Python Programming

Unit-4

Topics to be covered:

Functions - Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments,Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions(Function Returning Values), Scope of the Variables in a Function - Global and Local Variables.
Modules: Creating modules, import statement, from. Import statement, name spacing,
Python packages, Introduction to PIP, Installing Packages via PIP, Using Python Packages

Objective: Understanding Functions, Modules and Packages in Python Programming
Outcome: Students are able to write functions, modules and packages.

Introduction to Function

Definition – A Function is a block of program statementS that perform ***single***, ***specific*** and well defined ***task***. Python enables it's programmers to break the program into functions, each of which has some specific task.

When a function is called, the program control is passed to the first statement in the function. All the statements in the function are executed in sequence and the control is transferred back to function call. The function that calls another function is known as "***Calling Function***", and the function that is being called by another function is known as "***Called Function***".

Why we need Functions?

1. **Simpler Code**

A program's code seems to be simpler and easier to understand when it is broken down intofunctions. Several small functions are much easier to read than one long sequence of statements.

2. **Code Reuse**

Functions also reduce the duplication of code within a program. If a specific operation needs to be performed in several places in a program, then a function can be written once to perform thatoperation, and then be executed any number of times. This benefit of using functions isknown as ***code reuse***because you are writing the code to perform a task once and thenreusing it each time you need to perform that task.

3. **Better Testing**

When each task of the program is coded in terms of functions, testing and debuggingwill be simpler. Programmers can test each function in a program individually, to determinewhether it is correctly performing its operation.

4. **Faster Development**

The entire program is divided into tasks. Each task is assigned to individual programmer or team. So that it will be easy to accomplish the program in a faster manner.

Types of Functions

There are two different types of functions, **built-in functions** and **user defined functions**. The functions such as input(), print(), min(), max() are example for the built-in functions. The user defined functions are created by user. The user selects his own name for the function name. The naming rules for the function name are same as identifier rule.

Defining Functions

To create a function we write its ***definition***. Here is the general format of a function definition in Python:

```
def function_name():   #function header
        statement1
        statement2          Function Body
        ……..
        StatementN
```

The first line is known as the ***function header***. It marks the beginning of the function definition. The function header begins with the key word **def,**followed by the name of thefunction,followed by a set of parentheses, followed by a colon(:).

The function body contains one or more statement. These statements are executed in sequence to perform the task for which it is intended to define.

Example function definition for even or odd:

```
#function definition
defeventest(x):
if x%2==0:
print("even")
else:
print("odd")
```

In the above function definition, “eventest” is the name of the function, “x” is the parameter or argument. The body contains some lines of code for finding whether a given number is even or odd.

Calling Functions

A function definition specifies what a function does, but it does not cause the function toexecute. To execute a function, you must ***call***it. This is how we would call the "eventest" function:

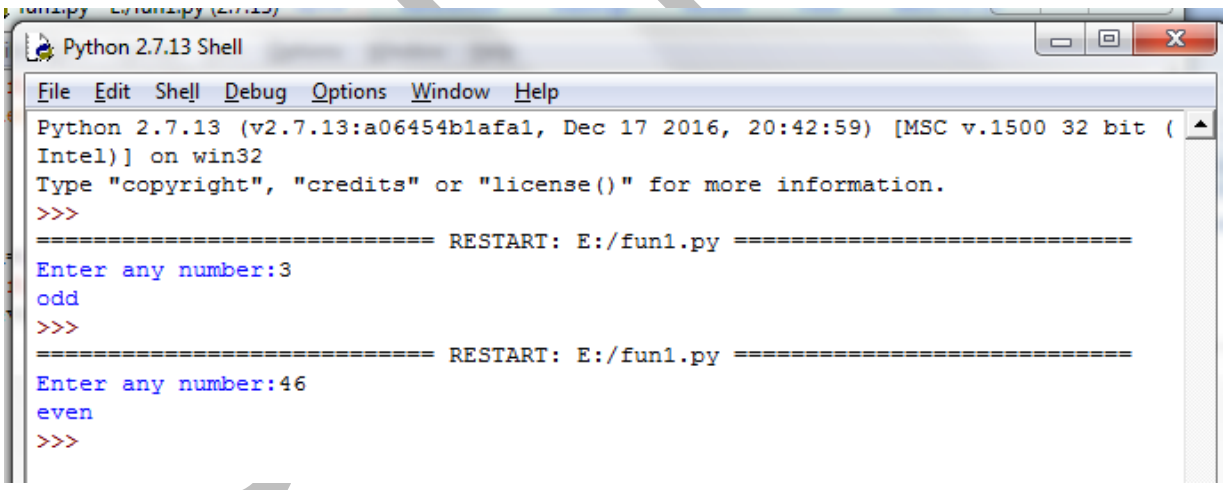
eventest(n)

