to do is perform the followi

- Import the *Tkinter* module.
- Create the GUI application main window.
- Add one or more of the above-mentioned widgets to the GUI application.
- Enter the main event loop to take action against each event triggered by the user.

Example

```
#!/usr/bin/python

import Tkinter
top = Tkinter.Tk()
# Code to add widgets will go here...
top.mainloop()
```

This would create a following window −

Tkinter Widgets

Tkinter provides various controls, such as buttons, labels and text boxes used in a GUI applica controls are commonly called widgets.

There are currently 15 types of widgets in Tkinter. We present these widgets as well as a brief de the following table −

Sr.No.	Operator & Description
1	**Button** The Button widget is used to display buttons in your application.
2	**Canvas** The Canvas widget is used to draw shapes, such as lines, ovals, polygons and rect your application.
3	**Checkbutton** The Checkbutton widget is used to display a number of options as checkboxes. The select multiple options at a time.
4	**Entry** The Entry widget is used to display a single-line text field for accepting values from a u
5	**Frame** The Frame widget is used as a container widget to organize other widgets.
6	**Label** The Label widget is used to provide a single-line caption for other widgets. It can als images.
7	**Listbox** The Listbox widget is used to provide a list of options to a user.
8	**Menubutton** The Menubutton widget is used to display menus in your application.
9	**Menu** The Menu widget is used to provide various commands to a user. These comm contained inside Menubutton.

Let us study these widgets in detail −

Standard attributes

Let us take a look at how some of their common attributes.such as sizes, colors and fonts are sp

- Dimensions
- Colors
- Fonts
- Anchors
- Relief styles
- Bitmaps
- Cursors

Let us study them briefly −

Geometry Management

All Tkinter widgets have access to specific geometry management methods, which have the organizing widgets throughout the parent widget area. Tkinter exposes the following geomet classes: pack, grid, and place.

- The *pack()* Method − This geometry manager organizes widgets in blocks before p in the parent widget.
- The *grid()* Method − This geometry manager organizes widgets in a table-like stru parent widget.
- The *place()* Method − This geometry manager organizes widgets by placing them i position in the parent widget.

Let us study the geometry management methods briefly −

Python - Extension Programming with C

Any code that you write using any compiled language like C, C++, or Java can be integrated into another Python script. This code is considered as an "extension."

A Python extension module is nothing more than a normal C library. On Unix machines, the usually end in **.so** (for shared object). On Windows machines, you typically see **.dll** (for dynam library).

Pre-Requisites for Writing Extensions

To start writing your extension, you are going to need the Python header files.

- On Unix machines, this usually requires installing a developer-specific packag python2.5-dev .
- Windows users get these headers as part of the package when they use the bir installer.

Additionally, it is assumed that you have good knowledge of C or C++ to write any Python Extens programming.

First look at a Python Extension

For your first look at a Python extension module, you need to group your code into four part −

- The header file *Python.h*.
- The C functions you want to expose as the interface from your module.
- A table mapping the names of your functions as Python developers see them to C func the extension module.
- An initialization function.

The Header File *Python.h*

You need include *Python.h* header file in your C source file, which gives you access to the inte API used to hook your module into the interpreter.

Make sure to include Python.h before any other headers you might need. You need to follow t with the functions you want to call from Python.

The C Functions

The signatures of the C implementation of your functions always takes one of the following three

```
static PyObject *MyFunction( PyObject *self, PyObject *args );

static PyObject *MyFunctionWithKeywords(PyObject *self,
                                PyObject *args,
                                PyObject *kw);

static PyObject *MyFunctionWithNoArgs( PyObject *self );
```

Each one of the preceding declarations returns a Python object. There is no such thing as a *voi* Python as there is in C. If you do not want your functions to return a value, return the C e

Python's **None** value. The Python headers define a macro, Py_RETURN_NONE, that does this f

The names of your C functions can be whatever you like as they are never seen outside of th module. They are defined as *static* function.

Your C functions usually are named by combining the Python module and function names t shown here −

```
static PyObject *module_func(PyObject *self, PyObject *args) {
   /* Do your stuff here. */
   Py_RETURN_NONE;
}
```

This is a Python function called *func* inside of the module *module*. You will be putting pointer functions into the method table for the module that usually comes next in your source code.

