MODULE – 1

1.1 WHY SHOULD YOU LEARN TO WRITE PROGRAMS?

Programs are generally written to solve the real-time arithmetic/logical problems. Nowadays, computational devices like personal computer, laptop, and cell phones are embedded with operating system, memory and processing unit. Using such devices one can write a program in the language (which a computer can understand) of one's choice to solve various types of problems. Humans are tend get bored by doing computational tasks multiple times. Hence, the computer can act as a personal assistant for people for doing their job!! To make a computer to solve the required problem, one has to feed the proper program to it. Hence, one should know how to write a program!!

There are many programming languages that suit several situations. The programmer must be able to choose the suitable programming language for solving the required problem based on the factors like computational ability of the device, data structures that are supported in the language, complexity involved in implementing the algorithm in that language etc.

1.1.1 Creativity and Motivation

When a person starts programming, he himself will be both the programmer and the end-user. Because, he will be learning to solve the problems. But, later, he may become a proficient programmer. A programmer should have logical thinking ability to solve a given problem. He/she should be creative in analyzing the given problems, finding the possible solutions, optimizing the resources available and delivering the best possible results to the end-user. Motivation behind programming may be a job-requirement and such other prospects. But, the programmer should follow certain ethics in delivering the best possible output to his/her clients. The responsibilities of a programmer includes developing a feasible, user-friendly software with very less or no hassles. The user is expected to have only the abstract knowledge about the working of software, but not the implementation details. Hence, the programmer should strive hard towards developing most effective software.

1.1.2 Computer Hardware Architecture

To understand the art programming, it is better to know the basic architecture of computer hardware. The computer system involves some of the important parts as shown in Figure 1.1. These parts are as explained below:

- **Central Processing Unit (CPU):** It performs basic arithmetic, logical, control and I/O operations specified by the program instructions. CPU will perform the given tasks with a tremendous speed. Hence, the good programmer has to keep the CPU busy by providing enough tasks to it.
- **Main Memory:** It is the storage area to which the CPU has a direct access. Usually, the programs stored in the secondary storage are brought into main memory before the execution. The processor (CPU) will pick a job from the main memory and performs the tasks. Usually, information stored in the main memory will be vanished when the computer is turned-off.

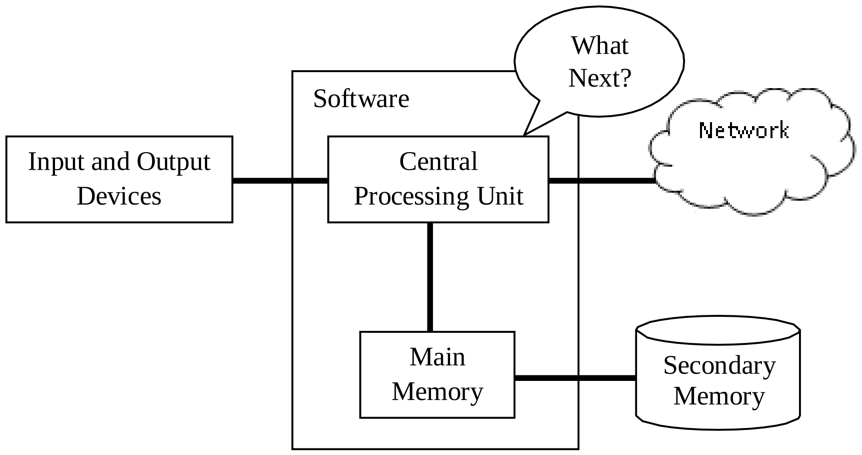


Figure 1.1 Computer Hardware Architecture

- **Secondary Memory:** The secondary memory is the permanent storage of computer. Usually, the size of secondary memory will be considerably larger than that of main memory. Hard disk, USB drive etc can be considered as secondary memory storage.
- **I/O Devices:** These are the medium of communication between the user and the computer. Keyboard, mouse, monitor, printer etc. are the examples of I/O devices.
- **Network Connection:** Nowadays, most of the computers are connected to network and hence they can communicate with other computers in a network. Retrieving the information from other computers via network will be slower compared to accessing the secondary memory. Moreover, network is not reliable always due to problem in connection.

The programmer has to use above resources sensibly to solve the problem. Usually, a programmer will be communicating with CPU by telling it ‘what to do next’. The usage of main memory, secondary memory, I/O devices also can be controlled by the programmer.

To communicate with the CPU for solving a specific problem, one has to write a set of instructions. Such a set of instructions is called as a program.

1.1.3 Understanding Programming

A programmer must have skills to look at the data/information available about a problem, analyze it and then to build a program to solve the problem. The skills to be possessed by a good programmer includes –

- **Thorough knowledge of programming language**: One needs to know the vocabulary and grammar (technically known as syntax) of the programming language. This will help in constructing proper instructions in the program.
- **Skill of implementing an idea**: A programmer should be like a ‘story teller’. That is, he must be capable of conveying something effectively. He/she must be able to solve the problem by designing suitable algorithm and implementing it. And, the program must provide appropriate output as expected.

Thus, the art of programming requires the knowledge about the problem's requirement and the strength/weakness of the programming language chosen for the implementation. It is always advisable to choose appropriate programming language that can cater the complexity of the problem to be solved.

1.1.4 Words and Sentences

Every programming language has its own constructs to form syntax of the language. Basic constructs of a programming language includes set of characters and keywords that it supports. The keywords have special meaning in any language and they are intended for doing specific task. Python has a finite set of keywords as given in Table 1.1.

Table 1.1 Keywords in Python

and	as	assert	break	class	continue
def	del	elif	else	except	False
finally	for	from	global	if	import
in	is	lambda	None	nonlocal	not
or	pass	raise	return	True	try
while	with	Yield			

A programmer may use *variables* to store the values in a program. Unlike many other programming languages, a variable in Python need not be declared before its use.

1.1.5 Python Editors and Installing Python

Before getting into details of the programming language Python, it is better to learn how to install the software. Python is freely downloadable from the internet. There are multiple IDEs (Integrated Development Environment) available for working with Python. Some of them are PyCharm, LiClipse, IDLE etc. When you install Python, the IDLE editor will be available automatically. Apart from all these editors, Python program can be run on command prompt also. One has to install suitable IDE depending on their need and the Operating System they are using. Because, there are separate set of editors (IDE) available for different OS like Window, UNIX, Ubuntu, Soloaris, Mac, etc. The basic Python can be downloaded from the link:

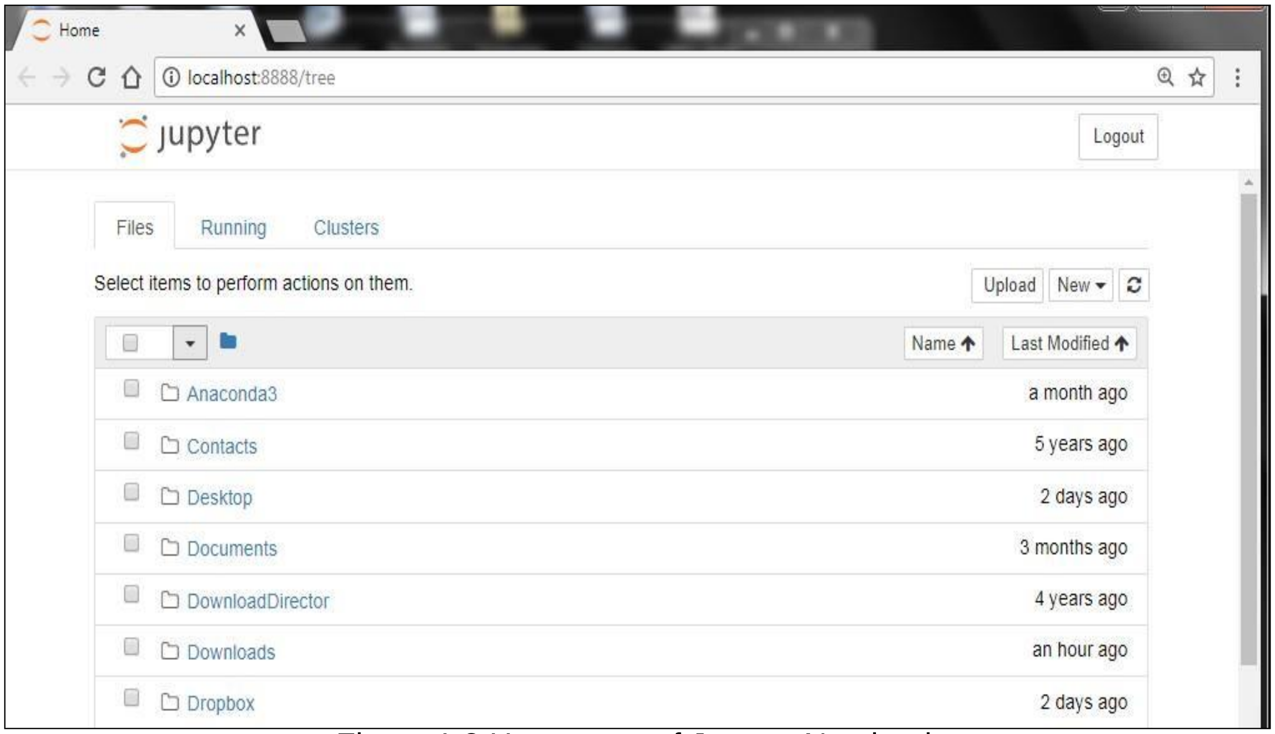
https://www.python.org/downloads/

Python has rich set of libraries for various purposes like large-scale data processing, predictive analytics, scientific computing etc. Based on one's need, the required packages can be downloaded. But, there is a free open source distribution ***Anaconda***, which simplifies package management and deployment. Hence, it is suggested for the readers to install *Anaconda* from the below given link, rather than just installing a simple Python.

https://anaconda.org/anaconda/python

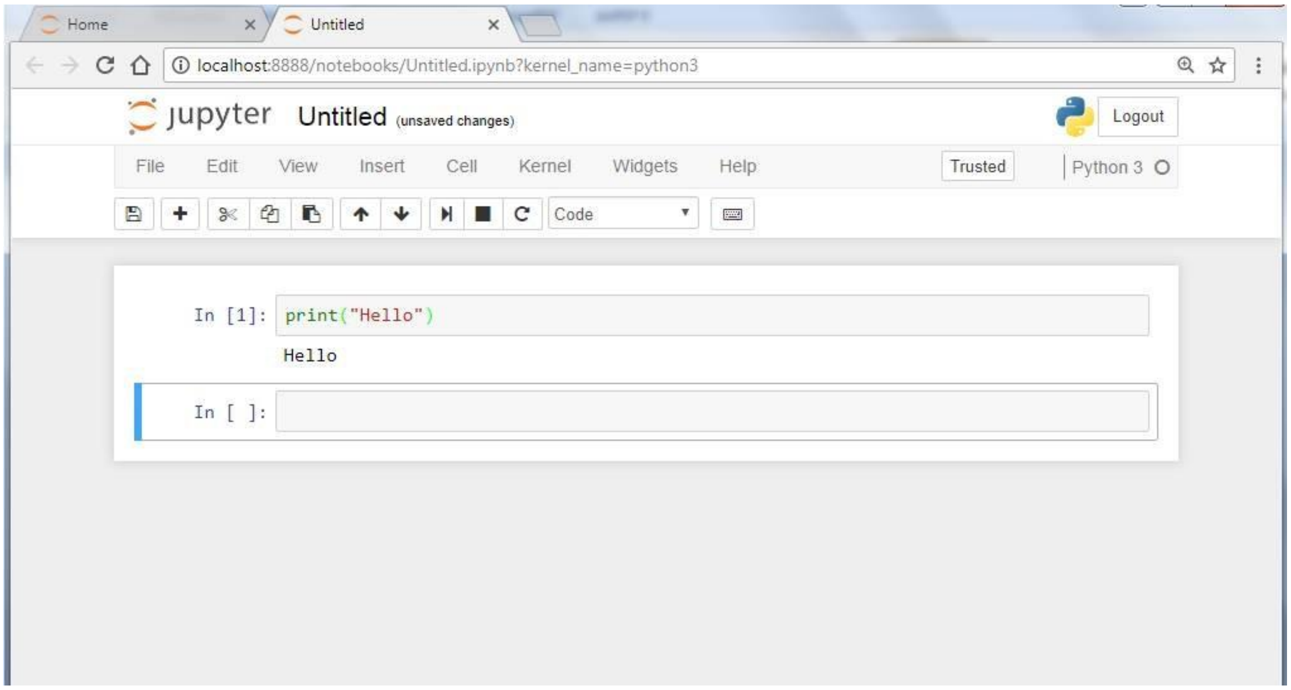
Successful installation of *anaconda* provides you Python in a command prompt, the default editor IDLE and also a browser-based interactive computing environment known as ***jupyter notebook***.

The jupyter notebook allows the programmer to create notebook documents including live code, interactive widgets, plots, equations, images etc. To code in Python using jupyter notebook, search for *jupyter notebook* in windows search (at *Start* menu). Now, a browser window will be opened similar to the one shown in Figure 1.2.



Name	Last Modified
Anaconda3	a month ago
Contacts	5 years ago
Desktop	2 days ago
Documents	3 months ago
DownloadDirector	4 years ago
Downloads	an hour ago
Dropbox	2 days ago

Figure 1.2 Homepage of Jupyter Notebook


Home
Untitled
localhost:8888/notebooks/Untitled.ipynb?kernel_name=python3
jupyter
Untitled (unsaved changes)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Trusted
Python 3
Code

```
In [1]: print("Hello")
        Hello
In [ ]:
```

Figure 1.3 IDE of Jupyter Notebook

You can choose the working directory of your choice for storing your work. To open a notebook for Python programming, click on *New* button at the right-side of the screen. Now select *Python 3* from the drop-down list. A new notebook (or workbook will be created as shown in Figure 1.3. Type a command of your choice and press *Ctrl+Enter* to run that command. One can give headings/subheadings etc for the commands being typed, store the entire workbook for future reference etc. Readers are advised to try and experience various options/menu’s available.

1.1.6 Conversing with Python

Once Python is installed, one can go ahead with working with Python. Use the IDE of your choice for doing programs in Python. After installing Python (or Anaconda distribution), if you just type ‘python’ in the command prompt, you will get the message as shown in Figure 1.4. The prompt >>> (usually called as ***chevron***) indicates the system is ready to take Python instructions. If you would like to use the default IDE of Python, that is, the IDLE, then you can just run IDLE and you will get the editor as shown in Figure 1.5.

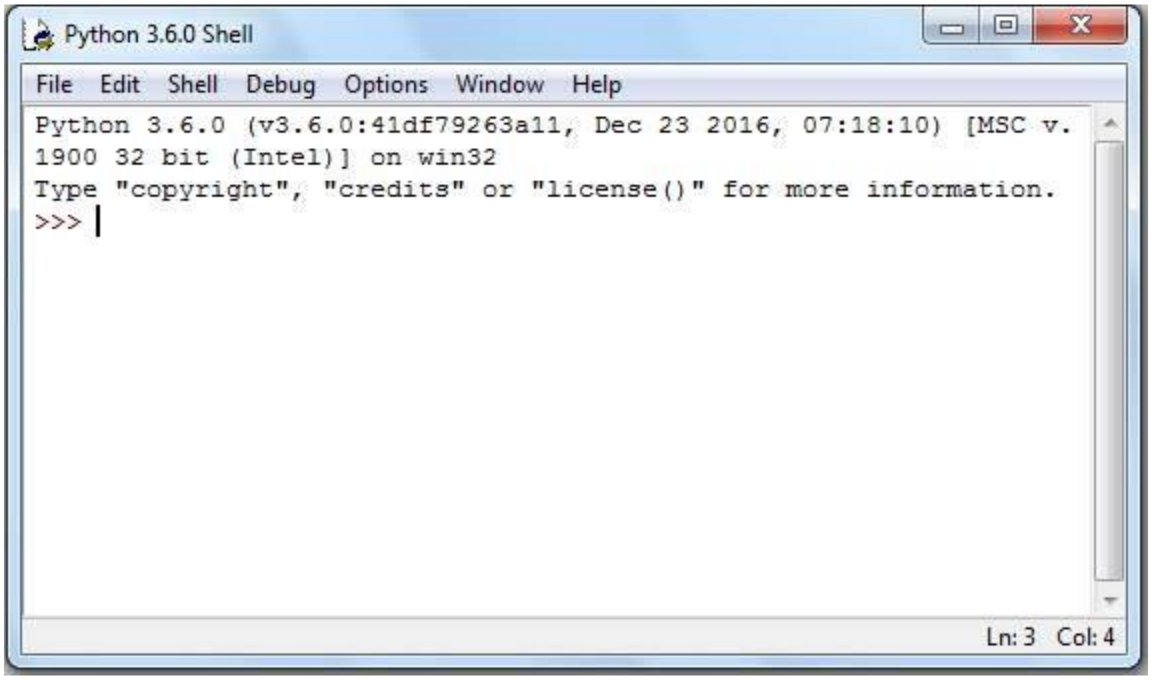
```
C:\users\rajatha>python
Python 3.7.6 (default, Dec 30 2019, 19:38:28)
[Clang 11.0.0 (clang-1100.0.33.16)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

Figure 1.4 Python initialization in command prompt

After understanding the basics of few editors of Python, let us start our communication with Python, by saying *Hello World*. The Python uses *print()* function for displaying the contents. Consider the following code –