When a function is called, the interpreter jumps to that function ***definition***and executes the statementsin its body. Then, when the end of the body is reached, the interpreter jumps backtothe part of the program that called the function, and the program resumes execution atthatpoint. When this happens, we say that the function ***returns***

Complete example for eventest.py

```
#function definition
defeventest(x):#function header
if x%2==0:
print("even")
else:
print("odd")
n=int(input("Enter any number:"))
#function calling
eventest(n).
```

Output:



Passing Arguments to Function

An argument is any piece of data that is passed into a function when thefunction is called. This argument is copied to the argument in the function definition. The arguments that are in the function call are known as "***Actual Arguments or Parameters***". The arguments that are in function definition are called "***Formal arguments or Parameters***". We can pass one or more

number of actual arguments in the function call. The formal argument list and their type must match with actual arguments.

```
#function definition
defeventest(x):#function header, here x is called Formal Argument or Parameter
if x%2==0:
print("even")
else:
print("odd")
n=int(input("Enter any number:"))
#function calling
eventest(n).# here n is called Actual Parameter
```

Example Program to calculate Simple Interest

```
#finding the simple interest

defsi(p,t,r):    #here p,t,r are formal arguments

   s=(p*t*r)/100;

print("The simple interest is:",s)

   T=p+s;

print("The Total amount with interest is:",T)

n1=float(input("Enter principal amount:"))

n2=float(input("Enter number of months:"))

n3=float(input("Enter rate of Interest"))

#function call

si(n1,n2,n3) #here n1,n2,n3 are actual arguments
```

Note: Write an Example Program to calculate Compound Interest (A=p*(1+(r/n))^tn)

Keyword Arguments

When we call a function with some values, these values are passed to the formal arguments in the function definition based on their position. Python also allows functions to be called using the keyword arguments in which the order (position) of the arguments can be changed. The values are not copied not according to their position, but based on their names.

The actual arguments in the function call can be written as follow:

Function_name (Argument_name1=value1, argument_name2=value2)

An argument that is written according to this syntax is known as "***Keyword Argument***".

Example program: (1) Calculating Simple interest using keyword arguments.

```
#keyword arguments
defsimpleinter(principal,rate,time):#function Header
    i=(principal*rate*time)/100
print("The interest is:",i)
print("Total amount is:",principal+i)
#function call
simpleinter(rate=7.25,time=3,principal=5000)
```

Output:

```
('The interest is:', 1087.5)
('Total amount is:', 6087.5)
```

The order of the actual arguments and formal arguments changed. Here, based on the name of the actual arguments the values are copied to the formal arguments. The position of the arguments does not matter.

Example program: (2) using the keyword arguments

```
#function definition
defdisp(name,phone,email):#function header
print "Your name:",name
print " Your Phone Number:",phone
print "Your email id:",email
disp(phone=9704,email="me@gmail.com",name="Rosum")#order of arguments is changed
```

Output:

```
Your name: Rosum
```

```
Your Phone Number: 9704
Your email id: me@gmail.com
```

Note: keyword arguments make program code easier to read and understand.

Default Arguments

Python allows functions to be called without or with less number of arguments than that are defined in the function definition. If we define a function with three arguments and call that function with two arguments, then the third argument is considered from the default argument.

The default value to an argument is provided using the assignment (=) operator. If the same number of arguments are passed then the default arguments are not considered. The values of actual arguments are assigned or copied to formal arguments if passed, default arguments are considered otherwise.Hence, the formal arguments are overwritten by the actual arguments if passed.