The Method Mapping Table

This method table is a simple array of PyMethodDef structures. That structure looks something li

```
struct PyMethodDef {
   char *ml_name;
   PyCFunction ml_meth;
   int ml_flags;
   char *ml_doc;
};
```

Here is the description of the members of this structure −

- **ml_name** − This is the name of the function as the Python interpreter presents when Python programs.
- **ml_meth** − This must be the address to a function that has any one of the signatures d previous seection.
- **ml_flags** − This tells the interpreter which of the three signatures ml_meth is using.
  - This flag usually has a value of METH_VARARGS.
  - This flag can be bitwise OR'ed with METH_KEYWORDS if you want to allo arguments into your function.
  - This can also have a value of METH_NOARGS that indicates you do not wa any arguments.
- **ml_doc** − This is the docstring for the function, which could be NULL if you do not feel one.

This table needs to be terminated with a sentinel that consists of NULL and 0 values for the members.

Example

For the above-defined function, we have following method mapping table −

```
static PyMethodDef module_methods[] = {
   { "func", (PyCFunction)module_func, METH_NOARGS, NULL },
   { NULL, NULL, 0, NULL }
};
```

The Initialization Function

The last part of your extension module is the initialization function. This function is called by interpreter when the module is loaded. It is required that the function be named **init*Module***, wh is the name of the module.

The initialization function needs to be exported from the library you will be building. The Pyth define PyMODINIT_FUNC to include the appropriate incantations for that to happen for th environment in which we're compiling. All you have to do is use it when defining the function.

Your C initialization function generally has the following overall structure −

```
PyMODINIT_FUNC initModule() {
   Py_InitModule3(func, module_methods, "docstring...");
}
```

Here is the description of *Py_InitModule3* function −

- **func** − This is the function to be exported.
- ***module*_methods** − This is the mapping table name defined above.
- ***docstring*** − This is the comment you want to give in your extension.

Putting this all together looks like the following −

```
#include <Python.h>

static PyObject *module_func(PyObject *self, PyObject *args) {
   /* Do your stuff here. */
   Py_RETURN_NONE;
}

static PyMethodDef module_methods[] = {
   { "func", (PyCFunction)module_func, METH_NOARGS, NULL },
   { NULL, NULL, 0, NULL }
};

PyMODINIT_FUNC initModule() {
   Py_InitModule3(func, module_methods, "docstring...");
}
```

Example

A simple example that makes use of all the above concepts −

```
#include <Python.h>

static PyObject* helloworld(PyObject* self) {
   return Py_BuildValue("s", "Hello, Python extensions!!");
}

static char helloworld_docs[] =
   "helloworld( ): Any message you want to put here!!\n";

static PyMethodDef helloworld_funcs[] = {
   {"helloworld", (PyCFunction)helloworld,
      METH_NOARGS, helloworld_docs},
      {NULL}
};

void inithelloworld(void) {
   Py_InitModule3("helloworld", helloworld_funcs,
                  "Extension module example!");
}
```

Here the *Py_BuildValue* function is used to build a Python value. Save above code in hello.c file see how to compile and install this module to be called from Python script.

Building and Installing Extensions

The *distutils* package makes it very easy to distribute Python modules, both pure Python an modules, in a standard way. Modules are distributed in source form and built and installed via a usually called *setup.py* as follows.

For the above module, you need to prepare following setup.py script −

```
from distutils.core import setup, Extension
setup(name='helloworld', version='1.0',  \
      ext_modules=[Extension('helloworld', ['hello.c'])])
```

Now, use the following command, which would perform all needed compilation and linking ste right compiler and linker commands and flags, and copies the resulting dynamic library into an directory −

```
$ python setup.py install
```

On Unix-based systems, you'll most likely need to run this command as root in order to have pe write to the site-packages directory. This usually is not a problem on Windows.

Importing Extensions

Once you installed your extension, you would be able to import and call that extension in your P as follows −

```
#!/usr/bin/python
import helloworld

print helloworld.helloworld()
```

This would produce the following result −

```
Hello, Python extensions!!
```

Passing Function Parameters

As you will most likely want to define functions that accept arguments, you can use one c signatures for your C functions. For example, following function, that accepts some number of p would be defined like this −

```
static PyObject *module_func(PyObject *self, PyObject *args) {
   /* Parse args and do something interesting here. */
   Py_RETURN_NONE;
}
```

The method table containing an entry for the new function would look like this −

```
static PyMethodDef module_methods[] = {
   { "func", (PyCFunction)module_func, METH_NOARGS, NULL },
   { "func", module_func, METH_VARARGS, NULL },
   { NULL, NULL, 0, NULL }
};
```

You can use API *PyArg_ParseTuple* function to extract the arguments from the one PyOb passed into your C function.