```
>>> print(“Hello World”)       #type this and press enter key
Hello World                    #output displayed
>>>                            #prompt returns again
```

Here, after typing the first line of code and pressing the enter key, we could able to get the output of that line immediately. Then the prompt (>>>) is returned on the screen. This indicates, Python is ready to take next instruction as input for processing.



```
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.
1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> 
```

Figure 1.5 Python IDLE editor

Once we are done with the program, we can close or terminate Python by giving *quit()* command as shown –

```
>>> quit()     #Python terminates
```

1.1.7 Terminology: Interpreter and Compiler

All digital computers can understand only the machine language written in terms of zeros and ones. But, for the programmer, it is difficult to code in machine language. Hence, we generally use high level programming languages like Java, C++, PHP, Perl, JavaScript etc. Python is also one of the high level programming languages. The programs written in high level languages are then translated to machine level instruction so as to be executed by CPU. How this translation behaves depending on the type of translators viz. ***compilers*** and ***interpreters***.

A compiler translates the source code of high-level programming language into machine level language. For this purpose, the source code must be a complete program stored in a file (with extension, say, .java, .c, .cpp etc). The compiler generates executable files (usually with extensions .exe, .dll etc) that are in machine language. Later, these executable files are executed to give the output of the program.

On the other hand, interpreter performs the instructions directly, without requiring them to be pre-compiled. Interpreter parses (syntactic analysis) the source code ant interprets it immediately. Hence, every line of code can generate the output immediately, and the source code as a complete set, need not be stored in a file. That is why, in the previous section, the usage of single line `print(“Hello World”)` could able to generate the output immediately.

Consider an example of adding two numbers –

```
>>> x=10
>>> y=20
>>> z= x+y
>>> print(z)
30
```

Here, `x, y` and `z` are variables storing respective values. As each line of code above is processed immediately after the line, the variables are storing the given values. Observe that, though each line is treated independently, the knowledge (or information) gained in the previous line will be retained by Python and hence, the further lines can make use of previously used variables. Thus, each line that we write at the Python prompt are logically related, though they look independent.

NOTE that, Python do not require variable declaration (unlike in C, C++, Java etc) before its use. One can use any valid variable name for storing the values. Depending on the type (like number, string etc) of the value being assigned, the type and behavior of the variable name is judged by Python.

1.1.8 Writing a Program

As Python is interpreted language, one can keep typing every line of code one after the other (and immediately getting the output of each line) as shown in previous section. But, in real-time scenario, typing a big program is not a good idea. It is not easy to logically debug such lines. Hence, Python programs can be stored in a file with extension ***.py*** and then can be run. Programs written within a file are obviously reusable and can be run whenever we want. Also, they are transferrable from one machine to other machine via pen-drive, CD etc.

1.1.9 What is a Program?

A program is a sequence of instructions intended to do some task. For example, if we need to count the number of occurrences of each word in a text document, we can write a program to do so. Writing a program will make the task easier compared to manually counting the words in a document. Moreover, most of the times, the program is a generic solution. Hence, the same program may be used to count the frequency of words in another file. The person who does not know anything about the programming also can run this program to count the words.

Programming languages like Python will act as an intermediary between the computer and the programmer. The end-user can request the programmer to write a program to solve one's problem.

1.1.10 The Building Blocks of Programs

There are certain low-level conceptual structures to construct a program in any programming language. They are called as building-blocks of a program and listed below –

- **Input:** Every program may take some inputs from outside. The input may be through keyboard, mouse, disk-file etc. or even through some sensors like microphone, GPS etc.
- **Output:** Purpose of a program itself is to find the solution to a problem. Hence, every program must generate at least one output. Output may be displayed on a monitor or can be stored in a file. Output of a program may even be a music/voice message.
- **Sequential Execution:** In general, the instructions in the program are sequentially executed from the top.
- **Conditional Execution:** In some situations, a set of instructions have to be executed based on the truth-value of a variable or expression. Then conditional constructs (like *if*) have to be used. If the condition is true, one set of instructions will be executed and if the condition is false, the true-block is skipped.
- **Repeated Execution:** Some of the problems require a set of instructions to be repeated multiple times. Such statements can be written with the help of looping structures like *for, while* etc.
- **Reuse:** When we write the programs for general-purpose utility tasks, it is better to write them with a separate name, so that they can be used multiple times whenever/wherever required. This is possible with the help of *functions*.

The art of programming involves thorough understanding of the above constructs and using them legibly.

1.1.11 What Could Possibly Go Wrong?

It is obvious that one can do mistakes while writing a program. The possible mistakes are categorized as below –

- **Syntax Errors:** The statements which are not following the grammar (or syntax) of the programming language are tend to result in syntax errors. Python is a case-sensitive language. Hence, there is a chance that a beginner may do some syntactical mistakes while writing a program. The lines involving such mistakes are encountered by the Python when you run the program and the errors are thrown by specifying possible reasons for the error. The programmer has to correct them and then proceed further.
- **Logical Errors:** Logical error occurs due to poor understanding of the problem. Syntactically, the program will be correct. But, it may not give the expected output. For example, you are intended to find a%b, but, by mistake you have typed a/b. Then it is a logical error.
- **Semantic Errors:** A semantic error may happen due to wrong use of variables, wrong operations or in wrong order. For example, trying to modify un-initialized variable etc.

Note that, some of textbooks/authors refer logical and semantic error both as same, as the distinction between these two is very small.

NOTE: There is one more type of error – runtime error, usually called as *exceptions*. It may occur due to wrong input (like trying to divide a number by zero), problem in database connectivity etc. When a run-time error occurs, the program throws some error, which may not be understood by the normal user. And he/she may not understand how to overcome such errors. Hence, suspicious lines of code have to be treated by the programmer himself by the procedure known as *exception handling*. Python provides mechanism for handling various possible exceptions like *ArithmeticError, FloatingpointError, EOFError, MemoryError* etc. A brief idea about exception handling is there in Section 1.3.7 later in this Module. For more details, interested readers can go through the links –

https://docs.python.org/3/tutorial/errors.html and
https://docs.python.org/2/library/exceptions.html

1.2 VARIABLES, EXPRESSIONS AND STATEMENTS

After understanding some important concepts about programming and programming languages, we will now move on to learn Python as a programming language with its syntax and constructs.

1.2.1 Values and Types

A *value* is one of the basic things in a program. It may be like 2, 10.5, “Hello” etc. Each value in Python has a type. Type of 2 is integer; type of 10.5 is floating point number; “Hello” is string etc. The type of a value can be checked using ***type*** function as shown below –

```
>>> type("hello")
     <class 'str'>        #output
>>> type(3)
     <class 'int'>
>>> type(10.5)
     <class 'float'>
>>> type("15")
     <class 'str'>
```

In the above four examples, one can make out various types *str, int* and *float.* Observe the 4th example – it clearly indicates that whatever enclosed within a double quote is a string.

1.2.2 Variables

A variable is a named-literal which helps to store a value in the program. Variables may take value that can be modified wherever required in the program. Note that, in Python, a variable need not be declared with a specific type before its usage. Whenever you want a variable, just use it. The type of it will be decided by the value assigned to it. A value can be assigned to a variable using *assignment operator* (=). Consider the example given below–

