PYTHON

Contents

Introduction to Python

Introduction:

- Using Programming languages and technologies we develop applications.
- Applications are used to store data and perform operations on data.

Types of applications:

Standalone apps:

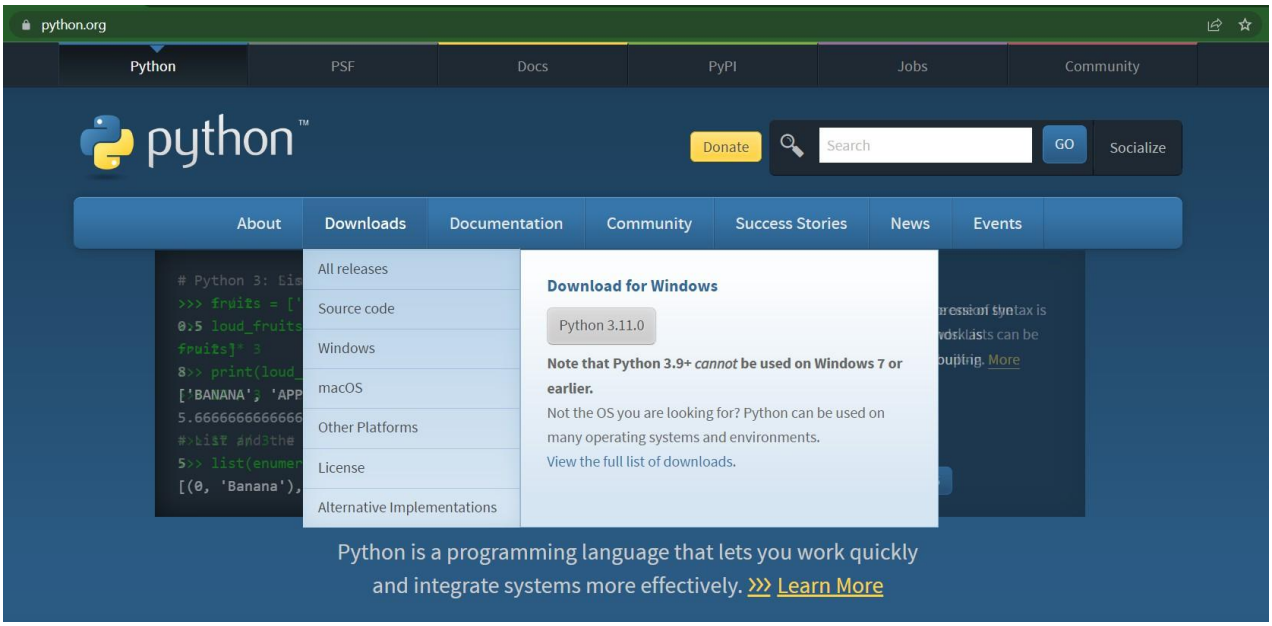
- The application runs from single machine.
- Internet connection is not required to run the application.
- Application needs to be installed on machine.
- **Examples:** VLC, MS-office, Anti-virus, Browser, **Programming languages**.

Web apps:

- The application runs from multiple machines in a network.
- Internet connection is required to run the application.
- Application installed in server and run from the clients.
- **Examples:** Gmail, YouTube, IRCTC, Flip Kart etc.

Download python:

- Python is an Open-Source Technology.
- We can download and install Python software from official website www.python.org

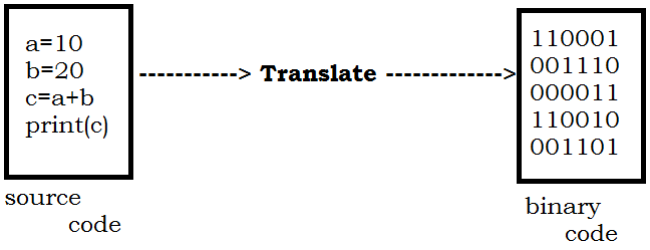


Python is used to develop both Standalone and Web applications:

- Core + Advance python + GUI + DBMS = Standalone app development
- Core + Advance + DBMS + HTML + CSS + JavaScript + Django = Web app develop

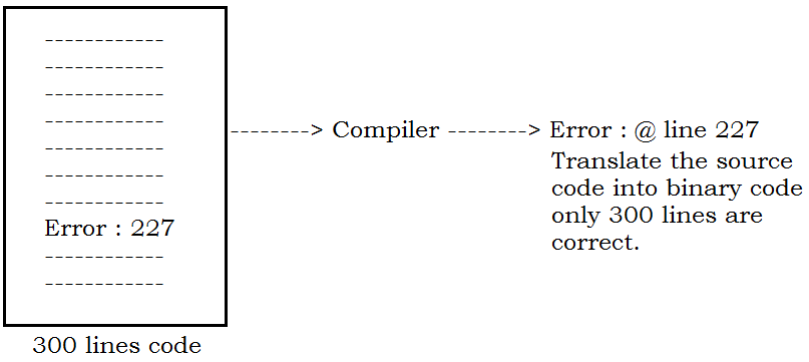
Translators:

- Programmer can define only source code.
- We need to convert the source code into binary code before run.
- We use 2 translators to convert Source code into byte code.
    - Compiler
    - Interpreter



Compiler:

- Compiler checks the source code syntactically correct or not.
- If we define the code correctly, it converts source code into byte code.
- Compiler shows error message with line number if there is a syntax error.



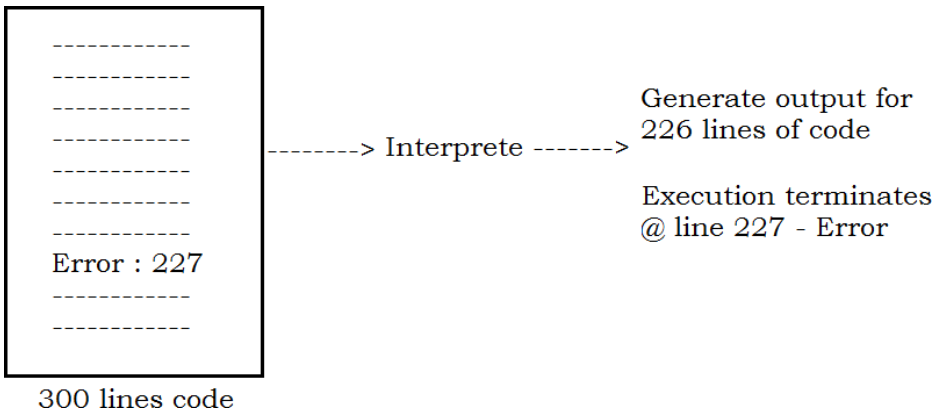
Note: Java programming language use compilation

```
class Program
{
        public static void main(String[] args)
        {
                int a=10;
                System.out.println("a val : " + a);
                int b=20;
                System.out.println("b val : " + b);
                System.out.println("c val : " + c);
        }
}
```

Compile: Error @ line – 11 (variable "c" not present)

Interpreter:

- Line by line translation of source code into binary code.
- Python uses interpreter for program execution.



Note: Python programming uses interpretation

```
a=10
print("a val :",a)
b=20
print("b val :",b)
print("c val :",c)
```

Output:

```
a val : 10
b val : 20
NameError: name 'c' is not defined
```

Python(Programming & Scripting):

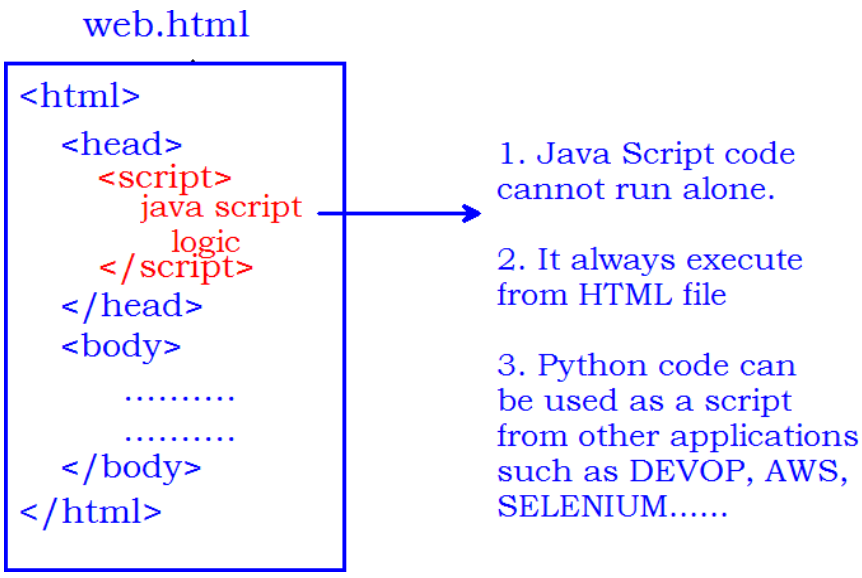
- Programming language are directly used to develop applications.
  - **Examples:** C, C++, PythonJava, .Net etc.
- Scripting languages always run from another program.
  - **Examples:** JavaScript, TypeScript, Python….

Program:

- A set of instructions.
- Program runs alone.

Script:

- Script is a set of Instructions
- Scripts is a program that always execute from another program.
- JavaScript is the best example of Scritping language.
- JavaScript code always run with HTML program.



Python is Dynamic:

- Every programming language is used to develop applications
- Application is used to store and process the data.
- Generally we allocate memory to variables in 2 ways
    1. Static memory allocation
    2. Dynamic memory allocation

Static memory:

- Static means "fixed memory"
- The languages which are supporting primitive types allowed allocating static memory.
- Primitive variable size and type are fixed.
- Primitive variable stores data directly.
- Compiler raises error when data limit or type is deviated from specified.

Primitive : Variable stores the data

In C :

```
int  a ;
a = 10 ;
a = a+15 ;
a = 23.45 ; -> Error : only integer allowed
a = 50000 ; -> Error : Can store a value between -32768 to +32767
```

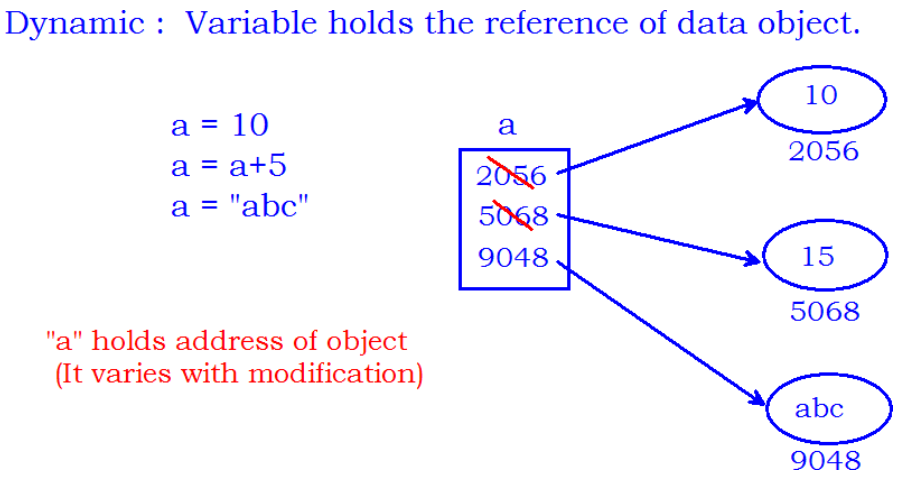
a (2 bytes)

~~10~~ 25

2046

Dynamic memory:

- Python is dynamic.
- Dynamic memory means type and size of data can vary.
- Python can store information in Object format.
- Dynamic variables cannot store the data directly.
- Dynamic variables store the reference of Object which holds data.
- In Python, object location changes every time when we modify the data.




```
>>> a=10
>>> print(a)
10
>>> print("Address :",id(a))
Address : 1628169120

>>> a=a+15
>>> print(a)
25
>>> print("Address :",id(a))
Address : 1628169360

>>> a="python"
>>> print(a)
python
>>> print("Address :",id(a))
Address : 48576832
```

Python Variables

Variable:

- Variable is an identity of memory location.
- Variables used to store values
- You can assign any value to a variable using the "=" operator.

```
# Example:
x = 10
```

Variables can be of different types in Python, such as integer, float, string, boolean, etc.

```
# Example:
age = 25
height = 5.7
name = "Amar"
is_student = True
```

You can assign the same value to multiple variables at once using the "=" operator.

```
# Example:
x = y = z = 0
```

Variables can be updated with new values as the program runs.

```
# Example:
x = 10
x = x + 1
```

Variables can be deleted using the "del" keyword.

```
# Example:
x = 10
del x
```

Python allows you to assign values to variables in a single line

```
# Example:
x, y, z = 10, 20, 30
```

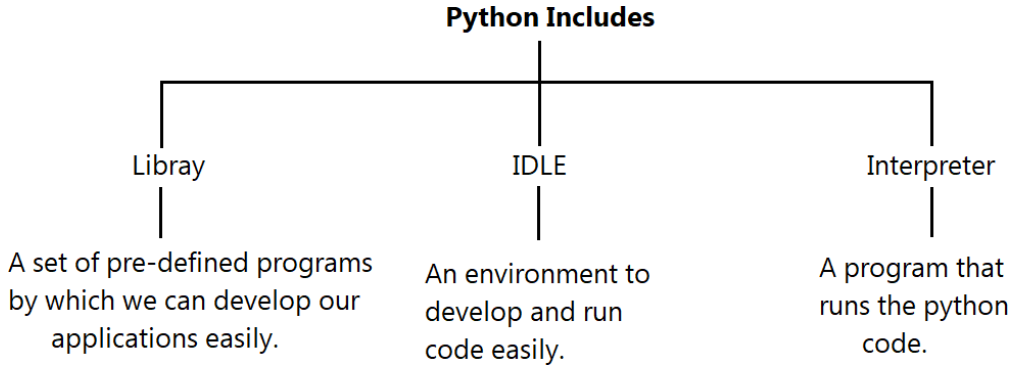
Python variables are case-sensitive, which means "a" and "A" are different variables.

```
# Example:
a = 10
A = 20
```

You can use underscores in variable names for better readability.