The first argument to PyArg_ParseTuple is the args argument. This is the object you will be *p* second argument is a format string describing the arguments as you expect them to appear. Eac is represented by one or more characters in the format string as follows.

```
static PyObject *module_func(PyObject *self, PyObject *args) {
   int i;
   double d;
   char *s;

   if (!PyArg_ParseTuple(args, "ids", &i, &d, &s)) {
      return NULL;
   }

   /* Do something interesting here. */
   Py_RETURN_NONE;
}
```

Compiling the new version of your module and importing it enables you to invoke the new functi number of arguments of any type −

```
module.func(1, s="three", d=2.0)
module.func(i=1, d=2.0, s="three")
module.func(s="three", d=2.0, i=1)
```

You can probably come up with even more variations.

The *PyArg_ParseTuple* Function

Here is the standard signature for **PyArg_ParseTuple** function −

```
int PyArg_ParseTuple(PyObject* tuple,char* format,...)
```

This function returns 0 for errors, and a value not equal to 0 for success. tuple is the PyObject* t C function's second argument. Here *format* is a C string that describes mandatory and optional a

Here is a list of format codes for **PyArg_ParseTuple** function −

Code	C type	Meaning
c	char	A Python string of length 1 becomes a C char.
d	double	A Python float becomes a C double.
f	float	A Python float becomes a C float.
i	int	A Python int becomes a C int.
l	long	A Python int becomes a C long.
L	long long	A Python int becomes a C long long
O	PyObject*	Gets non-NULL borrowed reference to Python argument.
s	char*	Python string without embedded nulls to C char*.
s#	char*+int	Any Python string to C address and length.
t#	char*+int	Read-only single-segment buffer to C address and length.
u	Py_UNICODE*	Python Unicode without embedded nulls to C.
u#	Py_UNICODE*+int	Any Python Unicode C address and length.
w#	char*+int	Read/write single-segment buffer to C address and length.
z	char*	Like s, also accepts None (sets C char* to NULL).

z#	char*+int	Like s#, also accepts None (sets C char* to NULL).
(...)	as per ...	A Python sequence is treated as one argument per item.
|		The following arguments are optional.
:		Format end, followed by function name for error messages.
;		Format end, followed by entire error message text.

Returning Values

Py_BuildValue takes in a format string much like *PyArg_ParseTuple* does. Instead of pas addresses of the values you are building, you pass in the actual values. Here's an example sho implement an add function −

```
static PyObject *foo_add(PyObject *self, PyObject *args) {
   int a;
   int b;

   if (!PyArg_ParseTuple(args, "ii", &a, &b)) {
      return NULL;
   }
   return Py_BuildValue("i", a + b);
}
```

This is what it would look like if implemented in Python −

```
def add(a, b):
   return (a + b)
```

You can return two values from your function as follows, this would be cauptured using a list in P

```
static PyObject *foo_add_subtract(PyObject *self, PyObject *args) {
   int a;
   int b;

   if (!PyArg_ParseTuple(args, "ii", &a, &b)) {
      return NULL;
   }
   return Py_BuildValue("ii", a + b, a - b);
}
```

This is what it would look like if implemented in Python −

```
def add_subtract(a, b):
   return (a + b, a - b)
```

The *Py_BuildValue* Function

Here is the standard signature for **Py_BuildValue** function −

```
PyObject* Py_BuildValue(char* format,...)
```

Here *format* is a C string that describes the Python object to build. The following arg
Py_BuildValue are C values from which the result is built. The *PyObject** result is a new referenc

Following table lists the commonly used code strings, of which zero or more are joined into string

Code	C type	Meaning
c	char	A C char becomes a Python string of length 1.
d	double	A C double becomes a Python float.
f	float	A C float becomes a Python float.
i	int	A C int becomes a Python int.
l	long	A C long becomes a Python int.
N	PyObject*	Passes a Python object and steals a reference.
O	PyObject*	Passes a Python object and INCREFs it as normal.
O&	convert+void*	Arbitrary conversion
s	char*	C 0-terminated char* to Python string, or NULL to None.
s#	char*+int	C char* and length to Python string, or NULL to None.
u	Py_UNICODE*	C-wide, null-terminated string to Python Unicode, or NULL to N
u#	Py_UNICODE*+int	C-wide string and length to Python Unicode, or NULL to None.
w#	char*+int	Read/write single-segment buffer to C address and length.
z	char*	Like s, also accepts None (sets C char* to NULL).
z#	char*+int	Like s#, also accepts None (sets C char* to NULL).
(...)	as per ...	Builds Python tuple from C values.
[...]	as per ...	Builds Python list from C values.
{...}	as per ...	Builds Python dictionary from C values, alternating keys and va

Code {...} builds dictionaries from an even number of C values, alternately keys and values. Fo
Py_BuildValue("{issi}",23,"zig","zag",42) returns a dictionary like Python's {23:'zig','zag':42}.

Previous Page

Next