General format of default arguments:

```
#function definition
deffunction_name(arg1=val1,arg2=val2,arg3=val3)
        Statement 1
        Statement 2
        Statement 3
#function call
function_name()   #without arguments
function_name(val1,val2) #with two arguments, third argument is taken from default argument
```

Example Program:

```
#default arguments
def add(x=12,y=13,z=14):
   t=x+y+z
print("The sum is:",t)
#function call without arguments
add()
#function call with one argument
add(1)
#function call with two arguments
add(10,20)
#function call with three arguments
add(10,20,30)
```

Output:

```
('The sum is:', 39)
('The sum is:', 28)
('The sum is:', 44)
('The sum is:', 60)
```

Variable-length arguments

In some situations, it is not known in advance how many number of arguments have to be passed to the function. In such cases, Python allows programmers to make function calls with arbitrary (or any) number of arguments.

When we use arbitrary arguments or variable-length arguments, then the function definition uses an asterisk (*) before the formal parameter name.

Syntax:

deffun_name([arg1,arg2,..argn],*var_length_tuple)

Example program:

```
#variable-length argument
defvar_len_arg(name,*args):
print "\n",name,"Hobbies are:"
for x in args:
print(x)
#function call
#subash is assigned to name, and rest of arguments are assigned to *args
var_len_arg("Subash","Cricket","Movies","Traveling")
#rajani is assigned to name, and rest of arguments are assigned to *args
var_len_arg("Rajani","Reading Books","Singing","Tennis")
```

Output:

```
Subash Hobbies are:
Cricket
Movies
Traveling
-----------------------
Rajani Hobbies are:
Reading Books
Singing
Tennis
```

Anonymous Functions

Lambda or anonymous functions are so called because they are not declared as other functions using the ***def*** keyword. Rather, they are declared using the lambda keyword. Lambda functions are throw-away functions, because they are just used where they have been created.
Lambda functions contain only a single line. Its syntax will be as follw:

lambda arguments:expression

The arguments contain a comma separated list of arguments and the expression is an arithmetic expression that uses these arguments. The function can be assigned to a variable to give it a name.

Write a Python program using anonymous function to find the power of a number?

Program	**Output**
#lambda or anonymouse function n=lambda x,y: x**y x=int(input("Enter value of x :")) y=int(input("Enter value of y :")) ***#function call in the print() function*** print(x,"power",y,"is",n(x,y))	Enter value of x :3 Enter value of y :4 (3, 'power', 4, 'is', 81)

Properties of Lambda or Anonymous functions:

- ✓ Lambda functions have no name
- ✓ Lambda functions can take any number of arguments
- ✓ Lambda functions can just return a single value
- ✓ Lambda functions cannot access variables other than in their parameter list.
- ✓ Lambda functions cannot even access global variables.

Calling lambda function from other functions

It is possible to call the lambda function from other function. The function that uses the lambda function passes arguments to lambda function. The Lambda function will perform its task, and returns the value to caller.

Write a program to increment the value of x by one using lambda function.

Program	**Output**
#lambda or anonymouse function definc(y): return(lambda x: x+1)(y) x=int(input("Enter value of x :")) #function call in the print() function	Enter value of x :3 ('the increment value of ', 3, 'is', 4)

print("the increment value of ",x,"is",inc(x))	

Fruitful Functions(Function Returning Values)

The functions that return a value are called "Fruitful Functions". Every function after performing its task it return the program control to the caller. This can be done implicitly. This implicit return return nothing to the caller, except the program control. A function can return a value to the caller explicitly using the "***return***" statement.

Syntax:

```
return (expression)
```

The expression is written in parenthesis that computes a single value. This return statement is used for two things: **First**, it returns a value to the caller. **Second**, To end and exit a function and go back to the caller.

Write a program using fruitful function to compute the area of a circle.