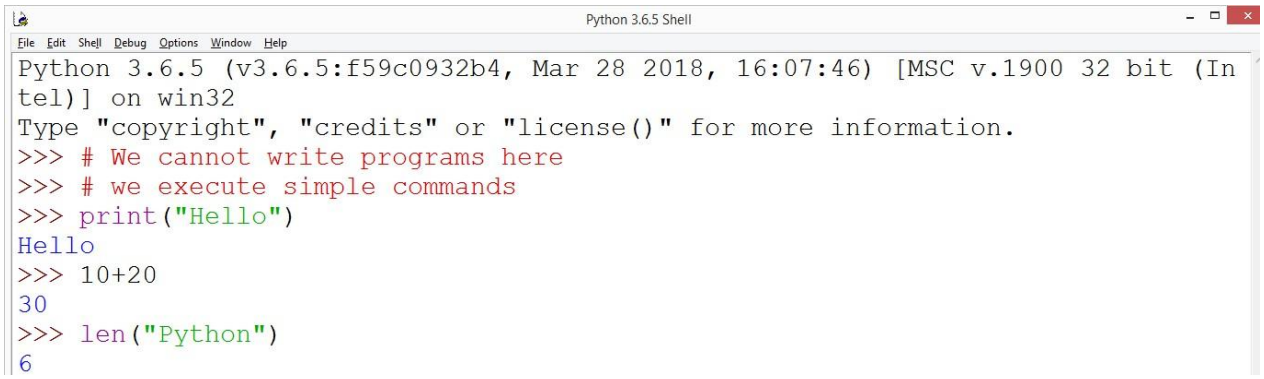
```
# Example:
my_variable = 10
```

Edit and Run python program:



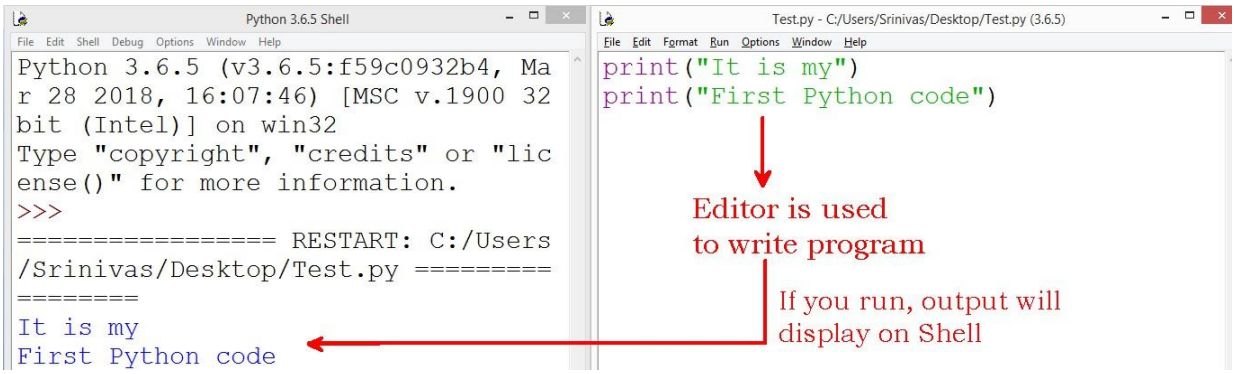
Working with IDLE:

- Once python installed, we can open IDLE by searching its name.
- A shell window will be opened where we can run only commands.



Writing and executing programs:

- We can write and execute programs from editor
- Go to File menu
- Select "new" file – Opens an editor
- Write code and Save with .py extension
- Run – with shortcut f5



Operators and Control Statements

Operator:

- Operator is a symbol that performs operation on one or more operands.
- The member on which operator operates is called the operand.
- In the expression a = 5+9,
  a, 5,9 are operands
  =, + are operators

Python supports the following operators:

1. Arithmetic Operators
2. Comparison (Relational) Operators
3. Assignment Operators
4. Logical Operators
5. Bitwise Operators
6. Membership Operators
7. Identity Operators

Arithmetic operators:

Arithmetic operators are used to perform mathematical operations like addition, subtraction, multiplication etc.

Operators are +, - , * , / , % , // , **

Operator	Meaning	Example
+	Add 2 operands	X+Y
-	Subtract right from left	X-Y
*	Multiply 2 operands	X*Y
/	Divide left with right	X/Y
%	Divide and returns Remainder	X%Y
//	Floor division - division that results into whole number adjusted to the left in the number line	X//Y
**	Exponent - left operand raised to the power of right	X**Y

a = 5 , b = 2

2) 5 (2.5 5 0 a/b = 2.5	2) 5 (2 4 1 a%b = 1	2) 5 (2.5 5 0 a//b = 2 ← floor value of 2.5	5^2 = 25 a**b = 25

Division (/) : Operator divide and returns quotient. Result is float value.

Remainder (%): It returns the remainder after division. It performs operation only on integers.

Division	Mod

>>> 5/2
2.5
 	
>>> 10/3
3.3333333333333335
 	
>>> 10/5
2.0
	>>> 5%2
	1
	>>> 10%4
	2
	>>> 5.0%2.5
	0.0
	>>> 5.0%2
	1.0

Floor division (//): Returns floor value after divide.

Exponent (**): returns the power value of specified base.

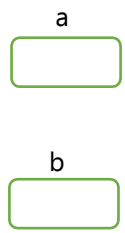
>>> 10/3
3.3333333333333335
>>> 10//3
3
>>> 10/4
2.5
>>> 10//4
2
	>>> 2**2
	4
	>>> 2**4
	16
	>>> 3**3
	27

print("Arithmetic operations")

```
print("5+2 :", 5+2)
print("5-2 :", 5-2)
print("5*2 :", 5*2)
print("5/2 :", 5/2)
print("5%2 :", 5%2)
print("5//2 :", 5//2)
print("5**2 :", 5**2)
```

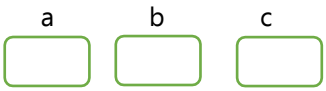
Complete this work sheet Arithmetic Operators

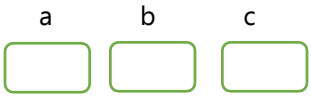
a=10 a=20 a=30 a=40 a=50 print(a)	a 	a=5 a=a+1 a=a+1 a=a+1 a=a+1 print(a)	a
a=5 a=a+1 a=a+2 a=a+3 a=a+4 print(a)	a 	a=15 a=a+5 a=a+4 a=a+3 a=a+4 print(a)	a

a, x = 5, 1 a=a+x x = x+1 a=a+x x = x+1 a=a+x print(a, x) 	a, b = 5, 1 a=a+b b = b-1 a=a+b b= b-1 a=a+b print(a, b) 

n=2;
int s=n*n;
print(s);
 
	n=2;
	int c=n*n*n;
	print(c);
	 

n=2;
int s=n*n;
int c=n*n*n;
print(s+c);
 
	bal=5000;
	int amt=3500;
	bal = bal + amt;
	print(bal);
	 

a=5, b=3;
int c=a+b;
print(c);
 
	a=5, b=3;
	a=b;
	b=a;
	print(a,b);
	 

a=5, b=3, c;
c=a;
a=b;
b=c;
print(a,b);
 
	a=2, b=3;
	a=a+b;
	b=a+a;
	print(a,b);
	 

a=2, b=3;
a=a+b;
b=a-b;
a=a-b;
print(a,b);
 
	a=2, b=3;
	a=a*b;
	b=a//b;
	a=a//b;
	print(a,b);
	 

n=234;
int d=n%10;
print(d);
 
	n=234;
	int d=n//10;
	print(d);
	 

sum=0, i=1;
sum=sum+i;
i=i+1;
sum=sum+i;
i=i+1;
sum=sum+i;
print(sum);
 
	fact=1, i=1;
	fact=fact*i;
	i=i+1;
	fact=fact*i;
	i=i+1;
	fact=fact*i;
	print(fact);
	 

n=2345, rev=0;
rev=rev*10+n%10;
n=n//10;
Print(rev, n);
rev=rev*10+n%10;
n=n//10;
Print(rev, n);
	rev=rev*10+n%10;
	n=n//10;
	Print(rev, n);
	rev=rev*10+n%10;
	n=n//10;
	Print(rev, n);

Python Input()

Reading input from End-user :

- The input() function is used read data from user.
- The function prompts the message to enter the value
    - **input(prompt)**
- The function waits for the user to enter the value followed by pressing the "Enter" key.
- The function reads the input as string.

Reading the name and display:

```
print("Enter your name :")
name = input()
print("Hello,",name)
```

We can give the prompt while reading input

```
name = input("Enter your name : ")
print("Hello,",name)
```

Every input value will be returned in String format only.

```
print("Enter 2 numbers :")
a = input()
b = input()
c = a+b   # "5" + "6" = "56"
print("Sum :",c)
```

We need to convert the string type input values into corresponding type to perform operations.

int( ) :

- It is pre-defined function
- It can convert input value into integer type.
- On success, it returns integer value
- On failure(if the input is not valid, raised error)

Adding 2 numbers

```
print("Enter 2 numbers :")
a = input()
b = input()
c = int(a)+int(b)
print("Sum :",c)
```

Data Conversion Functions

int( ) :

- It is pre-defined function
- It can convert input value into integer type.
- On success, it returns integer value
- On failure(if the input is not valid, raised error)

```
>>> int(10)
10
>>> int(23.45)
23
>>> int(True)
1
>>> int(False)
0
>>> int("45")
45
>>> int("python") # Error : Invalid input
```

Adding 2 numbers:

```
print("Enter 2 numbers :")
a = input()
b = input()
c = int(a)+int(b)
print("Sum :",c)
```

We can give the prompt directly while calling input() function.

```
x = int(input("First Num :"))
y = int(input("Second Num :"))
print("Sum : ",x+y)
```

float() :

- converts the input value into float type.
- Raise error if the input is not valid.

```
>>> float(2.3)
2.3
>>> float(5)
5.0
>>> float(True)
1.0
>>> float("3.4")
3.4
```

```
>>> float("abc")
ValueError: could not convert string to float: 'abc'
```

bool():

- Returns a boolean value depends on input value.
- boolean values are pre-defiend (True , False)

```
>>> bool(True)
True
>>> bool(-13)
True
>>> bool(0.0013)
True
>>> bool(0)
False
>>> bool("abc")
True
>>> bool("   ")
True
>>> bool("")
False
>>> bool(False)
False
>>> bool("False")
True
```

str(): convert any input int string type.

```
>>> str(3)
'3'
>>> str(2.3)
'2.3'
>>> str(True)
'True'
```

bin(): Returns binary value for specified decimal value.

```
>>> bin(10)
'0b1010'
>>> bin(8)
'0b1000'
```

Character System:

- File is a collection of bytes.
- Every symbol occupies 1 byte memory in File.
- Every symbol stores into memory in binary format.
- Symbol converts into binary based on its ASCII value.
- Character system is the representation of all symbols of a language using constant integer values.
- Examples are ASCII and UNICODE.

ASCII : (Americans Standard Code for Information Interchange)

- Represents all symbols 1 language using constants
- The range is 0 - 255
- A language is at most having 256 symbols.
- 1 byte range is (0-255) - 2^8 value
- Hence we represent a symbol using 1 byte memory.

A-65	a-97	0-48	#-35
B-66	b-98	1-49	$-36
..	..	..	..
..	..	..	..
Z-90	z-122	9-57	..