```
>>> x=10
>>> print(x)
     10              #output
```

```
>>> type(x)
     <class 'int'>  #type of x is integer
>>> y="hi"
>>> print(y)
     hi             #output
>>> type(y)
     <class 'str'>  #type of y is string
```

It is observed from above examples that the value assigned to variable determines the type of that variable.

1.2.3 Variable Names and Keywords

It is a good programming practice to name the variable such that its name indicates its purpose in the program. There are certain rules to be followed while naming a variable –

- Variable name must not be a keyword
- They can contain alphabets (lowercase and uppercase) and numbers, but should not start with a number.
- It may contain a special character underscore(_), which is usually used to combine variables with two words like *my_salary, student_name* etc. No other special characters like @, $ etc. are allowed.
- As Python is case-sensitive, variable name *sum* is different from *SUM, Sum* etc.

Examples:

```
>>> 3a=5                      #starting with a number
SyntaxError: invalid syntax
>>> a$=10                     #contains $
SyntaxError: invalid syntax
>>> if=15                     #if is a keyword
SyntaxError: invalid syntax
```

1.2.4 Statements

A *statement* is a small unit of code that can be executed by the Python interpreter. It indicates some action to be carried out. In fact, a program is a sequence of such statements. Following are the examples of statements –

```
>>> print("hello")       #printing statement
hello
>>> x=5                  #assignment statement
>>> print(x)             #printing statement
```

1.2.5 Operators and Operands

Special symbols used to indicate specific tasks are called as *operators*. An operator may work on single operand (unary operator) or two operands (binary operator). There are several types of operators like arithmetic operators, relational operators, logical operators etc. in Python.

Arithmetic Operators are used to perform basic operations as listed in Table 1.2.

Table 1.2 Arithmetic Operators

Operator	**Meaning**	**Example**
+	Addition	Sum= a+b
-	Subtraction	Diff= a-b
*	Multiplication	Pro= a*b

/	Division	Q = a/b
		X = 5/3
		(X will get a value 1.666666667)

//	Floor Division – returns only integral part after division	F = a//b X= 5//3 (X will get a value 1)
%	Modulus – remainder after division	R = a %b (Remainder after dividing a by b)
**	Exponent	E = x** y (means x to the powder of y)

Relational or Comparison Operators are used to check the relationship (like less than, greater than etc) between two operands. These operators return a Boolean value – either *True* or *False*.

Assignment Operators: Apart from simple assignment operator = which is used for assigning values to variables, Python provides compound assignment operators. For example,

x= x+y

can be written as –

x+=y

Now, += is compound assignment operator. Similarly, one can use most of the arithmetic and bitwise operators (only binary operators, but not unary) like *, /, %, //, &, ^ etc. as compound assignment operators. For example,

```
>>> x=3
>>> y=5
>>> x+=y        #x=x+y
>>> print(x)
     8
>>> y//=2       #y=y//2
>>> print(y)
     2          #only integer part will be printed
```

NOTE:

1. Python has a special feature – one can assign values of different types to multiple variables in a single statement. For example,

```
>>> x, y, st=3, 4.2, "Hello"
>>> print("x= ", x, " y= ",y, " st= ", st)
     x=3  y=4.2  st=Hello
```

2. Python supports bitwise operators like &(AND), **|** (OR), ~(NOT), ^(XOR), >>(right shift) and <<(left shift). These operators will operate on every bit of the operands. Working procedure of these operators is same as that in other languages like C and C++.
3. There are some special operators in Python viz. *Identity operator* (`is` and `is not`) and *membership operator* (`in` and `not in`). These will be discussed in further Modules.

1.2.6 Expressions

A combination of values, variables and operators is known as expression. Following are few examples of expression –

```
x=5
y=x+10
z= x-y*3
```

The Python interpreter evaluates simple expressions and gives results even without *print()*. For example,

```
>>> 5
5               #displayed as it is
>>> 1+2
3               #displayed the sum
```

But, such expressions do not have any impact when written into Python script file.

1.2.7 Order of Operations

When an expression contains more than one operator, the evaluation of operators depends on the *precedence of operators*. The Python operators follow the precedence rule (which can be remembered as *PEMDAS*) as given below –

- **Parenthesis** have the highest precedence in any expression. The operations within parenthesis will be evaluated first. For example, in the expression (a+b)*c, the addition has to be done first and then the sum is multiplied with c.
- **Exponentiation** has the 2nd precedence. But, it is right associative. That is, if there are two exponentiation operations continuously, it will be evaluated from right to left (unlike most of other operators which are evaluated from left to right). For example,

```
>>> print(2**3)   #It is 2³
  8
>>> print(2**3**2) #It is 2^(3^2), so to be evaluated from right
  512
```

- **Multiplication and Division** are the next priority. Out of these two operations, whichever comes first in the expression is evaluated.

```
>>> print(5*2/4)       #multiplication and then division
  2.5
>>> print(5/4*2)       #division and then multiplication
  2.5
```

- **Addition and Subtraction** are the least priority. Out of these two operations, whichever appears first in the expression is evaluated.

1.2.8 String Operations

String concatenation can be done using + operator as shown below –

```
>>> x="32"
>>> y="45"
>>> print(x+y)
  3245
```

Observe the output: here, the value of y (a string “45”, but not a number 45) is placed just in front of value of x(a string “32”). Hence the result would be “3245” and its type would be *string.*

NOTE: One can use single quotes to enclose a string value, instead of double quotes.

1.2.9 Asking the User for Input

Python uses the built-in function ***input()*** to read the data from the keyboard. When this function is invoked, the user-input is expected. The input is read till the user presses enter-key. For example:

```
>>> str1=input()
Hello how are you?       #user input
>>> print(“String is “,str1)
String is Hello how are you?       #printing str1
```

When *input()* function is used, the curser will be blinking to receive the data. For a better understanding, it is better to have a prompt message for the user informing what needs to be entered as input. The *input()* function itself can be used to do so, as shown below –

```
>>> str1=input("Enter a string: ")
Enter a string: Hello
>>> print("You have entered: ",str1)
You have entered:  Hello
```

One can use new-line character \n in the function *input()* to make the cursor to appear in the next line of prompt message –

```
>>> str1=input("Enter a string:\n")
Enter a string:
Hello                    #cursor is pushed here
```

The key-board input received using *input()* function is always treated as a string type. If you need an integer, you need to convert it using the function ***int()***. Observe the following example –

```
>>> x=input("Enter x:")
Enter x:10          #x takes the value “10”, but not 10
>>> type(x)         #So, type of x would be str
<class 'str'>
```

```
>>> x=int(input("Enter x:"))       #use int()
Enter x:10
>>> type(x)          #Now, type of x is int
<class 'int'>
```

A function ***float()*** is used to convert a valid value enclosed within quotes into float number as shown below –

```
>>> f=input("Enter a float value:")
Enter a float value: 3.5
>>> type(f)
<class 'str'>       #f is actually a string "3.5"
>>> f=float(f)      #converting "3.5" into float value 3.5
>>> type(f)
<class 'float'>
```

A function ***chr()*** is used to convert an integer input into equivalent ASCII character.

```
>>> a=int(input("Enter an integer:"))
Enter an integer:65
>>> ch=chr(a)
>>> print("Character Equivalent of ", a, "is ",ch)
Character Equivalent of 65 is A
```

There are several such other utility functions in Python, which will be discussed later.

1.2.10 Comments

It is a good programming practice to add comments to the program wherever required. This will help someone to understand the logic of the program. Comment may be in a single line or spread into multiple lines. A single-line comment in Python starts with the symbol #. To add multiline comments, you should begin each line with the pound (#) symbol.

Ex1.
```
# This is a single-line comment
```

Python (and all programming languages) ignores the text written as comment lines. They are only for the programmer's (or any reader's) reference.

1.2.11 Choosing Mnemonic Variable Names

Choosing an appropriate name for variables in the program is always at stake. Consider the following examples –

Ex1.

```
a=10000
b=0.3*a
c=a+b
print(c)       #output is 13000
```

Ex2.