Program	**Output**

#finding the area of a circle
def area(r):
  a=3.14*r*r
  return(a) ***#function returning a value to the caller***
#begining of main function
x=int(input("Enter the radius :"))
#calling the function
r=area(x)
print("The area of the circle is:",r)
	Enter the radius :5
	('The area of the circle is:', 78.5)

Scope of the Variables in a Function

All variables in a program may not be accessible at all locations in that program. This depends on where you have declared a variable. The part of the program in which a variable can be accessed is called its ***scope***. The duration for which a variable exists is called its "***Lifetime***". If a variable is declared and defined inside a function its scope is limited to that function only. It cannot be accessed to outside that function. If an attempt is made to access it outside that function an error is raised.

The scope of a variable determines the portion of the program where you can access a particular identifier. There are two basic scopes of variables in Python:

- **Global Scope** -variables defined outside the function and part of main program
- **Local Scope** - variables defined inside functions have local scope

Global vs. Local variables

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

This means that local variables can be accessed only inside the function in which they are declared, whereas global variables can be accessed throughout the program body by all functions. When you call a function, the variables declared inside it are brought into scope. Following is a simple example –

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
	tot=10
	def sum(a,b):
	global tot**#refering the global variable**
	tot=a+b
	print("The sum is:",tot)
	sum(12,3)
	print("The global value of tot is:",tot)

Note: To refer the global variable "global" keyword is used.

Modules

A module is file that contains Python code. This code contains***functions*** and ***variable***s that perform related tasks. This approach is called "***Modularization***". This makes the program easier to understand, test and maintain.

Modules also make it much easier to reuse same code in more than one program. If we have written set of functions that are needed in several different programs, we can place them in modules. Then we can import these modules in each program to call one of the functions.

Creating Modules

For example we use the functions such as area of circle, circumference of circle, area of rectangle and circumference of rectangle in many programs. So we can create two modules such as: circle and rectangle, and put the functions related to the circle in that module and functions related to the Rectangle in another module called rectangle. We can just import these modules into any number of programs if their functions are needed.

Rules for Module Names:

- ✓ A module file name should end with .py. If it is not ended with .py we cannot import it into other programs.
- ✓ A module name cannot be keyword.
- ✓ The module must be saved within the same folder (directory) where you are accessing it.

Import statement - Accessing these modules

To use these modules in program, we import them in program with import statement. To import the circle module, we write it as follow:

```
import circle
```

When the Python interpreter reads this statement it will look for the file ***circle.py*** in thesame folder as the program that is trying to import it. If it finds the file it will load it intomemory. If it does not find the file, an error occurs.

Example program: **circle.py** module

1. **Creating the Module**

```
#definition of area function
def area(r):
   a=3.14*r*r
return(a)
#definition of circumference
defcircum(r):
   c=2*3.14*r
return(c)
```

2. **Using the Module in another program**

testcircle.py

```
import circle
x=float(input("Enter the Radius:"))
#function call to area
res=circle.area(x)
print "The area of the Circle is:",res
#function call to circum
res=circle.circum(x)
print "The Circumference of the Circle is:",res
```

from. Import statement

There are Four ways of using **import** to import a module and subsequently use what was imported. Wewill use the **math** module to illuminate:

```
# Way 1
importmath
printmath.cos(math.pi/2.0)
```

This method imports ***everything*** from the math module, and members of the module are accessed using**dot** notation.

```
#way 2
frommath import cos
printcos(3.14159265/2.0)
```

This method imports only the dentition of **cos** from the **math** library. Nothing else is imported.

```
#way 3
frommath import cos, pi
printcos(pi/2.0)
```

This method imports only the dentitions of **cos** and **pi** from the math library. Nothing else is imported.

```
#way 4
frommath import *
printcos(pi/2.0)
```

This method also imports everything from the math module, the difference being that ***dot notation*** isnot needed to access module members.

Example Program for 4th way

circle.py module	

#definition of area function
def area(r):
  a=3.14*r*r
  return(a)
#definition of circumference
defcircum(r):
  c=2*3.14*r
	from circle import*
	x=float(input("Enter the Radius:"))
	#function call to area
	res=area(x)
	print "The area of the Circle is:",res
	#function call to circum
	res=circum(x)

return(c)	print "The Circumference of the Circle is:",res

Knowing the current module name
If we want to know the name of the current module, then we can use the attribute "__name__" to print the name of the module with help of the print() function.
Example:

```
Print "The module name is:",__name__
```

Namespacing

A **namespace** is a ***syntactic container*** which permits the same name to be used in different modules orfunctions. Each module determines its own namespace, so we can use the same name in multiple moduleswithout causing an identification problem.