26 + 26 + 10 + 150 < 256 symbols

chr(): Return the symbol for specified integer value.
ord(): Returns the integer for specified symbol.

```
>>> chr(65)
'A'
>>> chr(50)
'2'
>>> ord('a')
97
>>> ord('$')
36
>>> ord('1')
49
```

Programs On Arithmetic Operators

Adding 2 numbers:

```
num1 = float(input("Enter the first number: "))
num2 = float(input("Enter the second number: "))
sum = num1 + num2
print("The sum of", num1, "and", num2, "is", sum)
```

Arithmetic Operations:

```
num1 = float(input("Enter the first number: "))
num2 = float(input("Enter the second number: "))

sum = num1 + num2
difference = num1 - num2
product = num1 * num2
quotient = num1 / num2
remainder = num1 % num2
floordiv = num1 // num2

print("Sum:", sum)
print("Difference:", difference)
print("Product:", product)
print("Quotient:", quotient)
print("Remainder :", remainder)
print("Floor Division :", floordiv)
```

Program to display the last digit of given number:

```
num = int(input("Enter a number: "))
last_digit = num % 10
print("The last digit of", num, "is", last_digit)
```

Progam to remove last digit of given number:

```
num = int(input("Enter a number: "))
num = num//10
print("The number with the last digit removed is", num)
```

Find Total and Average of 4 numbers:

```
mark1 = float(input("Enter the first mark: "))
mark2 = float(input("Enter the second mark: "))
mark3 = float(input("Enter the third mark: "))
mark4 = float(input("Enter the fourth mark: "))
average = (mark1 + mark2 + mark3 + mark4) / 4
print("The average of the four marks is", average)
```

Find sum of square and cube of given number:

```
num = int(input("Enter a number: "))
square = num ** 2
cube = num ** 3
sum = square + cube
print("The sum of the square and cube of", num, "is", sum)
```

Calculate Total Salary for given basic Salary:

```
basic_salary = float(input("Enter the basic salary: "))

# Calculate the allowances and deductions
hra = 0.2 * basic_salary
da = 0.1 * basic_salary
pf = 0.05 * basic_salary

# Calculate the gross and net salary
gross_salary = basic_salary + hra + da
net_salary = gross_salary - pf

# Print the result
print("Basic salary:", basic_salary)
print("HRA:", hra)
print("DA:", da)
print("PF:", pf)
print("Gross salary:", gross_salary)
print("Net salary:", net_salary)
```

Swapping 2 numbers:

```
num1 = float(input("Enter the first number: "))
num2 = float(input("Enter the second number: "))

# Before swapping
print("Before swapping:")
print("num1 =", num1)
print("num2 =", num2)

# Swap the values
temp = num1
num1 = num2
num2 = temp

# After swapping
print("After swapping:")
print("num1 =", num1)
print("num2 =", num2)
```

Swapping 2 number without third variable:

```
# Take input from the user
num1 = float(input("Enter the first number: "))
num2 = float(input("Enter the second number: "))

# Swap the values without using a third variable
num1, num2 = num2, num1

# After swapping
print("After swapping:")
print("num1 =", num1)
print("num2 =", num2)
```

Another Way:

```
// Swap the values without using a third variable
num1 = num1 + num2;
num2 = num1 - num2;
num1 = num1 - num2;
```

Relational operators:

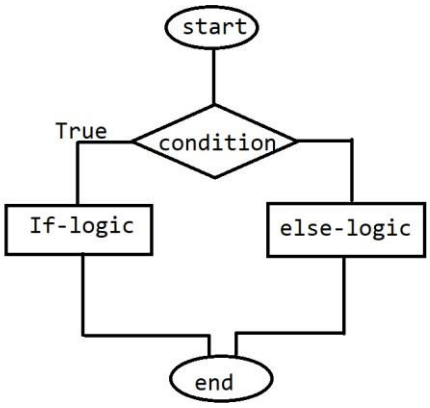
- Operators are > , < , >= , <= , == , !=
- These operators validate the relation among operands and return a boolean value.
- If relation is valid returns True else False

Program to understand Relational operators:

```
print("Relational operations")
print("5>3 :", 5>3)
print("5==3 :", 5==3)
print("5<3 :", 5<3)
print("5!=3 :", 5!=3)
print("5>=3 :", 5>=3)
print("5<=3 :", 5<=3)
```

If-else Conditional Statement:

```
Syntax :
    if(condition) :
        ......
        if-logic
        ......
    else:
        ......
        else-logic
        ......
```



Check the Number is Zero or Not

```
n = int(input("Enter number : "))
if(n==0):
    print("Number equals to zero")
else:
    print("Number is not zero")
```

Check the Number is Positive or Not

```
n = int(input("Enter number : "))
if(n>=0):
    print("Positive Number")
else:
    print("Negative Number")
```

Check the 2 numbers equal or not

```
n1 = int(input("Enter First num : "))
n2 = int(input("Enter Second num : "))
if(n1==n2):
    print("Equal numbers")
else:
    print("Not equal Numbers")
```

Check the first number greater than second number or not

```
n1 = int(input("Enter First num : "))
n2 = int(input("Enter Second num : "))
if(n1>n2):
    print("First Number is big")
else:
    print("Second Number is big")
```

Check the person eligible for vote or not

```
age = int(input("Enter age : "))
if(age>=18):
    print("Eligible for vote")
else:
    print("Not eligible for vote")
```

Check the number is divisible by 7 or not

```
num = int(input("Enter number : "))
if(num%7==0):
    print("Divisible by 7")
else:
    print("Not divisible by 7")
```

Check the number is even or not

```
num = int(input("Enter number : "))
if(num%2==0):
    print("Even Number")
else:
    print("Not Even")
```

Check the last digit of number is zero or not

```
num = int(input("Enter number : "))
if(num%10==0):
    print("Last digit is zero")
else:
    print("Last digit is not zero")
```

Check the sum of 2 numbers equal to 10 or not

```
n1 = int(input("Enter First number : "))
n2 = int(input("Enter Second number : "))
if(n1+n2==10):
    print("Equal to 10")
else:
    print("Not equal to 10")
```

Check last digits of given 2 numbers equal or not

```
n1 = int(input("Enter First number : "))
n2 = int(input("Enter Second number : "))
if(n1%10 == n2%10):
    print("Equal")
else:
    print("Not equal")
```

Check the average of 3 numbers greater than 60 or not

```
print("Enter 3 numbers :")
n1 = int(input())
n2 = int(input())
n3 = int(input())

if((n1+n2+n3)/3 > 60):
    print("avg Greater than 60")
else:
    print("Not")
```

Check the last digit of number is divisible by 3 or not

```
n = int(input("Enter num : "))
if((n%10)%3==0):
    print("Last digit divisible by 3")
else:
    print("Not divisible")
```

Logical operators: These operators returns True or False be validating more than one expression

Operator	Meaning	Example
and	True if both the operands are true	x and y
or	True if either of the operands is true	x or y
not	True if operand is false (complements the operand)	not x

And examples:	Or examples:	Not examples:

>>> True and True
True
>>> 5>3 and 3>2
True
>>> True and False
False
>>> False and True
False
>>> False and False
False
>>> 5>3 and 5!=5
False
	>>> False or False
	False
	>>> False or True
	True
	>>> True or False
	True
	>>> True or True
	True
	>>> 3>5 or 5>2
	True
		>>> not True
		False
		>>> not False
		True
		>>> not 5>3
		False
		>>> not 3!=3
		True

Check the Number Divisible by 3

N%3==0 (3, 6, 9, 12....)

Check the Number Divisible by 5

N%5==0 (5, 10, 15, 20....)

Check the Number Divisible by both 3 and 5

N%3==0 and N%5==0 (15, 30, 45, 60....)

Check the Number Divisible by either 3 or 5

N%3==0 and N%5==0 (3, 5, 6, 9, 10, 12, 15...)

Program to check the Number Divisible by both 3 and 5:

```
n = int(input("enter number : "))
if n%3==0 and n%5==0:
    print("Divisible by 3 and 5")
else:
    print("Not divisible")
```

Check the person age between 20 and 50:

```
age = int(input("enter age : "))
if age>=20 and age<=50:
    print("Age between 20 and 50")
else:
    print("Not in between")
```

Check the Number is Single Digit or Not:

```
n = int(input("enter num : "))
if n>=0 and n<=9:
    print("Single Digit")
else:
    print("Not Sigle Digit")
```

Check the Number is Two Digit or Not:

```
n = int(input("enter num : "))
if n>=10 and n<=99:
    print("Two Digit")
else:
    print("Not Two Digit")
```

Check the Character is Upper case Alphabet or Not:

```
ch = input("enter character : ")
if ch>='A' and ch<='Z':
    print("Upper case Alphabet")
else:
    print("Not")
```

Check the Character is Lower case Alphabet or Not:

```
ch = input("enter character : ")
if ch>='a' and ch<='z':
    print("Lower case Alphabet")
else:
    print("Not")
```

Check the Character is Digit or Not:

```
ch = input("enter character : ")
if ch>='0' and ch<='9':
    print("Digit")
else:
    print("Not")
```

Character is Vowel or Not:

```
ch = input("enter character : ")
if ch=='a' or ch=='e' or ch=='i' or ch=='o' or ch=='u':
    print("Vowel")
else:
    print("Not")
```

Check the Character is Alphabet or Not:

```
ch = input("enter character : ")
if((ch>='A' and ch<='Z') or (ch>='a' and ch<='z')):
    print("Alphabet")
else:
    print("Not")
```

Check the Student passed in all 3 subjects or not with minimum 35 marks:

```
subj1 = int(input("Enter subj1 score: "))
subj2 = int(input("Enter subj2 score: "))
subj3 = int(input("Enter subj3 score: "))
if subj1 >= 35 and subj2 >= 35 and subj3 >= 35:
    print("Pass")
else:
    print("Fail")
```

Check A greater than both B and C:

```
print("Enter 3 numbers : ")
x = int(input())
y = int(input())
z = int(input())
if(x>y and x>z):
   print("Yes")
else:
    print("No")
```

Check given 3 numbers equal or not:

```
print("Enter 3 numbers : ")
x = int(input())
y = int(input())
z = int(input())
if(x==y and y==z and z==x):
    print("Equal numbers")
else:
    print("Not equal numbers")
```

Check given 3 numbers unique (not equal):

```
print("Enter 3 numbers : ")
x = int(input())
y = int(input())
z = int(input())
if(x!=y and y!=z and z!=x):
    print("Unique numbers")
else:
    print("Not unique numbers")
```

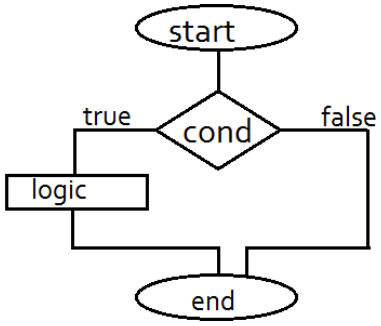
Check any 2 numbers are equal among the given 3 numbers:

```
print("Enter 3 numbers : ")
x = int(input())
y = int(input())
z = int(input())
if(x==y or y==z or z==x):
    print("Any 2 equal")
else:
    print("Not equal numbers")
```

If-block: Execute a block of instructions only if the given condition if true

Syntax :

```
if (condition) :
    .....
    logic
    .....
```



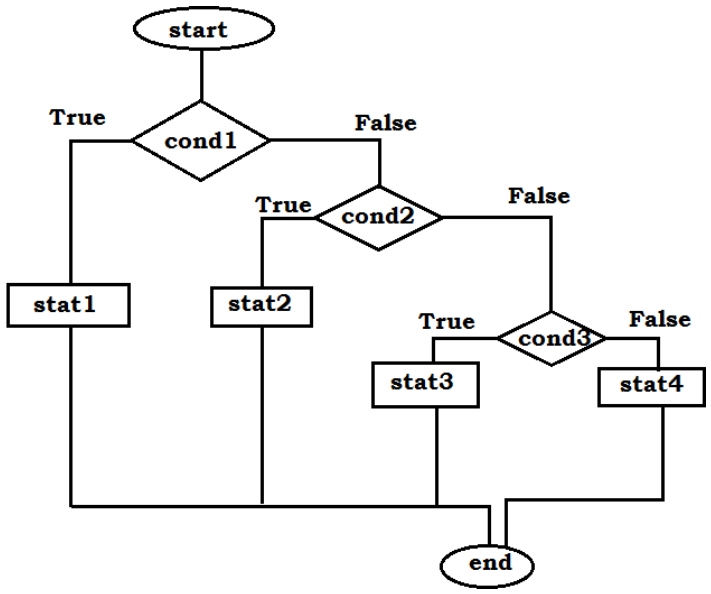
Program to give 20% discount to customer if the bill amount is > 5000

```
print("Enter bill amount :")
bill = float(input())
if(bill>5000):
    discount = 0.2*bill
    bill = bill-discount

print("Plz pay : ", bill)
```

if-elif-else: if-elif-else is a control flow structure in programming that allows a program to execute different blocks of code based on one or more conditions.