```
basic=10000
da=0.3*basic
gross_sal=basic+da
print("Gross Sal = ",gross_sal)    #output is 13000
```

One can observe that both of these two examples are performing same task. But, compared to Ex1, the variables in Ex2 are indicating what is being calculated. That is, variable names in Ex2 are indicating the purpose for which they are being used in the program. Such variable names are known as ***mnemonic variable names**.* The word *mnemonic* means *memory aid*. The mnemonic variables are created to help the programmer to remember the purpose for which they have been created.

Python can understand the set of reserved words (or keywords), and hence it flashes an error when such words are used as variable names by the programmer. Moreover, most of the Python editors have a mechanism to show keywords in a different color. Hence, programmer can easily make out the keyword immediately when he/she types that word.

1.2.12 Debugging

Some of the common errors a beginner programmer may make are syntax errors. Though Python flashes the error with a message, sometimes it may become hard to understand the cause of errors. Some of the examples are given here –

Ex1.

```
>>> avg sal=10000
SyntaxError: invalid syntax
```

Here, there is a space between the terms `avg` and `sal`, which is not allowed.

Ex2.

```
>>> m=09
SyntaxError: invalid token
```

Python does not allow preceding zeros for numeric values.

Ex3.

```
>>> basic=2000
>>> da=0.3*Basic
NameError: name 'Basic' is not defined
```

As Python is case sensitive, `basic` is different from `Basic`.

As shown in above examples, the syntax errors will be alerted by Python. But, programmer is responsible for logical errors or semantic errors. Because, if the program does not yield into expected output, it is due to mistake done by the programmer, about which Python is unaware of.

1.3 CONDITIONAL EXECUTION

In general, the statements in a program will be executed sequentially. But, sometimes we need a set of statements to be executed based on some conditions. Such situations are discussed in this section.

1.3.1 Boolean Expressions

A *Boolean Expression* is an expression which results in *True* or *False*. The *True* and *False* are special values that belong to class ***bool***. Check the following –

```
>>> type(True)
<class 'bool'>
>>> type(False)
<class 'bool'>
```

Boolean expression may be as below –

```
>>> 10==12
False
>>> x=10
>>> y=10
>>> x==y
True
```

Various comparison operations are shown in Table 1.3.

Table 1.3 Relational (Comparison) Operators

Operator	Meaning	Example
>	Greater than	a>b
<	Less than	a<b
>=	Greater than or equal to	a>=b
<=	Less than or equal to	a<=b
==	Comparison	a==b
!=	Not equal to	a !=b
is	Is same as	a is b
is not	Is not same as	a is not b

Few Examples:

```
>>> a=10
>>> b=20
>>> x= a>b
>>> print(x)
     False
>>> print(a==b)
     False
```

```
>>> print("a<b is ", a<b)
     a<b is True
>>> print("a!=b is", a!=b)
     a!=b is True
>>> 10 is 20
     False
>>> 10 is 10
     True
```

NOTE: For a first look, the operators `==` and `is` look same. Similarly, the operators `!=` and `is not` look the same. But, the operators `==` and `!=` does the ***equality test*.** That is, they will compare the values stored in the variables. Whereas, the operators `is` and `is not` does the ***identity test***. That is, they will compare whether two objects are same. Usually, two objects are same when their memory locations are same. This concept will be more clear when we take up classes and objects in Python.

1.3.2 Logical Operators

There are 3 logical operators in Python as shown in Table 1.4. (NOTE that symbols like &&, || are not used in Python for representing logical operators)

Table 1.4 Logical Operators

Operator	**Meaning**	**Example**
`and`	Returns true, if both operands are true	`a and b`
`or`	Returns true, if any one of two operands is true	`a or b`
`not`	Return true, if the operand is false (it is a unary operator)	`not a`

NOTE:
1. Logical operators treat the operands as Boolean (True or False).
2. Python treats any non-zero number as True and zero as False.
3. While using *and* operator, if the first operand is False, then the second operand is not evaluated by Python. Because *False and'*ed with anything is False.
4. In case of *or* operator, if the first operand is True, the second operand is not evaluated. Because True *or'*ed with anything is True.

Example 1 (with Boolean Operands)**:**

```
>>> x= True
>>> y= False
>>> print('x and y is', x and y)
     x and y is False
>>> print('x or y is', x or y)
     x or y is True
>>> print('Complement of x is ', not x)
     Complement of x is False
```

Example 2 (With numeric Operands)**:**

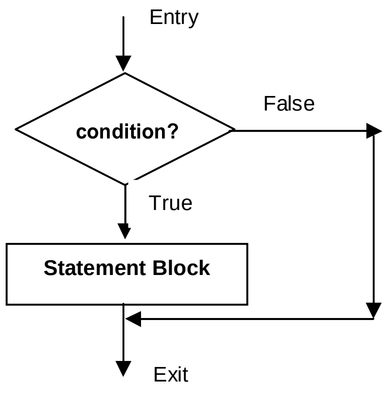
```
>>> a=-3
>>> b=10
>>> print(a and b)       #and operation
     10        #a is true, hence b is evaluated and printed

>>> print(a or b)        #or operation
     -3                  #a is true, hence b is not evaluated
>>> print(0 and 5)       #0 is false, so printed
     0
```

1.3.3 Conditional Execution

The basic level of conditional execution can be achieved in Python by using *if* statement. The syntax and flowcharts are as below –

```
if condition:
     Statement block
```



Observe the colon symbol after *condition*. When the *condition* is true, the *Statement block* will be executed. Otherwise, it is skipped. A set (block) of statements to be executed under *if* is decided by the indentation (tab space) given.

Consider an example –

```
>>> x=10
>>> if x<40:
          print("Fail")       #observe indentation after if

Fail           #output
```

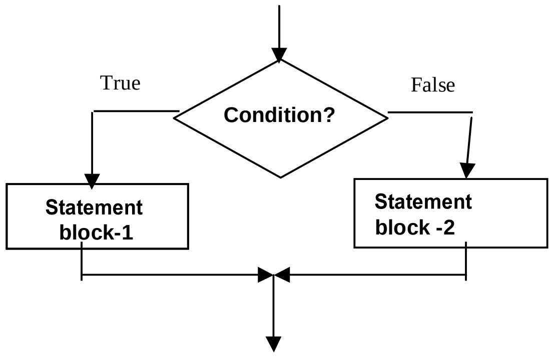
Usually, the *if* conditions have a statement block. In any case, the programmer feels to do nothing when the condition is true, the statement block can be skipped by just typing ***pass*** statement as shown below –

```
>>> if x<0:
          pass           #do nothing when x is negative
```

1.3.4 Alternative Execution

A second form of *if* statement is *alternative execution*. Here, when the condition is true, one set of statements will be executed and when the condition is false, another set of statements will be executed. The syntax and flowchart are as given below –

```
if condition:
   Statement block -1
else:
   Statement block -2
```



As the *condition* will be either true or false, only one among *Statement block-1* and *Statement block-2* will be get executed. These two alternatives are known as ***branches*.**

Example:

```
x=int(input("Enter x:"))
if x%2==0:
    print("x is even")
else:
     print("x is odd")
```

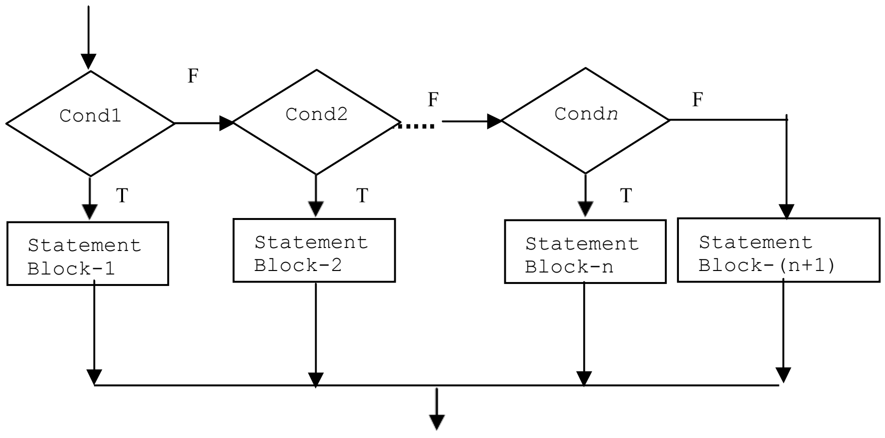
Sample output:

```
Enter x: 13
x is odd
```

1.3.5 Chained Conditionals

Some of the programs require more than one possibility to be checked for executing a set of statements. That means, we may have more than one branch. This is solved with the help of *chained conditionals*. The syntax and flowchart is given below –

```
if condition1:
     Statement Block-1
elif condition2:
     Statement Block-2
     |
     |
     |
     |
elif condition_n:
     Statement Block-n
else:
     Statement Block-(n+1)
```



The conditions are checked one by one sequentially. If any condition is satisfied, the respective statement block will be executed and further conditions are not checked. Note that, the last *else* block is not necessary always.

Example:
```
marks=float(input("Enter marks:"))
if marks >= 80:
    print("First Class with Distinction")
elif marks >= 60 and marks < 80:
    print("First Class")
elif marks >= 50 and marks < 60:
    print("Second Class")
elif marks >= 35 and marks < 50:
    print("Third Class")
else:
    print("Fail")
```

Sample Output:
```
Enter marks: 78
First Class
```

1.3.6 Nested Conditionals

The conditional statements can be nested. That is, one set of conditional statements can be nested inside the other. It can be done in multiple ways depending on programmer's requirements. Examples are given below –

Ex1.
```
marks=float(input("Enter marks:"))
if marks>=60:
    if marks<70:
        print("First Class")
    else:
        print("Distinction")
```

Sample Output:
```
Enter marks:68
First Class
```

Here, the outer condition `marks>=60` is checked first. If it is true, then there are two branches for the inner conditional. If the outer condition is false, the above code does nothing.

Ex2.
```
gender=input("Enter gender:")
age=int(input("Enter age:"))

if gender == "M" :
    if age >= 21:
        print("Boy, Eligible for Marriage")
    else:
        print("Boy, Not Eligible for Marriage")
elif gender == "F":
    if age >= 18:
        print("Girl, Eligible for Marriage")
    else:
        print("Girl, Not Eligible for Marriage")
```

Sample Output:

```
Enter gender: F
Enter age: 17
Girl, Not Eligible for Marriage
```

NOTE: Nested conditionals make the code difficult to read, even though there are proper indentations. Hence, it is advised to use logical operators like *and* to simplify the nested conditionals. For example, the outer and inner conditions in **Ex1** above can be joined as -

```
if marks>=60 and marks<70:
     #do something
```

1.3.7 Catching Exceptions using try and except

As discussed in Section 1.1.11, there is a chance of runtime error while doing some program. One of the possible reasons is wrong input. For example, consider the following code segment –

```
a=int(input("Enter a:"))
b=int(input("Enter b:"))
c=a/b
print(c)
```

When you run the above code, one of the possible situations would be –

```
Enter a:12
Enter b:0
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ZeroDivisionError: division by zero
```

For the end-user, such type of system-generated error messages is difficult to handle. So the code which is prone to runtime error must be executed conditionally within *try* block. The ***try*** block contains the statements involving suspicious code and the ***except*** block contains the possible remedy (or instructions to user informing what went wrong and what could be the way to get out of it). If something goes wrong with the statements inside ***try*** block, the ***except*** block will be executed. Otherwise, the except-block will be skipped. Consider the example –

```
a=int(input("Enter a:"))
b=int(input("Enter b:"))
try:
    c=a/b
    print(c)
```

```
except:
    print("Division by zero is not possible")
```

Output:

```
Enter a:12
Enter b:0
Division by zero is not possible
```

Handling an exception using *try* is called as ***catching*** an exception. In general, catching an exception gives the programmer to fix the probable problem, or to try again or at least to end the program gracefully.

1.3.8 Short-Circuit Evaluation of Logical Expressions

When a logical expression (expression involving operands *and, or, not*) is being evaluated, it will be processed from left to right. For example, consider the statements -

```
x= 10
y=20
if x<10 and x+y>25:
     #do something
```

Here, the expression `x<10 and x+y>25` involves the logical operator `and`. Now, `x<10` is evaluated first, which results to be *False.* As there is an `and` operator, irrespective of the result of `x+y>25`, the whole expression will be *False*. In such situations, Python ignores the remaining part of the expression. This is known as ***short-circuiting*** the evaluation. When the first part of logical expression results in *True*, then the second part has to be evaluated to know the overall result.

The short-circuiting not only saves the computational time, but it also leads to a technique known as ***guardian pattern*.** Consider following sequence of statements –

```
>>> x=5
>>> y=0
>>> x>=10 and (x/y)>2
False

>>> x>=2 and (x/y)>2
Traceback (most recent call last):
  File "<pyshell#3>", line 1, in <module>
    x>=2 and (x/y)>2
ZeroDivisionError: division by zero
```

Here, when we executed the statement `x>=10 and (x/y)>2`, the first half of logical expression itself was *False* and hence by applying short-circuit rule, the remaining part was not executed at all. Whereas, in the statement `x>=2 and (x/y)>2,` the first half is *True* and the second half is resulted in runtime-error. Thus, in the expression `x>=10 and (x/y)>2`, short-circuit rule acted as a *guardian* by preventing an error.

One can construct the logical expression to strategically place a *guard* evaluation just before the evaluation that might cause an error as follows:

```
>>> x=5
>>> y=0
>>> x>=2 and y!=0 and(x/y)>2
False
```

Here, `x>=2` results in *True*, but `y!=0` evaluates to be False. Hence, the expression `(x/y)>2` is never reached and possible error is being prevented from happening.

1.3.9 Debugging

One can observe from previous few examples that when a runtime error occurs, it displays a term *Traceback* followed by few indications about errors. A *traceback* is a stack trace from the point of error-occurrence down to the call-sequence till the point of call. This is helpful when we start using functions and when there is a sequence of multiple function calls from one to other. Then, traceback will help the programmer to identify the exact position where the error occurred. Most useful part of error message in traceback are –

- What kind of error it is
- Where it occurred

Compared to runtime errors, syntax errors are easy to find, most of the times. But, *whitespace* errors in syntax are quite tricky because spaces and tabs are invisible. For example –

```
>>> x=10
>>>  y=15
 SyntaxError: unexpected indent
```

The error here is because of additional space given before y. As Python has a different meaning (separate block of code) for indentation, one cannot give extra spaces as shown above.

In general, error messages indicate where the problem has occurred. But, the actual error may be before that point, or even in previous line of code.

1.4 FUNCTIONS

Functions are the building blocks of any programming language. A sequence of instructions intended to perform a specific independent task is known as a *function*. In this section, we will discuss various types of built-in functions, user-defined functions, applications/uses of functions etc.

1.4.1 Function Calls

A function is a named sequence of instructions for performing a task. When we define a function we will give a valid name to it, and then specify the instructions for performing required task. Later, whenever we want to do that task, a function is *called* by its name. Consider an example –

```
>>> type(15)
<class 'int'>
```

Here *type* is a function name, 15 is the argument to a function and `<class 'int'>` is the result of the function. Usually, a function *takes* zero or more arguments and *returns* the result.

1.4.2 Built-in Functions

Python provides a rich set of built-in functions for doing various tasks. The programmer/user need not know the internal working of these functions; instead, they need to know only the purpose of such functions. Some of the built in functions are given below –

- **max():** This function is used to find maximum value among the arguments. It can be used for numeric values or even to strings.
```
o max(10, 20, 14, 12)       #maximum of 4 integers
       20
o max("hello world")
       'w'            #character having maximum ASCII code
o max(3.5, -2.1, 4.8, 15.3, 0.2)
       15.3           #maximum of 5 floating point values
```

- **min():** As the name suggests, it is used to find minimum of arguments.
```
o min(10, 20, 14, 12)       #minimum of 4 integers
       10
o min("hello world")
       ' '            #space has least ASCII code here
o min(3.5, -2.1, 4.8, 15.3, 0.2)
       -2.1           #minimum of 5 floating point values
```

- **len():** This function takes a single argument and finds its length. The argument can be a string, list, tuple etc.
  - len(“hello how are you?”)
    18

There are many other built-in functions available in Python. They are discussed in further Modules, wherever they are relevant.

1.4.3 Type Conversion Functions

As we have seen earlier (while discussing *input()* function), the type of the variable/value can be converted using functions ***int()***, ***float()***, ***str()***. Consider following few examples –