For example, functions such as area(r) and circum(r) are part of the module circle.py. We can also use same names in another module like "cir.py". These functions are called from these module independently.

mod1.py	**testans.py**
question="What is your name" ans="Write your answer"	**import mod1** **import mod2** q=mod1.question print "Question is:",q a=mod1.ans print "Answer is:",a q=mod2.question print "Question is:",q a=mod2.ans print "Answer is:",a
mod2.py question="What is your name" ans="Guido Van Rossum"	Question is: What is your name Answer is: write your name Question is: What is your name Answer is: Guido Van Rossum

Python Packages

Creating our own packages (Content Beyond Syllabus)

When you've got a large number of Python classes (or "modules"), you'll want to organize them into packages. When the number of modules (simply stated, a module might be just a file containing some classes) in any project grows significantly, it is wiser to organize them into packages – that is, placing functionally similar modules/classes in the same directory.

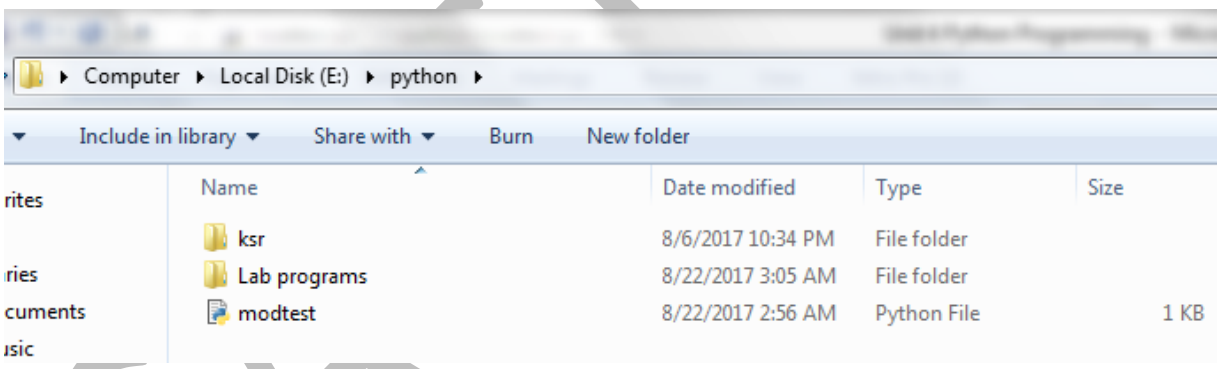
Steps to Create a Python Package

Working with Python packages is really simple. All you need to do is:

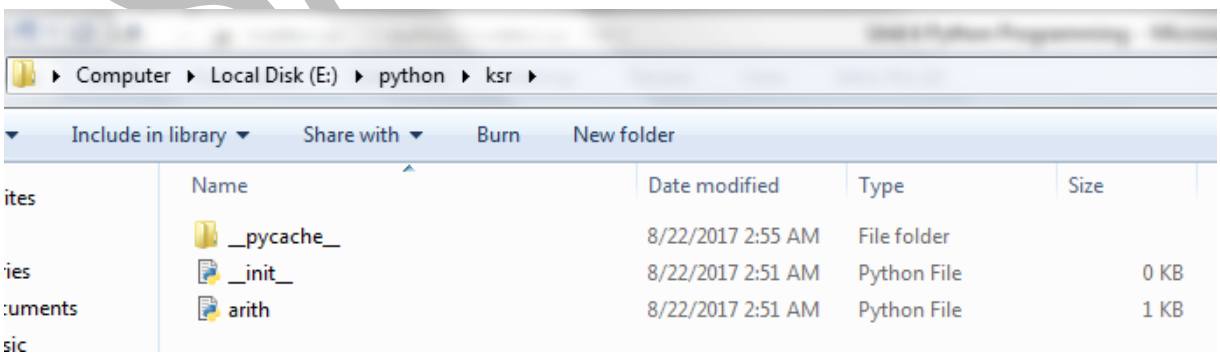
1. Create a directory and give it your package's name.
2. Put your module in it.
3. Create a **__init__.py** file in the directory

That's all! In order to create a Python package, it is very easy. The __init__.py file is necessary because with this file, Python will know that this directory is a **Python package** directory other than an ordinary directory (or folder – whatever you want to call it). Anyway, it is in this file where we'll write some import statements to ***import*** modules from our brand new package.