Syntax :

```
if(cond1) :
    stat1

elif(cond2) :
    stat2

elif(cond3) :
    stat3

else :
    stat4
```



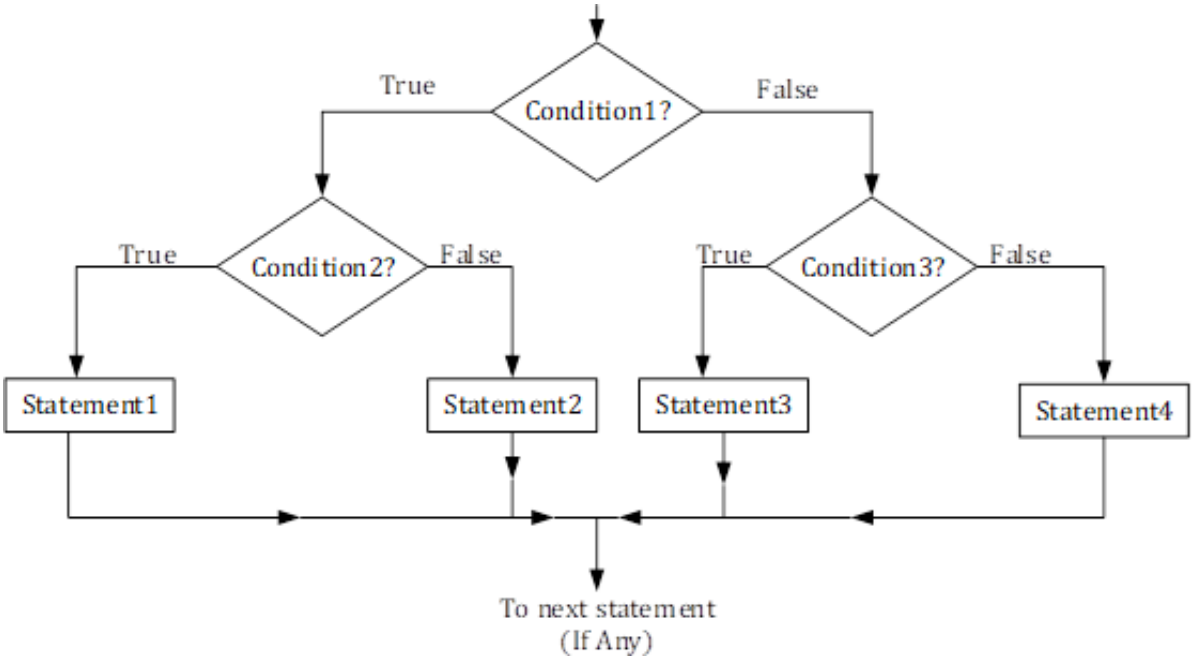
Check the Given number is Single Digit or Two Digit or Three Digit or Other

```
n = int(input("Enter number :"))
if(n>=0 and n<=9):
    print("Single digit")
elif(n>=10 and n<=99):
     print("Two digit")
elif(n>=100 and n<=999):
    print("Three digit")
else:
    print("Other digits number")
```

Check the given character is Upper case or Lower case or Digit or Symbol:

```
ch = input("Enter character :")
if(ch>='A' and ch<='Z'):
    print("Upper case alphabet")
elif(ch>='a' and ch<='z'):
    print("Lower case alphabet")
elif(ch>='0' and ch<='9'):
    print("Digit")
else:
   print("Symbol")
```

Nested-If: Writing if block inside another if block



Check the number is even or not only if the Number is positive

```
n = int(input("Enter number :"))
if n>=0:
    if n%2==0:
        print("Even number")
    else:
        print("Not even number")
else:
    print("Negative")
```

Check the biggest of 2 numbers only if the 2 numbers are not equal:

```
print("Enter 2 integers :")
a = int(input())
b = int(input())
if(a!=b):
    if(a>b):
        print("a is big")
    else:
        print("b is big")
else:
    print("equal numbers given")
```

Display Student Grade only if the Student passed in all subjects:

```
print("Enter 3 subject marks :")
m1 = int(input())
m2 = int(input())
m3 = int(input())

if(m1>=40 and m2>=40 and m3>=40):
    avg = (m1+m2+m3)/3
    if(avg>=75):
        print("Distinction")
    elif(avg>=60):
        print("A-Grade")
    elif(avg>=50):
        print("B-Grade")
    else:
        print("C-Graade")
else:
    print("Fail")
```

Bitwise operators:

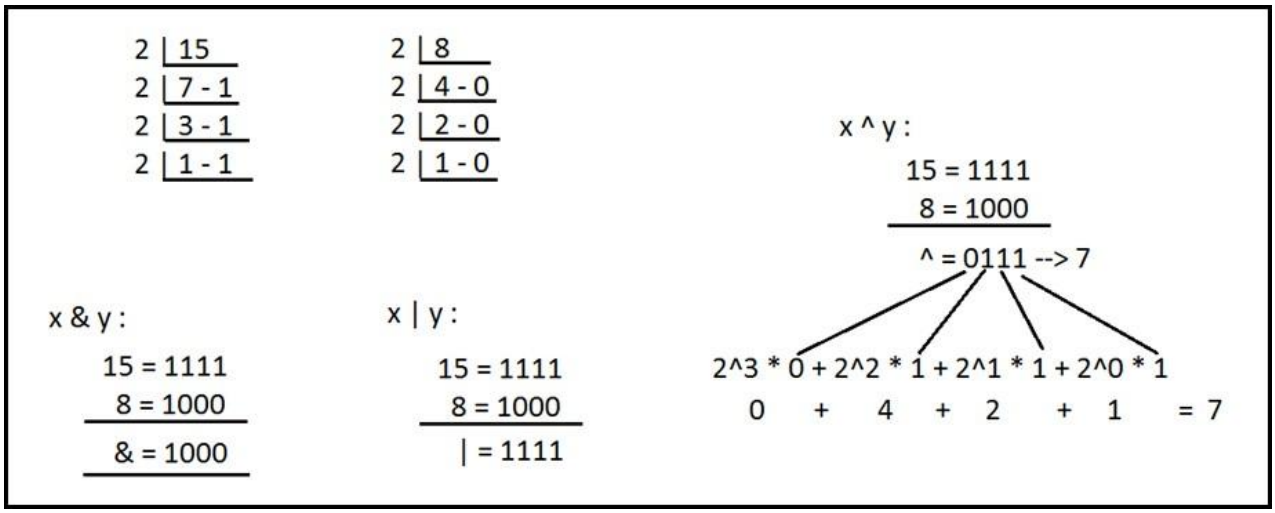
- Bitwise operators act on operands as if they were string of binary digits. It operates bit by bit, hence the name.
- For example, 2 is 10 in binary and 7 is 111.
- In the table below: Let x = 10 (0000 1010 in binary) and y = 4 (0000 0100 in binary)

Operator	Meaning	Example
&	Bitwise AND	x& y = 0 (0000 0000)
|	Bitwise OR	x | y = 14 (0000 1110)
~	Bitwise NOT	~x = -11 (1111 0101)
^	Bitwise XOR	x ^ y = 14 (0000 1110)
>>	Bitwise right shift	x>> 2 = 2 (0000 0010)
<<	Bitwise left shift	x<< 2 = 40 (0010 1000)

Bitwise truth table:

x	y	x&y	x|y	x^y
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

```
>>> x=15
>>> y=8
>>> x&y
8
>>> x|y
15
>>> x^y
```



Shift operators:

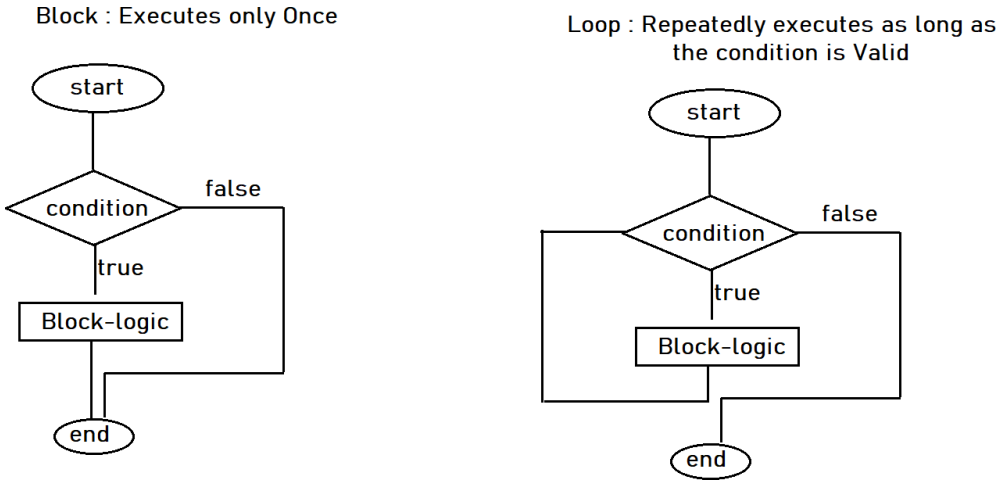
- These are used to move the bits in the memory either to right side or to left side.
- Moving binary bits in the memory change the value of variable.
- These operators return the result in decimal format only.
- Operators are Right shift (>>) and Left shift (<<)

```
>>> x=8
>>> x>>2
2
>>> x<<2
32
```

Right shift: n/2^s → 8/2^2 → 8/4 → 2
Left shift : n*2^s → 8*2^2 → 8*4 → 32

Introduction to Loops

Loop: A Block of instructions execute repeatedly as long the condition is valid.



Note: Block executes only once whereas Loop executes until condition become False

Python Supports 3 types of Loops:

1. For Loop
2. While Loop
3. While - else Loop

For Loop: We use for loop only when we know the number of repetitions. For example,

- Print 1 to 10 numbers
- Print String elements
- Print Multiplication table
- Print String character by character in reverse order

While loop: We use while loop when we don't know the number of repetitions.

- Display contents of File
- Display records of Database table

While – else : while-else loop is a type of loop that combines a while loop with an else statement that is executed after the loop has completed. The else block is executed only if the while loop completed normally

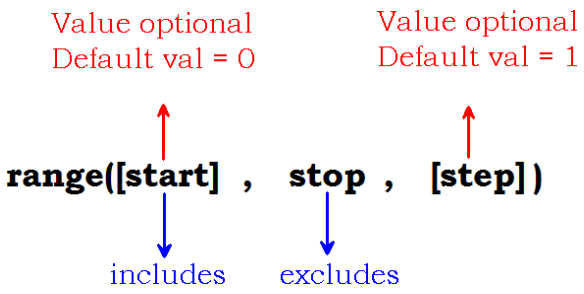
For Loop

for loop:

- "for" is a keyword.
- for loop executes a block repeatedly as long as the condition is valid.
- for loop uses range() function for loop repetition.

range():

- The range() function in Python generates a sequence of numbers within a given range.
- It takes up to three arguments: start (optional), stop (required), and step (optional).
- The sequence generated by the range() function is commonly used in for loops.



Print the numbers from 0 to 9:

```
for i in range(10):
    print(i)
```

Print the numbers from 3 to 8:

```
for i in range(3,9):
    print(i)
```

Print the numbers from 10 to 1:

```
for i in range(10, 0, -1):
    print(i)
```

Print every third number from 0 to 20:

```
for i in range(0, 21, 3):
    print(i)
```

Print the even numbers from 0 to 10:

```
for i in range(0, 11, 2):
    print(i)
```

Print the odd numbers from 1 to 9:

```
for i in range(1, 10, 2):
    print(i)
```

Print the even numbers from 10 to 0:

```
for i in range(10, -1, -2):
        print(i)
```

Display values side by side:

```
for i in range(1,6):
        # print(i)
        # print(i, end=' ') -> print values with spaces
        # print(i, end='\t') -> print values with tab spaces
        print(i, end='\n') # print values in new lines
```

Sum of First N numbers:

```
n = int(input("Enter a positive integer: "))
sum = 0
for i in range(1, n+1):
            sum += i
print("The sum of the first", n, "natural numbers is:", sum)
```

Find factorial for given number:

```
n = int(input("Enter a positive integer: "))
factorial = 1
for i in range(1, n+1):
        factorial *= i
print("The factorial of", n, "is:", factorial)
```

Multiplication table program:

```
n = int(input("Enter a positive integer: "))
for i in range(1, 11):
        product = i * n
        print(n, "x", i, "=", product)
```

Print even numbers from 1 to 10:

```
n = int(input("Enter a positive integer: "))
print("Even numbers from 1 to", n, "are:")
for i in range(1, n+1):
        if i % 2 == 0:
                print(i)
```

Print factors for given number:

```
n = int(input("Enter a positive integer: "))
print("Factors of", n, "are:")
for i in range(1, n+1):
        if n % i == 0:
                print(i)
```

Prime number program:

```
n = int(input("Enter a positive integer: "))
is_prime = True
for i in range(2, n):
        if n % i == 0:
                is_prime = False
                break
if is_prime:
print(n, "is a prime number")
else:
print(n, "is not a prime number")
```

Perfect number program:

```
n = int(input("Enter a positive integer: "))
sum = 0
for i in range(1, n//2 + 1):
        if n % i == 0:
                sum += i

if sum == n:
        print(n, "is a perfect number")
else:
print(n, "is not a perfect number")
```