```
• int('20')       #integer enclosed within single quotes
  20              #converted to integer type
• int("20")       #integer enclosed within double quotes
  20
```

-
  ```
  int("hello")    #actual string cannot be converted to int
  Traceback (most recent call last):
    File "<pyshell#23>", line 1, in <module>
      int("hello")
  ValueError: invalid literal for int() with base 10: 'hello'
  ```

-
  ```
  int(3.8)        #float value being converted to integer
  3               #round-off will not happen, fraction is ignored
  ```

-
  ```
  int(-5.6)
  -5
  ```

-
  ```
  float('3.5')    #float enclosed within single quotes
  3.5             #converted to float type
  ```

-
  ```
  float(42)       #integer is converted to float
  42.0
  ```

-
  ```
  str(4.5)        #float converted to string
  '4.5'
  ```

-
  ```
  str(21)         #integer converted to string
  '21'
  ```

1.4.4 Random Numbers

Most of the programs that we write are *deterministic*. That is, the input (or range of inputs) to the program is pre-defined and the output of the program is one of the expected values. But, for some of the real-time applications in science and technology, we need randomly generated output. This will help in simulating certain scenario. Radom number generation has important applications in games, noise detection in electronic communication, statistical sampling theory, cryptography, political and business prediction etc. These applications require the program to be *nondeterministic.* There are several algorithms to generate random numbers. But, as making a program completely *nondeterministic* is difficult and may lead to several other consequences, we generate ***pseudo-random numbers***. That is, the type (integer, float etc) and range (between 0 and 1, between 1 and 100 etc) of the random numbers are decided by the programmer, but the actual numbers are unknown. Moreover, the algorithm to generate the random number is also known to the programmer. Thus, the random numbers are generated using deterministic computation and hence, they are known as pseudo-random numbers!!

Python has a module ***random*** for the generation of random numbers. One has to *import* this module in the program. The function used is also ***random()***. By default, this function generates a random number between 0 and 1 (excluding 1). For example –

```
import random              #module random is imported
print(random.random())     #random() function is invoked
0.7430852580883088         #a random number generated
print(random.random())
0.5287778188896328         #one more random number
```

Importing a module creates an object. Using this object, one can access various functions and/or variables defined in that module. Functions are invoked using a dot operator.

There are several other functions in the module *random* apart from the function *random()*. (Do not get confused with module name and function name. Observe the parentheses while referring a function name). Few are discussed hereunder:

- **randint():** It takes two arguments *low* and *high* and returns a random integer between these two arguments (both *low* and *high* are inclusive). For example,

```
>>>random.randint(2,20)
   14                    #integer between 2 and 20 generated
>>> random.randint(2,20)
   10
```

- **choice():** This function takes a sequence (a *list* type in Python) of numbers as an argument and returns one of these numbers as a random number. For example,

```
>>> t=[1,2, -3, 45, 12, 7, 31, 22]   #create a list t
>>> random.choice(t)     #t is argument to choice()
    12                   #one of the elements in t
>>> random.choice(t)
    1                    #one of the elements in t
```

Various other functions available in *random* module can be used to generate random numbers following several probability distributions like Gaussian, Triangular, Uniform, Exponential, Weibull, Normal etc.

1.4.5 Math Functions

Python provides a rich set of mathematical functions through the module ***math***. To use these functions, the ***math*** module has to be imported in our code. Some of the important functions available in *math* are given hereunder –

- **sqrt():** This function takes one numeric argument and finds the square root of that argument.

```
>>> math.sqrt(34)       #integer argument
     5.830951894845301
>>> math.sqrt(21.5)     #floating point argument
     4.636809247747852
```

- **pi:** The constant value ***pi*** can be used directly whenever we require.

```
>>>print (math.pi)
     3.141592653589793
```

- **log10():** This function is used to find logarithm of the given argument, to the base 10.

```
>>> math.log10(2)
     0.3010299956639812
```

- **log():** This is used to compute natural logarithm (base e) of a given number.

```
>>> math.log(2)
     0.6931471805599453
```

- **sin():** As the name suggests, it is used to find *sine* value of a given argument. Note that, the argument must be in radians (not degrees). One can convert the number of degrees into radians by multiplying pi/180 as shown below –

```
>>>math.sin(90*math.pi/180)    #sin(90) is 1
     1.0
```

- **cos():** Used to find *cosine* value –

```
>>>math.cos(45*math.pi/180)
     0.7071067811865476
```

- **tan():** Function to find tangent of an angle, given as argument.

```
>>> math.tan(45*math.pi/180)
     0.9999999999999999
```

- **pow():** This function takes two arguments x and y, then finds x to the power of y.

```
>>> math.pow(3,4)
81.0
```

1.4.6 Adding New Functions (User-defined Functions)

Python facilitates programmer to define his/her own functions. The function written once can be used wherever and whenever required. The syntax of user-defined function would be –

```
def fname(arg_list):
     statement_1
     statement_2
     ……………
     Statement_n
     return value
```

Here	*def*	is a keyword indicating it as a function definition.
	fname	is any valid name given to the function
	arg_list	is list of arguments taken by a function. These are treated as inputs to the function from the position of function call. There may be zero or more arguments to a function.
	statements	are the list of instructions to perform required task.
	return	is a keyword used to return the output *value*. This statement is optional

The first line in the function ***def*** `fname(arg_list)` is known as ***function header***. The remaining lines constitute ***function body***. The function header is terminated by a colon and the function body must be indented. To come out of the function, indentation must be terminated. Unlike few other programming languages like C, C++ etc, there is no *main()*

function or specific location where a user-defined function has to be called. The programmer has to invoke (call) the function wherever required.

Consider a simple example of user-defined function –

Observe indentation

```
def myfun():
    print("Hello")
    print("Inside the function")


print("Example of function")
myfun()
print("Example over")
```

Statements outside the function without indentation. `myfun()` is called here.

The output of above program would be –

```
Example of function
Hello
Inside the function
Example over
```

The function definition creates an object of type *function*. In the above example, `myfun` is internally an object. This can be verified by using the statement –

```
>>>print(myfun)              # myfun without parenthesis
     <function myfun at 0x0219BFA8>
>>> type(myfun)              # myfun without parenthesis
     <class 'function'>
```

Here, the first output indicates that `myfun` is an object which is being stored at the memory address `0x0219BFA8` (0x indicates octal number). The second output clearly shows `myfun` is of type `function`.

(**NOTE:** In fact, in Python every type is in the form of class. Hence, when we apply *type* on any variable/object, it displays respective class name. The detailed study of classes will be done in Module 4.)

The *flow of execution* of every program is sequential from top to bottom, a function can be invoked only after defining it. Usage of function name before its definition will generate error. Observe the following code:

```
print("Example of function")
myfun()                      #function call before definition
print("Example over")

def myfun():                 #function definition is here
    print("Hello")
    print("Inside the function")
```

The above code would generate error saying

```
NameError: name 'myfun' is not defined
```

```
def myfun():
    print("Inside myfun()")

def repeat():
    myfun()
    print("Inside repeat()")
    myfun()


print("Example of function")

repeat()
print("Example over")
```

Functions are meant for code-reusability. That is, a set of instructions written as a function need not be repeated. Instead, they can be called multiple times whenever required. Consider the enhanced version of previous program as below –

The output is –

```
Example of function
Inside myfun()
Inside repeat()
Inside myfun()
Example over
```

Observe the output of the program to understand the flow of execution of the program. Initially, we have two function definitions `myfun()` and `repeat()` one after the other. But, functions are not executed unless they are called (or invoked). Hence, the first line to execute in the above program is –

```
print("Example of function")
```

Then, there is a function call `repeat()`. So, the program control jumps to this function. Inside `repeat()`, there is a call for `myfun()`. Now, program control jumps to `myfun()` and executes the statements inside and returns back to `repeat()` function. The statement `print("Inside repeat()")` is executed. Once again there is a call for `myfun()` function and hence, program control jumps there. The function `myfun()` is executed and returns to `repeat()`. As there are no more statements in `repeat()`, the control returns to the original position of its call. Now there is a statement `print("Example over")` to execute, and program is terminated.

1.4.7 Parameters and Arguments

In the previous section, we have seen simple example of a user-defined function, where the function was without any argument. But, a function may take arguments as an input from the calling function. Consider an example of a function which takes a single argument as below –