Step1: Creating the Directory with the name "ksr" in Pyhon folder.



Step 2& 3: Put your module "arith.py" in it along with "__init__.py" file



Importing the package

We can write another file "**arith.py**" that really uses this package. Put this file outside the "**ksr**" directory, but in the "**python**" directory as shown in the screenshot.

arith.py module	modtest.py

#this module contains all function to perform arithmetic operations
def add(x,y):
  return(x+y)
def sub(x,y):
  return(x-y)
defmul(x,y):
  return(x*y)
def div(x,y):
  return(x/y)
def rem(x,y):
  return(x%y)
	from ksr.arith import*
	#reading the data from keyboard
	a=int(input("Enter a value:"))
	b=int(input("Enter a value:"))
	#function calls
	print("The sum is :",add(a,b))
	print("The subtraction is :",sub(a,b))
	print("The product is:",mul(a,b))
	print("The quotient is:",div(a,b))
	print("The remainder is:",rem(a,b))

Output:

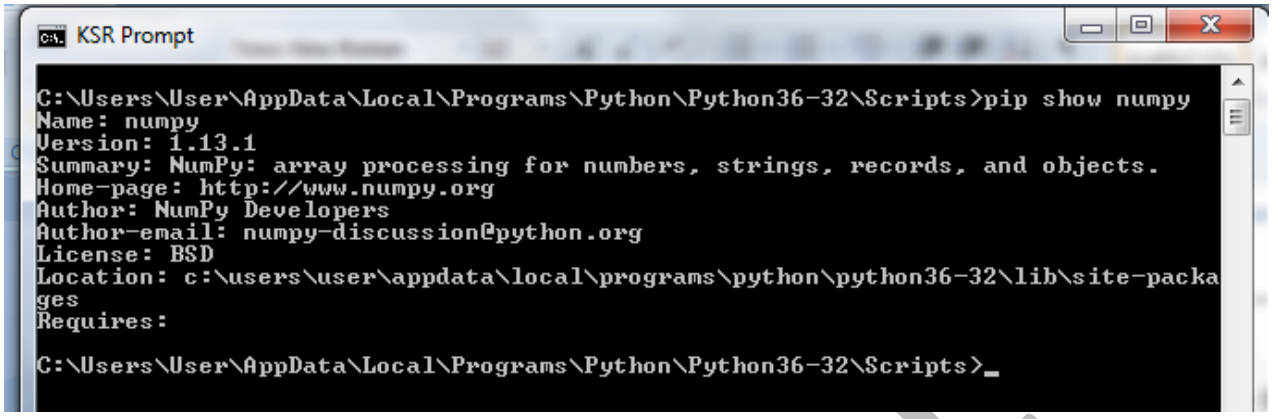
```
Enter a value:24
Enter a value:5
The sum is : 29
The subtraction is : 19
The product is: 120
The quotient is: 4.8
The remainder is: 4
```

Introduction to PIP

So far we have been working with package that we have created and is in our system. There may be situation where we want to install packages that are not in our system and created by others residing in other system. This can be done using the PIP tool.

The Python Package Index is a repository of software for the Python programming language. There are currently**1,15,120** packages here. If we need one package we can download it from this repository and install in our system. This can be performed using the PIP tool.