Fibonacci Series program:

```
n = int(input("Enter the number of terms: "))
a, b = 0, 1
for i in range(1, n+1):
        print(a)
        c = a + b
        a, b = b, c
```

Multiplication tables in the given range:

```
for n in range(5, 11):

    for i in range(1,11):
        print(n,'*',i,'=',n*i)
```

Factorials in the Given range:

```
for n in range(1,8):

    fact=1
    for i in range(1,n+1):
        fact=fact*i
    print("factorial of",n,"is",fact)
```

Prime numbers in given range:

```
for n in range(1,51):

    factors=0
    for i in range(1,n+1):
        if(n%i==0):
            factors=factors+1

    if(factors==2):
        print(n,"is prime")
```

Perfect numbers in given range:

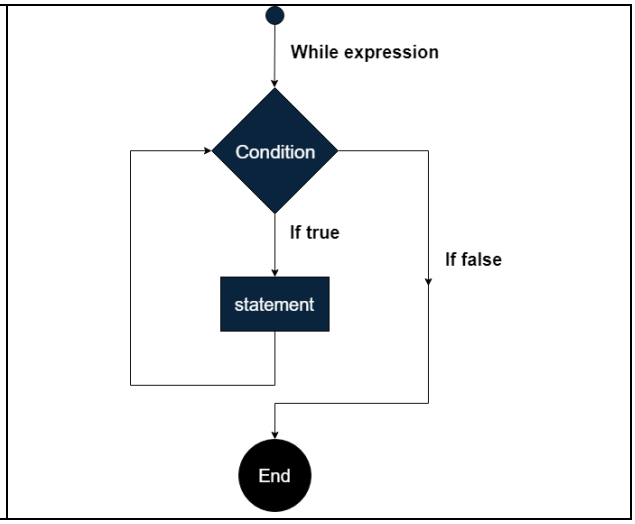
```
for n in range(1,10000):

    sum=0
    for i in range(1,n):
        if(n%i==0):
            sum=sum+i

    if(n==sum):
        print(n,"is perfect")
```

while loop:

- We use while loop when we dont know the number of iterations.
- **Examples:** Reading a File, Display records in dataabse.

Syntax:

```
while(condition):
        statements;
```



Check the even numbers until user quits:

```
while(True):
        n = int(input("enter num : "))
        if(n%2==0):
                print(n,"is even")
        else:
                print(n,"is odd")

        print("Do you check another num(y/n) :")
        ch = input()
        if(ch=='n'):
                break
```

Display Multiplication tables until user quits:

```
while(True):
        n = int(input("Enter table num : "))
        for i in range(1,11):
                print(n,'*',i,'=',n*i)

        print("Do you print another table(y/n) :")
        ch = input()
        if(ch=='n'):
                break
```

Menu Driven Program to perform all arithmetic operations:

```
while(True):
        print("1. Add")
        print("2. Subtract")
        print("3. Multiply")
        print("4. Divide")
        print("5. Quit")

        ch = int(input("enter choice :"))
        if(ch==1):
                print("Enter 2 numbers:")
                a=int(input())
                b=int(input())
                print("Res : ", a+b)
        elif(ch==2):
                print("Enter 2 numbers:")
                a=int(input())
                b=int(input())
                print("Res : ", a-b)
        elif(ch==3):
                print("Enter 2 numbers:")
                a=int(input())
                b=int(input())
                print("Res : ", a*b)
        elif(ch==4):
                print("Enter 2 numbers:")
                a=int(input())
                b=int(input())
                print("Res : ", a/b)
        elif(ch==5):
                break
        else:
                print("Invalid choice")
```

Count digits in the given number:

```
n = int(input("enter num : "))
count=0
while(n!=0):
        n=n//10
        count=count+1
print("Digits count : ", count)
```

Sum of digits in the given number:

```
n = int(input("Enter a number: "))
sum = 0
while n > 0:
        digit = n % 10
        sum += digit
        n //= 10
print("The sum of digits is:", sum)
```

Display only Even digits:

```
n = int(input("Enter a number: "))
while n > 0:
        digit = n % 10
        if digit % 2 == 0:
                print(digit)
        n //= 10
```

Sum of Even digits:

```
n = int(input("Enter a number: "))
sum = 0
while n > 0:
        digit = n % 10
        if digit % 2 == 0:
                sum += digit
        n //= 10
print("The sum of even digits is:", sum)
```

Largest digit in the given number:

```
n = int(input("Enter a number: "))
max_digit = 0
while n > 0:
    digit = n % 10
    if digit > max_digit:
        max_digit = digit
    n //= 10

print("The largest digit is:", max_digit)
```

Display First digit in the given number:

```
n = int(input("Enter a number: "))
while n >= 10:
    n //= 10

print("The first digit is:", n)
```

Sum of First and Last Digits in the given number:

```
n = int(input("Enter a number: "))
last_digit = n % 10
first_digit = n
while first_digit >= 10:
    first_digit //= 10

sum = first_digit + last_digit
print("The sum of the first and last digits is:", sum)
```

Reverse number program:

```
n = int(input("Enter a number: "))
reverse = 0

while n != 0:
    digit = n % 10
    reverse = (reverse * 10) + digit
    n //= 10

print("The reversed number is:", reverse)
```

Strong number program:

```
n = int(input("Enter a number: "))
temp = n
sum = 0

while temp != 0:
    digit = temp % 10
    fact = 1
    for i in range(1, digit + 1):
        fact *= i
    sum += fact
    temp //= 10

if sum == n:
    print(n, "is a strong number")
else:
    print(n, "is not a strong number")
```

ArmStrong Number program:

```
num = int(input("Enter a number: "))
sum = 0
temp = num

# find the number of digits
n = len(str(num))

# calculate sum of cubes of each digit
while temp > 0:
    digit = temp % 10
    sum += digit ** n
    temp //= 10

# display the result
if num == sum:
    print(num, "is an Armstrong number")
else:
    print(num, "is not an Armstrong number")
```

Break and Continue

break:

- It is a keyword
- It is called branching statement
- It is used to terminate the flow of a loop(for or while)

```
while True:
    print("Hi")
    print("Hello")
    break
```

Break loop on condition:

```
for i in range(10):
    if i==5:
        break
    print("i val :",i)
```

continue:

- It is a keyword.
- It is used to skip the current iteration in loop execution.

```
for i in range(1,11):
    if i==5:
        continue
    print("i val :",i)
```

```
for i in range(1,11):
    if i==3 or i==6:
        continue
    print("i val :",i)
```

Patterns Programming

Code:	Pattern:
for i in range(1,6): for j in range(1,6): print("*", end=" ") print()	* *

Code:	Pattern:

for i in range(1,6):
  for j in range(1,6):
  print(i, end=" ")
  print()
	1 1 1 1 1
	2 2 2 2 2
	3 3 3 3 3
	4 4 4 4 4
	5 5 5 5 5

Code:	Pattern:

for i in range(1,6):
  for j in range(1,6):
  print(j, end=" ")
  print()
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5

Code:	Pattern:

for i in range(1,6,1):
  for j in range(1,i+1,1):
  print(j, end=' ')
  print()
	1
	1 2
	1 2 3
	1 2 3 4
	1 2 3 4 5

Code:	Pattern:

for i in range(5,0,-1):
  for j in range(1,i+1,1):
  print(j, end=' ')
  print()
	1 2 3 4 5
	1 2 3 4
	1 2 3
	1 2
	1

Code:	Pattern:

for i in range(5,0,-1):
  for j in range(5,i-1,-1):
  print(j, end=' ')
  print()
	5
	5 4
	5 4 3
	5 4 3 2
	5 4 3 2 1

Code:	Pattern:

for i in range(1,6,1):
  for j in range(5,i-1,-1):
  print(j, end=' ')
  print()
	5 4 3 2 1
	5 4 3 2
	5 4 3
	5 4
	5

Code:	Pattern:

for i in range(1,6,1):
  for j in range(i,0,-1):
  print(j, end=' ')
  print()
	1
	2 1
	3 2 1
	4 3 2 1
	5 4 3 2 1

Code:	Pattern:

for i in range(5,0,-1):
  for j in range(i,0,-1):
  print(j, end=' ')
  print()
	5 4 3 2 1
	4 3 2 1
	3 2 1
	2 1
	1

Code:	Pattern:
for i in range(1,10): for j in range(1,10): if(i==5 or j==5): print("+", end=" ") else: print(" ", end=" ") print()	+ +

Code:	Pattern:
for i in range(1,10): for j in range(1,10): if(i==1 or j==1 or i==9 or j==9): print("+", end=" ") else: print(" ", end=" ") print()	+ +

Code:	**Pattern:**

```
for i in range(1,10):
    for j in range(1,10):
        if(i==j or j==10-i):
            print("+", end=" ")
        else:
            print(" ", end=" ")
    print()
```

```
+         +
 +       +
  +     +
   +   +
    + +
   + +
  +     +
 +       +
+         +
```

Code:	**Pattern:**

```
for i in range(1,10):
    for j in range(1,10):
        if(i==1 or i==9 or i==j or j==10-i):
            print("+", end=" ")
        else:
            print(" ", end=" ")
    print()
```

```
+ + + + + + + + + +
 +       +
  +     +
   +   +
    + +
   + +
  +     +
 +       +
+ + + + + + + + + +
```

Code:	**Pattern:**

```
for i in range(1,10):
    for j in range(1,10):
        if((i==1 and j<=5) or j==5 or (i==9 and
j>=5) or (j==9 and i<=5) or i==5 or (j==1
and i>=5)):
            print("+", end=" ")
        else:
            print(" ", end=" ")
    print()
```

```
+ + + + +     +
      +     +
      +     +
      +     +
+ + + + + + + + + +
+     +
+     +
+     +
+     + + + + +
```

Functions in Python

Functions:

- A block of instructions that performs a task.
- Function takes input, process the input and returns the output.
- "def" is a keyword is used to define functions in python programming.

Syntax:

```
def  identity(arguments) :
        ……
        Logic
        ……
```

Ex:

```
def  add(a, b):
        c=a+b
        return c
```

Every function consists:

1. Function definition: Function definition is a block which contains the logic.
2. Function call : It is a single statement used to access the function definition.

Definition:

```
def  add(a, b):
        c=a+b
        return c
```

Call:

```
res = add(10,20)
```

Basic functional programming:

- Function execute only when we call that function.
- Calling is a single statement used to access the function logic

```
def fun():
   print("Hello...")
   return

fun() # calling
```

Note : We cannot call a function before it has defined.

```
fun() # error :
def fun():
    print("Hello...")
    return
```

The main advantage of functions is code re-usability. We can call the function many times once we defined.

```
def test():
    print("logic..")
    return

test()
test()
test()
```

One source file(.py file) can have more than one function definition. Functions get executed in the order we invoke.

```
def m1():
    print("m1 .... ")
    return

def m2():
    print("m2 .... ")
    return

m2()
m1()
```

We can access one function from another function.

```
def m1():
    print("control in m1...")
    return

def m2():
    print("control in m2...")
    m1() #calling
    print("control back to m2 from m1...")
    return

print("Program starts...")
m2() #calling
print("Program ends...")
```

Classification of functions: The way of passing input and returning output, functions classified into

1. No arguments and No return values
2. With arguments and No return values
3. With arguments and With return values
4. No arguments and With return value
5. Recursion

No arguments and No return values:

- Defining a function without arguments. No need to pass input values while calling the function. 'return' statement is optional.

```
def sayHi():
    print("Hi to all...")
    return

sayHi()
sayHi()
sayHi()
```

With arguments and No return values:

- Defining a function with arguments(variables)
- Function takes input and it can be any type.
- We need to pass parameter values while calling the function.

```
def printMessage(msg):
    print("Message is :",msg)
    return

printMessage("Live Tution")
printMessage("Python")
printMessage("Tutorials")
```

With arguments and with return values:

- Defining a function with arguments and return values
- The value returned by function need to collect into variable.
- Function returned value back to the calling function.

```
def add(a,b):
    c=a+b
    return c
print("sum :",add(3,5))
print("sum :",add(5,8))
```

No arguments and with return values:

- Defining a function with no arguments
- Function returns a value from its definition.

```
def getPI():
    PI = 3.142
    return PI

print("PI value :",getPI())
```

Recursion:

- Function calling itself is called recursion.
- Calling the function from the definition of same function.
- Function executes from the allocated memory called STACK.
- While executing the program, if the stack memory is full, the program execution terminates abnormally.

```
def tutorials():
    print("Keep reading...")
    tutorials()
    return

tutorials()
```

Factorial of given number using recursion:

```
def fact(n):
    res=0
    if(n==0):
        res=1
    else:
        res=n*fact(n-1)
    return res

n = int(input("Enter n val :"))
print("Factorial val :", fact(n))
```

Argument type functions: Depends on the way of passing input and taking input, functions in python classified into

1. Default arguments function
2. Required arguments function
3. Keyword arguments function
4. Variable arguments function

Default arguments function:

- Defining a function by assigning values to arguments.
- Passing values to these arguments is optional while calling the function.
- We can replace the values of default arguments if required.

```
def default(a,b=20):
    print("a val :",a)
    print("b val :",b)
    return

default(10)
default(50,100)
default(10,"abc")
```

- Argument assigned with value is called default argument
- A Non default argument cannot follows default argument

```
def default(a=10,b):
    print("a val :",a)
    print("b val :",b)
    return
```

Required arguments function:

- Function definition without default arguments.
- We need to pass input value to all positional arguments of function.

```
def required(a,b):
    print("a val :",a)
    print("b val :",b)
    return

#required(10) -> Error:
required(10,20)
required(10,"abc")
```

Keyword arguments function:

- Calling the function by passing values using keys.
- We use arguments names as keys.

```
def keyword(name, age):
    print("Name is :",name)
    print("Age is :",age)
    return

keyword("Annie",21)
keyword(23,"Amar")
```

We can change the order of arguments while passing values using keys.

```
def keyword(name, age):
    print("Name is :",name)
    print("Age is :",age)
    return

keyword(age=23,name="Amar")
```

Keyword functions are useful mostly in default arguments function.

```
def default(a=10,b=20,c=30):
    print("a :",a)
    print("b :",b)
    print("c :",c)
    return

default()
# I want to change value of b=50
default(10,50,30)
# It is easy to use keyword arguments
default(b=50)
```

Variable arguments function:

- Passing different length of values while calling the function.
- We can collect these arguments into pointer type argument variable.

```
def variable(*arr):
    print("Length is :",len(arr))
    print("Elements :",arr)
    return

variable()
```

We can pass different types of data elements also

```
def variable(*arr):
    print("Elements :",arr)
    return

variable(10,20,30,40,50)
variable(10,2.3,"abc")
```

We can process the elements easily using for loop

```
def variable(*arr):
    print("Elements :")
    for ele in arr:
        print(ele)
    return

variable(10,20,30,40,50)
```

Local and Global Variables:

Local variables:

- Defining a variable inside the function.
- Local variables can be accessed only from the same function in which it has defined.
- We access the local variable directly.

```
def test():
    a=10 #local
    print("Inside :",a)
    return

test()
print("Outside :",a) #error :
```

Arguments(parameters):

- Variables used to store input of the function.
- Arguments are working like local variables.
- Arguments can access within that function only.

```
def test(a, b): #a,b are local
    print("Inside :",a)
    print("Inside :",b)
    return

test(10,20)
print("Outside :",a) #error
```

Global variables:

- Defining a variable outside to all the functions.
- We can access the variable directly.
- It is available throughout the application.

```
a=10 #global
def m1():
    print("Inside m1 :",a)
    return

def m2():
    print("Inside m2 :",a)
    return

m1()
m2()
print("Outside :",a)
```

- We can define local & global variables with the same name.
- We access both the variables directly using its identity.
- When we access a variable inside the function, it gives the first priority to local variable.
- If local is not present, then it is looking for Global variable.

```
a=10 #global
def m1():
    a=20 #local
    print("Inside m1 :",a)
    return

def m2():
    print("Inside m2 :",a)
    return

m1()
m2()
print("Outside :",a)
```

global:

- It is a keyword.
- It is used to define, access, modify & delete global variables from the function.
- global statement must be placed inside the function before the use of that variable.

Note: We can access global variable inside the function. We cannot modify the global variable from function directly.

```
a=10

def test():
    print("a  val  :",a)
    a=a+20 #error :
    print("a  val  :",a)
    return

test()
```

We can use global keyword to modify the global variable from the function:

```
a=10

def test():
    global a
    print("a val :",a)

    a=a+20
    print("a val :",a)

    a=a+30
    return

test()
print("a val :",a)
```

We can define global variables from the function using "global" :

```
def test():
    global a
    a=10
    print("Inside :",a)
    return

test()
print("Outside :",a)
```

Introduction to OOPS

Application:

- Programming Languages and Technologies are used to develop applications.
- Application is a collection of Programs.
- We need to design and understand a single program before developing an application.

Program Elements: Program is a set of instructions. Every Program consists,

1. Identity
2. Variables
3. Methods

1. Identity:

- Identity of a program is unique.
- Programs, Classes, Variables and Methods having identities
- Identities are used to access these members.

2. Variable:

- Variable is an identity given to memory location.

  or
- Named Memory Location
- Variables are used to store information of program(class/object)

Syntax	Examples

identity = value;	name = "amar";
	age = 23;
	salary = 35000.00;
	is_married = False;

3. Method:

- Method is a block of instructions with an identity
- Method performs operations on data(variables)
- Method takes input data, perform operations on data and returns results.

Syntax	Example
identity(arguments): body	add(int a, int b): c = a+b return c

Object Oriented Programming:

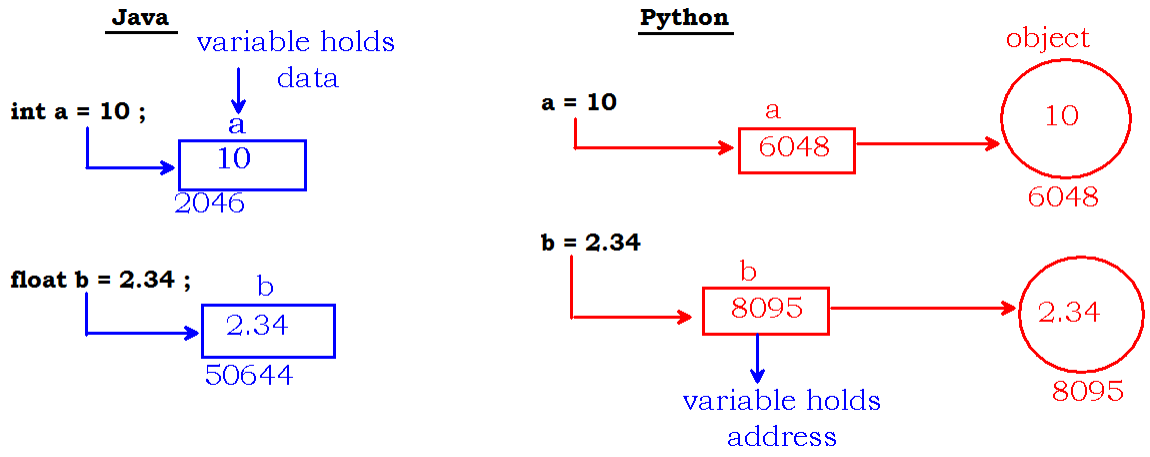
- Python is Object Oriented.
- Python is Fully Object Oriented because it doesn't support primitive data types.
- Languages which are supporting primitive types are called, Partial Object oriented programming languages.
- for example C++, Java, .Net...

Note: Primitive types such as int, float, char occupies fixed memory size and stores specific type of data.

Python is Dynamic:

- Python is dynamic
- Python variable stores address instead of data directly.
- Python stores information in the form of Objects.
- Depends on the data, the size of memory grows and shrinks dynamically.
- A python variable accepts any type of data assignment.

Note: In python, if we modify the value of variable, it changes the location.



id(): A pre-defined function that returns memory address of specified variable.

```
a=10
print("Val :",a)
print("Addr :",id(a))

a=a+5
print("Val :",a)
print("Addr :",id(a))
```

Object Oriented Programming features are:

1. Encapsulation
2. Inheritance
3. Polymorphism
4. Abstraction

Note: We implement Object-Oriented functionality using Classes and Objects

Class: Class contains variables and methods**.** Java application is a collection of classes

Syntax	Example
class ClassName: Variables ; & Methods ;	class Account: num; balance; withdraw(): logic; deposit(): logic;

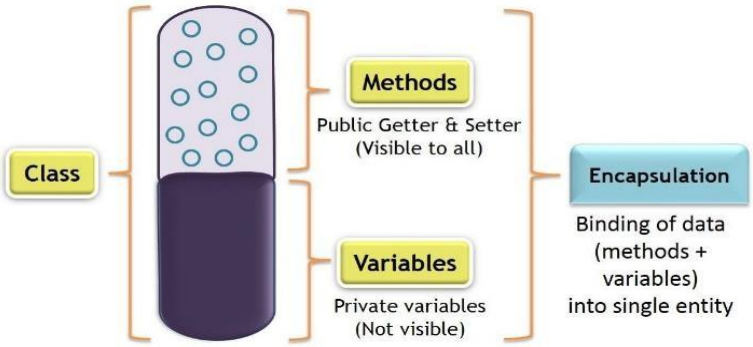
Object: Object is an instance of class. Instance (non static) variables of class get memory inside the Object.

Syntax: refVariableName = ClassName();
Example: acc = Account();

Note: Class is a Model from which we can define multiple objects of same type

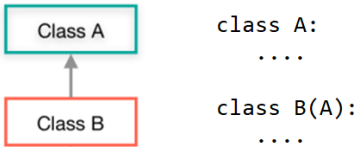
Encapsulation:

- The concept of protecting the data with in the class itself.
- **Implementation rules:**
  - Class is Public (to make visible to other classes).
  - Variables are Private (other objects cannot access the data directly).
  - Methods are public (to send and receive the data).



Inheritance:

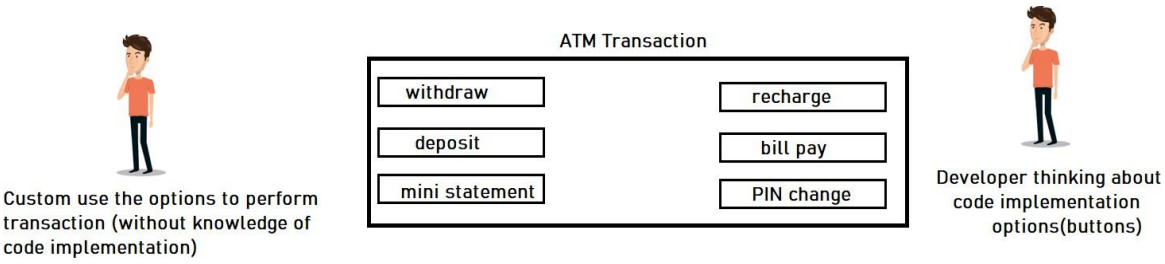
- Defining a new class by re-using the members of other class.
- We can implement inheritance using "extends" keyword.
- **Terminology:**
  - **Parent/Super class:** The class from which members are re-used.
  - **Child/Sub class:** The class which is using the members




```
class A:
   ....

class B(A):
   ....
```

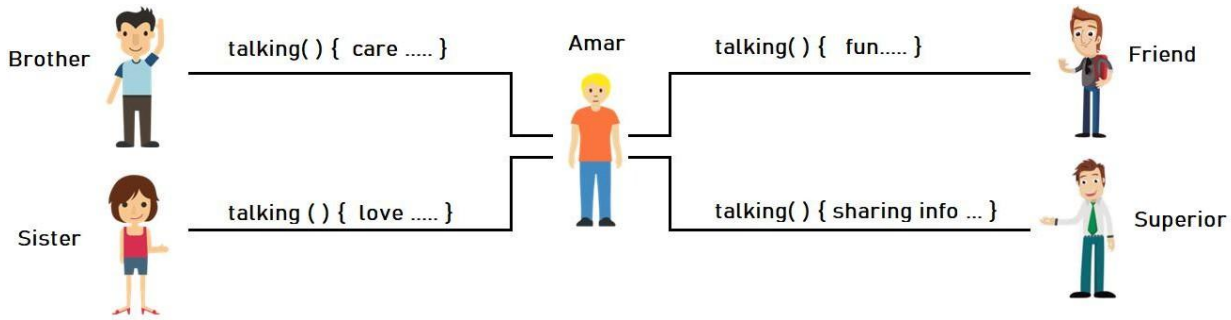
Abstraction:

- Abstraction is a concept of hiding implementations and shows functionality.
- Abstraction describes "What an object can do instead how it does it?".



Polymorphism:

- Polymorphism is the concept where object behaves differently in different situations.



Class Members or Static members:

- Defining variable or method inside the class.
- We can access these members using class name.

Note: Generally, we access the variables and functions directly after definition.

```
a=10
def test():
    print("test")
    return
print("a val :",a)
test()
```

- In Object Oriented application, variables and methods must be defined inside the class.
- "class" is a keyword.
- Defining variable and method inside the class called "static members"
- We need to access static members using identity of class.

```
class Test:
    a=10 # static
    def fun():
        print("static fun")
        return
print("a val :",Test.a)
Test.fun()
```

Connect classes:

- One python file allowed to define any number of classes
- We can access the members of these classes using "class names"

```
class First:
    def fun():
        print("First class fun")
        return
class Second:
    def fun():
        print("Second class fun")
        return
class Access:
    def main():
        print("starts @ main")
        First.fun()
        Second.fun()
        return

Access.main()
```

Local and Static variables:

- Defining a variable inside method is called local variable
- We access local variables directly but only from the same block in which it has defined.
- Defining a variable inside the class and outside to all methods is called static variable.
- We can access static variable using class name.

```
class Access:
    a=10 #static
    def main():
        a=20 #local
        print("local a :", a)
        print("static a :", Access.a)
        return

Access.main()
```

Global variables:

- Defining variables outside to all classes.
- We access global variables directly.
- When we access variable inside the method, it is looking for local variable first. If the local variable is not present, it accesses the global variable.

```
a=10 #Global
class Access:
    a=20 #Static
    def m1():
        a=30 #Local
        print("Inside m1")
        print(a)
        print(Access.a)
        return

    def m2():
        print("Inside m2")
        print(a)
        print(Access.a)
        return

    def main():
        Access.m1()
        Access.m2()
        return
Access.main()
```

Dynamic members

Dynamic Members:

- The specific functionality of Object must be defined as dynamic.
- We access dynamic members using object.
- We can create object for a class from static context.