```
def test(var):
    print("Inside test()")
    print("Argument is ",var)


print("Example of function with arguments")
x="hello"
test(x)
y=20
test(y)
print("Over!!")
```

The output would be –

```
Example of function with arguments
Inside test()
Argument is hello
Inside test()
Argument is 20
Over!!
```

In the above program, `var` is called as *parameter* and `x` and `y` are called as *arguments.* The argument is being passed when a function `test()` is invoked. The parameter receives the argument as an input and statements inside the function are executed. As Python variables are not of specific data types in general, one can pass any type of value to the function as an argument.

Python has a special feature of applying multiplication operation on arguments while passing them to a function. Consider the modified version of above program –

```
def test(var):
    print("Inside test()")
    print("Argument is ",var)


print("Example of function with arguments")
x="hello"
test(x*3)
y=20
test(y*3)
print("Over!!")
```

The output would be –

```
Example of function with arguments
Inside test()
Argument is hellohellohello        #observe repetition
Inside test()
Argument is 60                     #observe multiplication
Over!!
```

One can observe that, when the argument is of type *string*, then multiplication indicates that string is repeated 3 times. Whereas, when the argument is of numeric type (here, integer), then the value of that argument is literally multiplied by 3.

1.4.8 Fruitful Functions and void Functions

A function that performs some task, but do not return any value to the calling function is known as ***void function***. The examples of user-defined functions considered till now are void functions. The function which returns some result to the calling function after performing a task is known as ***fruitful function.*** The built-in functions like mathematical functions, random number generating functions etc. that have been considered earlier are examples for fruitful functions. One can write a user-defined function so as to return a value to the calling function as shown in the following example –

```
def sum(a,b):
    return a+b

x=int(input("Enter a number:"))
y=int(input("Enter another number:"))

s=sum(x,y)
print("Sum of two numbers:",s)
```

The sample output would be –

```
Enter a number:3
Enter another number:4
Sum of two numbers: 7
```

In the above example, The function `sum()` take two arguments and returns their sum to the receiving variable `s`.

When a function returns something and if it is not received using a LHS variable, then the return value will not be available. For instance, in the above example if we just use the statement `sum(x,y)` instead of `s=sum(x,y)`, then the value returned from the function is of no use. On the other hand, if we use a variable at LHS while calling void functions, it will receive `None.` For example,

```
p= test(var)    #function used in previous example
print(p)
```

Now, the value of `p` would be printed as `None`. Note that, `None` is not a string, instead it is of type `class 'NoneType'`. This type of object indicates *no value*.

1.4.9 Why Functions?

Functions are essential part of programming because of following reasons –

- Creating a new function gives the programmer an opportunity to name a group of statements, which makes the program easier to read, understand, and debug.
- Functions can make a program smaller by eliminating repetitive code. If any modification is required, it can be done only at one place.
- Dividing a long program into functions allows the programmer to debug the independent functions separately and then combine all functions to get the solution of original problem.
- Well-designed functions are often useful for many programs. The functions written once for a specific purpose can be re-used in any other program.

For the Curious Minds (Something beyond the syllabus)

Special parameters of print() – *sep* and *end* :

Consider an example of printing two values using *print()* as below –

```
>>> x=10
>>> y=20
>>> print(x,y)
10 20          #space is added between two values
```

Observe that the two values are separated by a space without mentioning anything specific. This is possible because of the existence of an argument ***sep*** in the *print()* function whose default value is white space. This argument makes sure that various values to be printed are separated by a space for a better representation of output.

The programmer has a liberty in Python to give any other character(or string) as a separator by explicitly mentioning it in *print()* as shown below –

```
>>> print("18","2","2018",sep='-')
     18-2-2018
```

We can observe that the values have been separated by hyphen, which is given as a value for the argument *sep*. Consider one more example –

```
>>> college="RNSIT"
>>> address="Channasandra"
>>> print(college, address, sep='@')
     RNSIT@Channasandra
```

If you want to deliberately suppress any separator, then the value of *sep* can be set with empty string as shown below –

```
>>> print("Hello","World", sep='')
     HelloWorld
```

You might have observed that in Python program, the *print()* adds a new line after printing the data. In a Python script file, if you have two statements like –

```
          print("Hello")
          print("World")
```

then, the output would be

```
          Hello
          World
```

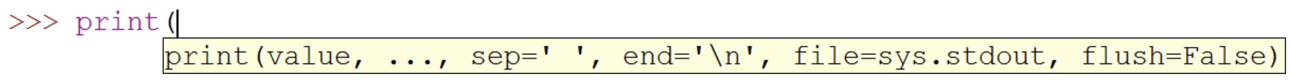
This may be quite unusual for those who have experienced programming languages like C, C++ etc. In these languages, one has to specifically insert a new-line character (\n) to get the output in different lines. But, in Python without programmer's intervention, a new line will be inserted. This is possible because, the *print()* function in Python has one more special argument ***end*** whose default value itself is new-line. Again, the default value of this argument can be changed by the programmer as shown below (Run these lines using a script file, but not in the terminal/command prompt) –

```
          print("Hello", end= '@')
          print("World")
```

The output would be –

```
          Hello@World
```

In fact, when you just type *print* and open a parentheses in any Python IDE, the intelliSense (the context-aware code completion feature of a programming language which helps the programmer with certain suggestions using a pale-yellow box) of *print()* will show the existence of ***sep*** and ***end*** arguments as below –



```
>>> print(
          print(value, ..., sep=' ', end='\n', file=sys.stdout, flush=False)
```

The above figure clearly indicates that the ***sep*** and ***end*** have the default values space and new-line respectively.

(NOTE: You can see two more arguments *file* and *flush* here. The default value *sys.stdout* of the argument *file* indicates that *print()* will send the data to standard output, which is usually keyboard. When you are willing to print the data into a specific file, the file-object can be given as a value for *file* argument. The *flush* argument with *True* value makes sure that operations are successfully completed and the values are flushed into the memory from the buffer. The default value of *flush* is False, because in most of the cases we need not check whether the data is really got flushed or not – as it would be happening even otherwise. While printing the data into a file (that is, when a file is open for write purpose), we may need to make sure whether the data got flushed or not. Because, someone else in the network trying to read the same file (trying to open a file for read purpose) when write operation is under progress may result in file corruption. In such situations, we need to set *flush* argument as True. Indeed, this is just a basic vague explanation of *flush* argument and it has much more meaning in real.)

Formatting the output:
There are various ways of formatting the output and displaying the variables with a required number of space-width in Python. We will discuss few of them with the help of examples.

- **Ex1:** When multiple variables have to be displayed embedded within a string, the *format()* function is useful as shown below –

```
        >>> x=10
        >>> y=20
        >>> print("x={0}, y={1}".format(x,y))
             x=10, y=20
```

While using *format()* the arguments of *print()* must be numbered as 0, 1, 2, 3, etc. and they must be provided inside the *format()* in the same order.

- **Ex2:** The *format()* function can be used to specify the width of the variable (the number of spaces that the variable should occupy in the output) as well. Consider below given example which displays a number, its square and its cube.

```
    for x in range(1,5):
         print("{0:1d} {1:3d} {2:4d}".format(x,x**2, x**3))
```

Output:

```
    1   1    1
    2   4    8
    3   9   27
    4  16   64
```

Here, 1d, 3d and 4d indicates 1-digit space, 2-digit space etc. on the output screen.

- **Ex3:** One can use % symbol to have required number of spaces for a variable. This will be useful in printing floating point numbers.

```
    >>> x=19/3
    >>> print(x)
    6.333333333333333        #observe number of digits after dot
    >>> print("%.3f"%(x))    #only 3 places after decimal point
    6.333

    >>> x=20/3
    >>> y=13/7
    >>> print("x= ",x, "y=",y)     #observe actual digits
         x=  6.666666666666667  y= 1.8571428571428572
    >>> print("x=%0.4f, y=%0.2f"%(x,y))
         x=6.6667, y=1.86          #observe rounding off digits
```

To know more about possibilities with *format()*, read –
https://docs.python.org/3/tutorial/inputoutput.html