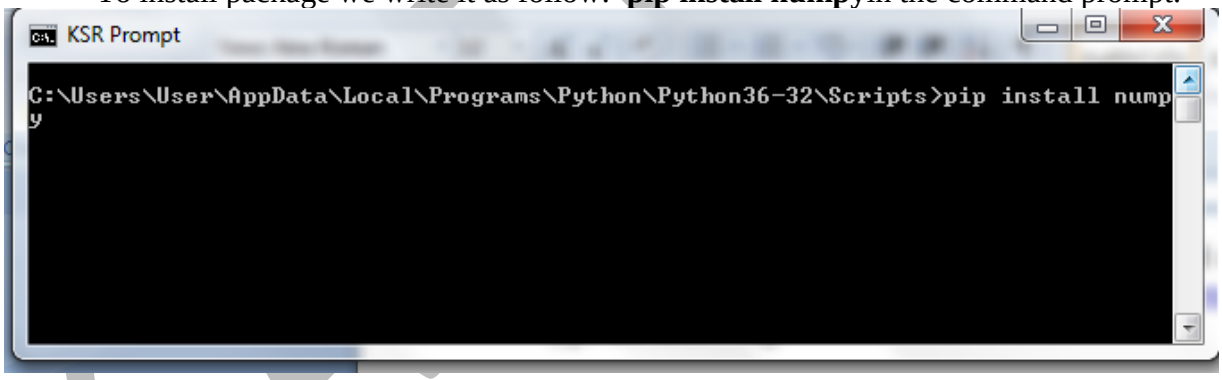
The PIP command is tool for installing and managing the packages, such as found in Python Packages Index repository (www.pypi.python.org). To ***search*** for a package say numpy, type the following:



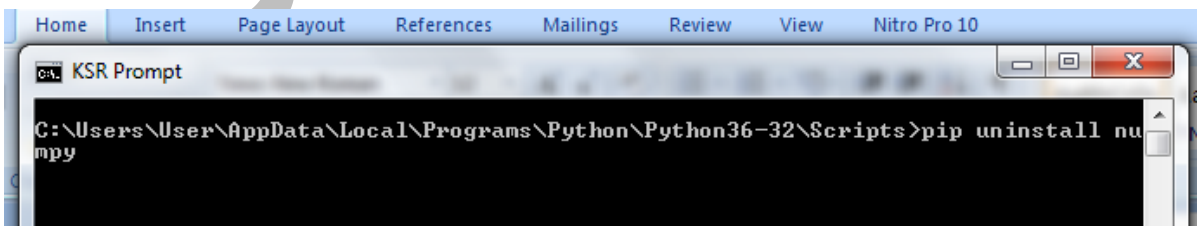
Installing Packages via PIP

To install a new package we can use the pip tool.

- To do this, first go to the path where Python software is installed and select the folder '**Scripts"** which contains pip tool.
- Use this path in the command prompt and type the pip command.
- The requested package is downloaded from the internet from the www.pypi.python.org website.
- So you must have internet connection when you want to download, error will be raised otherwise.
- To install package we write it as follow: **pip install numpy**in the command prompt.



To uninstall package we can use the pip tool as follow: **pip uninstall numpy** in the command prompt.



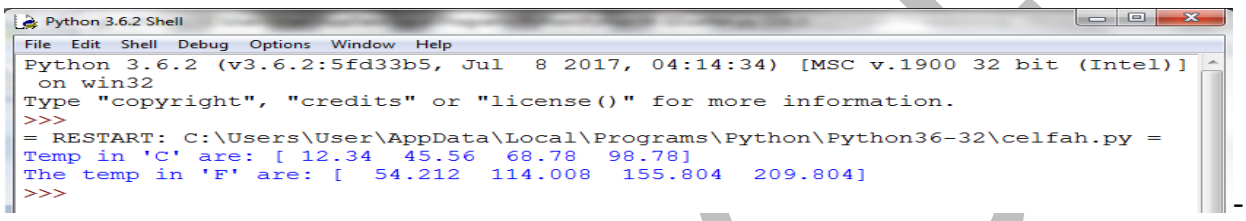
Using Python Packages

Write a program that uses the numpy package.

celfah.py

```
importnumpy#numpy package
l=[12.34,45.56,68.78,98.78]
a=numpy.array(l)#numpy array() function
print("Temp in 'C' are:",a)
f=(a*9/5+32)
print("The temp in 'F' are:",f)
```

Output:



----------**********End of 4th Unit**********----------