Dynamic method:

- Defining a method inside the class by writing "self" variable as first argument.
- "self" is not a keyword.
- "self" is a recommended variable to define Dynamic methods.
- Definition of dynamic method as follows.

```
class Test:
    def m1():
        # static method
        return

    def m2(self):
        # dynamic method
        return

    def  __init__(self):
        #  constructor
        return
```

self:

- It is used to define dynamic methods and constructor.
- It is not a keyword but it is the **most recommended** variable to define dynamic functionality.
- It is an argument(local variable of that function)
- We can access "self" only from the same function or constructor.
- "self" variable holds object address.

Constructor:

- A special method with pre-defined identity(__init__).
- It is a dynamic method(first argument is self)
- It invokes automatically in the process of Object creation.

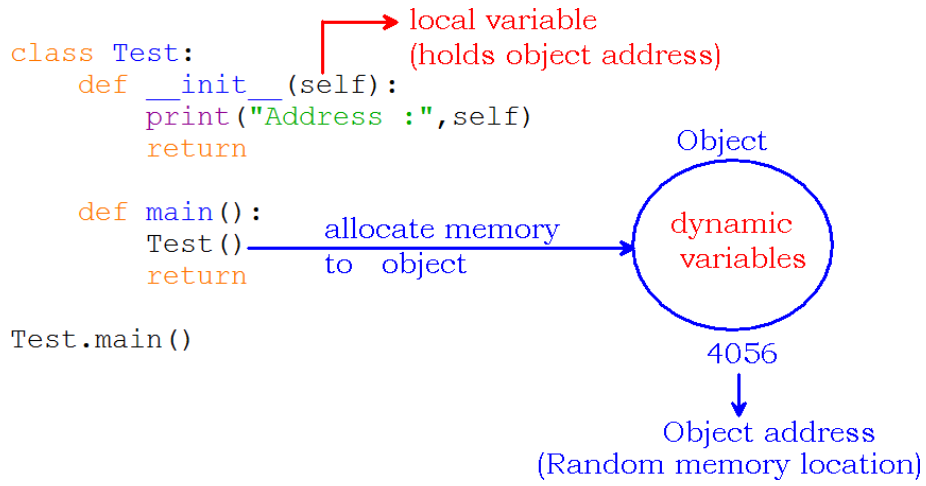
Creating object in main():

- Application execution starts from static context(main).
- We can access non static members using object address.
- We create object(take permission) in static context(main)

```
class Test:
    def _init_(self):
        print("Constructor")
        return

    def main():
        Test() #access constructor
        return

Test.main()
```

Constructor executes every time when we create the object.

```
class Test:
    def _init_(self):
        print("Constructor")
        return

    def main():
        for i in range(10):
            Test()
        return

Test.main()
```



```
class Test:
    def _init_(self):
        print("Address :",self)
        return

    def main():
        Test()
        return

Test.main()
```

id(): A pre-defined method that returns integer value of specified Object.
type(): Returns the class name of specified object.

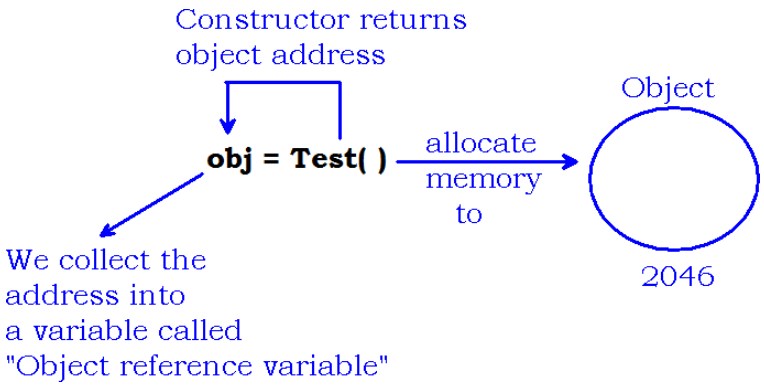
```
class Test:
    def _init_(self):
        print("Address :",id(self))
        print("Name :",type(self))
        return

    def main():
        Test()
        return
Test.main()
```

We cannot access 'self' in main() method to work with object.

```
class Test:
    def __init__(self):
        print("In Constructor :",id(self))
        return

    def main():
        Test()
        print("In main :", id(self))
        return

Test.main()
```

Object reference variable:

- Constructor returns address of Object after creation.
- We can collect the address assigning to any variable.
- The variable stores object address is called "Object reference variable"



We can display object address in main using "object reference variable.

```
class Test:
    def __init__(self):
        print("In Constructor :",id(self))
        return

    def main():
        addr = Test()
        print("In main :", id(addr))
        return

Test.main()
```

Access static and dynamic methods from main:

```
class Test:
    def m1():
        # static method
        return

    def m2(self):
        # dynamic method
        return
```

Default constructor:

- In object creation process, constructor executes implicitly.
- When we don't define any constructor, a default constructor will be added to the source code.
- Default constructor has empty definition – no logic.

```
class Test:

    def main():
        x = Test()
        y = Test()
        print("Address of x : ", id(x))
        print("Address of y : ", id(y))
        return

Test.main()
```

We can define the default constructor explicitly to understand the object creation process.

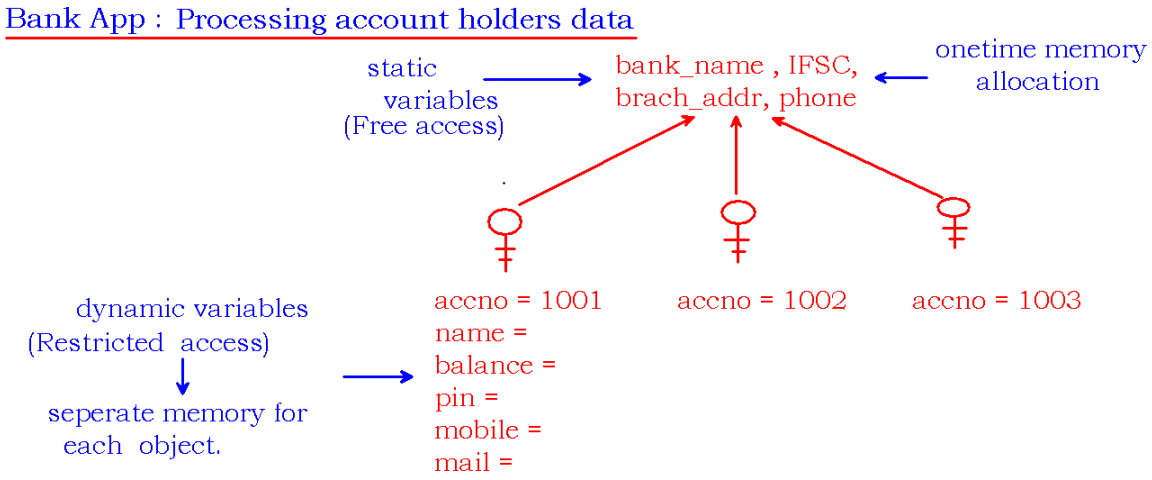
```
class Test:
    def __init__(self):
        print("Object Created :", id(self))
        return

    def main():
        x = Test()
        y = Test()
        print("Address of x : ", id(x))
        print("Address of y : ", id(y))
        return

Test.main()
```

Accessing static and dynamic methods:

```
class Test:
    def main():
        obj = Test()
        Test.m1()
        obj.m2()
        return

    def m1():
        print("Static method")
        return

    def m2(self):
        print("Dynamic method")
        return

Test.main()
```

Dynamic variables:

Static Variables	Dynamic Variables
Static variables store common information of Object.	We create dynamic variables inside the object using 'self' variable.
Static variables get memory only once.	Variables creation must be from constructor.
We can access static variables using class Name	We can access the variables through object address.



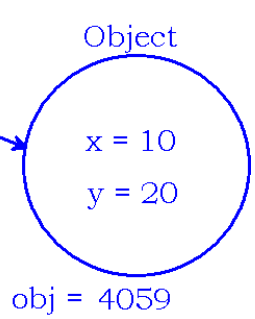
Constructor is used to define dynamic variables:

- Constructor is a special method
- Execute every time automatically in object creation process.
- Constructors used to create dynamic variables.
- As soon as object memory is ready, constructor allocates memory to dynamic variables inside the object.

Access instace variables:

```
class Test :
    def _init_(self):
        self.x = 10
        self.y = 20
        return

    def main():
        obj = Test()
        print("x val :", obj.x)
        print("y val :", obj.y)
        return
Test.main()
```

```
class Test :
    def __init__(self):
        self.x = 10
        self.y = 20
        return

    def main():
        obj = Test()
        print("x val :", obj.x)
        print("y val :", obj.y)
        return

Test.main()
```



Note: In the above program, if we assign values directly to dynamic variables, all objects initializes with same set of values.

```
class Test:
    def _init_(self):
        self.a = 10
        return

    def main():
        t1 = Test()
        print("t1 a val :", t1.a)

        t2 = Test()
        print("t2 a val :", t2.a)
        return

Test.main()
```

Arguments constructor:

- Constructor taking input values to initialize dynamic variables in Object creation process.
- Using arguments constructor, we can set different values to different object variables.
- Arguments are local variables and we can access directly.

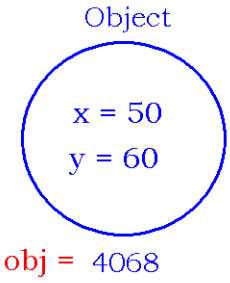
```
class Test :
    def _init_(self, a, b):
        self.x = a
        self.y = b
        return
```

```
    def main():
        obj = Test(50,60)
        print("x val :", obj.x)
        print("y val :", obj.y)
        return


Test.main()
```

```
class Test :
    def __init__(self, a, b):
        self.x = a
        self.y = b
        return

    def main():
        obj = Test(50,60)
        print("x val :", obj.x)
        print("y val :", obj.y)
        return

Test.main()
```

4068 50 60

Local variables (direct access)



self.x = a --> local variable "a" value assigning to dynamic variable "x"

- Local variables and dynamic variables can have the same identity.
- We access the local variable directly where as dynamic variable using object address.

```
class Test:
    def _init_(self,a,b):
        self.a = a
        self.b = b
        return

    def main():
        obj = Test(10,20)
        print("a val :", obj.a)
        print("b val :", obj.b)
        return

Test.main()
```

WAP to construct the object by taking user input:

```
class Test:
    def _init_(self,a,b):
        self.a = a
        self.b = b
        return

    def details(self):
        print("a val :", self.a)
        print("b val :", self.b)
        return

    def main():
        print("Enter a, b values :")
        a = input()
        b = input()
        obj = Test(a,b)
        obj.details()
        return

Test.main()
```

Read Emp details and Construct object:

```
class Emp:
    def _init_(self, num, name):
        self.num = num
        self.name = name
        return

    def details(self):
        print("Emp num is :", self.num)
        print("Emp name is :", self.name)
        return

class Access:
    def main():
        print("Enter emp details :")
        num = int(input())
        name = input()
        obj = Emp(num, name)
        obj.details()
        return
Access.main()
```

Account Operations program:

```
class Account:
    def  __init__(self,amt):
        self.balance = amt
        return

    def deposit(self,amt):
        self.balance=self.balance+amt
        print(amt,"deposited")
        return

    def withdraw(self,amt):
        print("Withdrawing :",amt)
        print("Avail bal :",self.balance)
        if(amt<=self.balance):
            print("Collect cash :",amt)
            self.balance=self.balance-amt
        else:
            print("Error : Low balance")
        return

class Bank:
    def main():
        amt = int(input("Enter initial bal : "))
        acc = Account(amt)
        print("Balance is :",acc.balance)

        amt = int(input("Enter deposit amt :"))
        acc.deposit(amt)
        print("After deposit :",acc.balance)

        amt = int(input("Enter withdraw amt :"))
        acc.withdraw(amt)
        print("Final balance :",acc.balance)
        return

Bank.main()
```

Access Modifiers

Access Modifiers:

- Access modifiers are used to set permissions to access the data.
- Python supports 3 access modifiers.
    - private(_ _var)
    - protected (_var)
    - public (var)

Note: Protected members can be discussed with Inheritance concept.

public:

- We can access public members (variables or methods) directly.
- All programs discussed before contains public variables and methods.

```
class Test:
    a=10
    def __init__(self,b):
        self.b = b
        return

class Access:
    def main():
        obj = Test(20)
        print("a val :", Test.a)
        print("b val :", obj.b)
        return

Access.main()
```

Private members:

- A member definition preceded by _ _ is called private member.
- One object(class) cannot access the private members of another object directly.

Note: A class itself can access the private members.

```
class First:
    a = 10 #public
    __b = 20 #private

    def main():
        print("a val :", First.a)
        print("b val :", First.__b)
        return

First.main()
```

Accessing private members of another class results Error:

```
class First:
    a = 10 #public
    __b = 20 #private

class Second:
    def main():
        print("a val :", First.a)
        print("b val :", First._b)
        return

Second.main()
```

Private dynamic variables creation and Access:

```
class First:
    def __init__(self,x,y):
        self.a = x # 'a' is public
        self._b = y # 'b' is private
        return

    def main():
        obj = First(10,20)
        print("a val : ", obj.a)
        print("b val : ", obj._b)
        return

First.main()
```

Accessing private variables from other class results error:

```
class First:
    def _init_(self,x,y):
        self.a = x
        self._b = y
        return

class Second:
    def main():
        obj = First(10,20)
        print("a val : ", obj.a)
        print("b val : ", obj._b)
        return

Second.main()
```

Accessing private variables from another class:

- One class cannot access the private information from another class directly.
- A class(object) is allowed to share(send or receive) the private data in communication.
- Communication between objects is possible using methods.
- Two standard methods get() and set() to share the information.

```
class First:
    __a = 10
    def getA():
        return First.__a

class Second:
    def main():
        # print("a val : ", First.__a)
        print("a val : ", First.getA())
        return

Second.main()
```

Accessing dynamic private variable using dynamic get() method:

```
class First:
    def _init_(self,a):
        self._a = a
        return

    def getA(self):
        return self._a

class Second:
    def main():
        obj = First(10)
        # print("a val : ", obj.__a)
        print("a val : ", obj.getA())
        return

Second.main()
```

Modifying private variables data:

- We cannot set values directly to private variables.
- We use set() method to modify the data.

Note: When we try set the value directly to private variable, the value will be omitted.

```
class First:
    _a=10
    def getA():
        return First._a
    def setA(a):
        First._a = a
        return

class Second:
    def main():
        print("a val :", First.getA())
        First__a=20
        print("a val :", First.getA())
        First.setA(20)
        print("a val :", First.getA())
        return

Second.main()
```

Setting values to dynamic private variables:

```
class First:
    def _init_(self,a):
        self._a = a
        return
    def getA(self):
        return self._a
    def setA(self,a):
        self._a = a
        return

class Second:
    def main():
        obj = First(10)
        print("a val :", obj.getA())
        obj.setA(20)
        print("a val :", obj.getA())
        return

Second.main()
```

Encapsulation: The concept of protecting object information.

Rules:

1. Class is public – Object is visible to other objects in communication.
2. Variables are private – One object cannot access the information of other object directly.
3. Communication between objects using get() and set() methods to share the information.

```
class Emp:
    def  __init__(self,num,name,salary):
        self._num = num
        self._name  =  name
        self._salary  =  salary
        return

    def getNum(self):
        return self._num
    def getName(self):
        return self._name
    def getSalary(self):
        return self._salary

    def setNum(self,num):
        self._num = num
        return
    def setName(self,name):
        self._name = name
        return
    def setSalary(self,salary):
        self._salary = salary
        return

class Access:
    def main():
        print("Enter Emp details :")
        num = int(input("Emp Num : "))
        name = input("Emp Name : ")
        salary = float(input("Emp Sal : "))
        obj = Emp(num, name, salary)
        print("Name :",obj.getName())
        return
Access.main()
```

Inheritance in Python

Inheritance:

- Defining an object by re-using the functionality of existing object.
- The main advantage of inheritance in code re-usability.

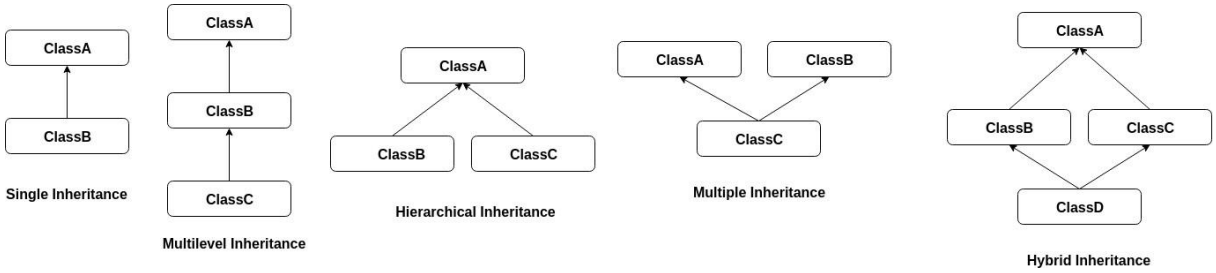
Terminology of inheritance :

- Parent – Child class
- Super – Sub class
- Base – Derived class

.

Types of Inheritance:

- Python supports all types of inheritance supported by Object Oriented Programming.
- The following diagram represents all types



Single Inheritance:

- In parent-child relation, we can access the functionality of Parent through child.
- We cannot access Child functionality using Parent.
- Accessing static members in Parent and Child as follows:

```
class Parent:
    def m1():
        print("Parent's m1")
        return

class Child(Parent):
    def m2():
        print("Child's m2")
        return

class Inheritance:
    def main():
        Child.m1()
        Child.m2()

Inheritance.main()
```

Accessing dynamic functionality in Parent-Child relation:

```
class Parent:
    def m1(self):
        print("Parent's m1")
        return

class Child(Parent):
    def m2(self):
        print("Child's m2")
        return

class Inheritance:
    def main():
        c = Child()
        c.m1()
        c.m2()

Inheritance.main()
```

Method overriding:

- Defining a method in the Child class with same name and same set of arguments of Parent class method.
- When two methods in Parent and Child with the same identity, it gives the first priority to Child object.

```
class Parent:
    def fun(self):
        print("Parent's fun()")
        return

class Child(Parent):
    def fun(self): #override
        print("Child's  fun()")
        return

class Inheritance:
    def main():
        obj = Child()
        obj.fun()
        return

Inheritance.main()
```

Advantage of overriding:

- Overriding is the concept of updating existing object functionality when it is not sufficient to extended object.
- Re-writing the function logic with the same identity.

Complete Inheritance with Code program:

```
# 1. Accessing existing functionality
# 2. Adding new features
# 3. Update(override) existing features
```

```
class Guru:
    def call(self):
        print("Guru - Call")
        return
    def camera(self):
        print("Guru - Camera - 2MP")
        return

class Galaxy(Guru):
    def videoCall(self):
        print("Galaxy - Video Call")
        return
    def camera(self):
        print("Galaxy - Camera - 8MP")
        return

class Inheritance:
    def main():
        g1 = Galaxy()
        g1.call()# Access existing
        g1.videoCall()# new feature
        g1.camera() #updated

        g2 = Guru()
        g2.call()
        g2.camera()
        g2.videoCall() # error:
        return

Inheritance.main()
```

Accessing overridden functionality of Parent class:

super():

- It is pre-defined method.
- It is used to access Parent class functionality(super) from Child(sub).

```
class Grand:
    def fun(self):
        print("Grand")
        return

class Parent(Grand):
    def fun(self):
        super().fun()
        print("Parent")
        return

class Child(Parent):
    def fun(self):
        super().fun()
        print("Child")
        return

class Inheritance:
    def main():
        obj = Child()
        obj.fun()
        return

Inheritance.main()
```

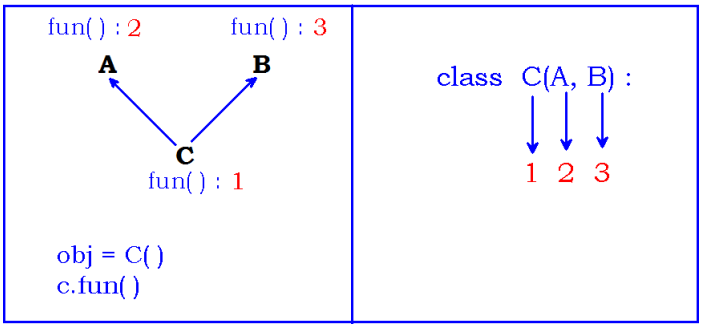
- We can access the functionality of all classes in the hierarchy from one place using super() method.
- We need to specify the Class type along with object reference variable.
- If we specify the Child type, it access Parent functionality.

```
class Grand:
    def fun(self):
        print("Grand")
        return

class Parent(Grand):
    def fun(self):
        print("Parent")
```

```
        return

class Child(Parent):
    def fun(self):
        print("Child")
        return

class Inheritance:
    def main():
        obj = Child()
        obj.fun()
        super(Child, obj).fun()
        super(Parent, obj).fun()
        return

Inheritance.main()
```

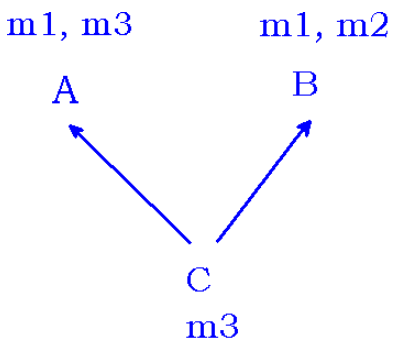
Accessing the functionality in Multiple Inheritance:

- While accessing the functionality of Multiple Inheritance or Hybrid Inheritance, we need to understand the concept of MRO(Method Resolution Order).
- MRO is the concept of how the Interpreter searching for methods while accessing using Child object address.




```
class A:
    def m1(self):
        print("A-m1")
        return

    def m3(self):
        print("A-m3")
        return
```

```
class B:
    def m1(self):
        print("B-m1")
        return

    def m2(self):
        print("B-m2")
        return

class C(A,B):
    def m3(self):
        print("C-m3")
        return

class Multiple:
    def main():
        c = C()
        c.m3()
        c.m2()
        c.m1()
        return

Multiple.main()
```

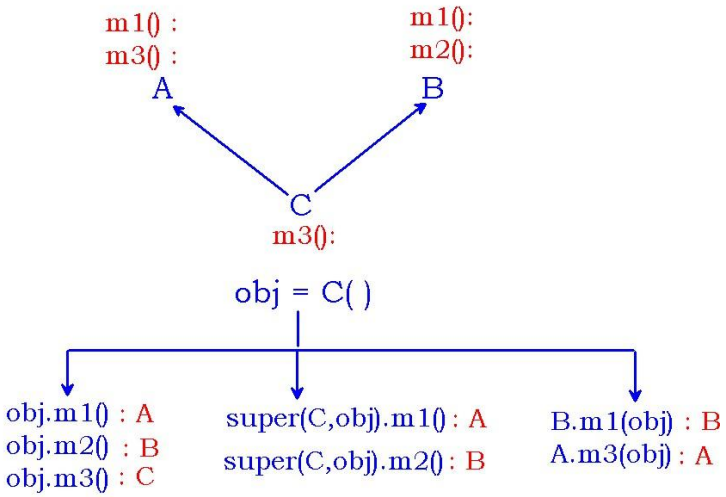


c.m3( ) ---> C - m3
c.m2( ) ---> B - m2
c.m1( ) ---> A - m1

Accessing the complete functionality of all objects in multiple inheritance:

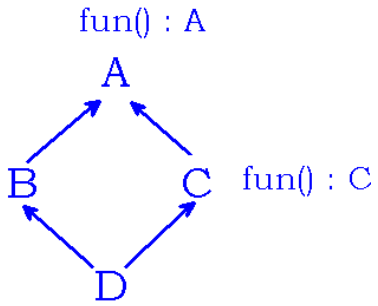
```
class A:
    def m1(self):
        print("A-m1")
        return

    def m3(self):
        print("A-m3")
        return

class B:
    def m1(self):
        print("B-m1")
        return

    def m2(self):
        print("B-m2")
        return

class C(A,B):
    def m3(self):
        print("C-m3")
        return

class Multiple:
    def main():
        obj = C()
        obj.m1()
        obj.m2()
        obj.m3()
        super(C,obj).m1()
        super(C,obj).m2()
        A.m3(obj)
        B.m1(obj)
        return

Multiple.main()
```

```
class A:
    def m1(self):
        print("A-m1")
        return

    def m3(self):
        print("A-m3")
        return

class B:
    def m1(self):
        print("B-m1")
        return

    def m2(self):
        print("B-m2")
        return

class C(A,B):
    def m3(self):
        print("C-m3")
        return
```



Hybrid inheritance:

```
class A:
    def fun(self):
        print("A")
        return

class B(A):
    pass

class C(A):
    def fun(self):
        print("C")
        return

class D(B,C):
    pass

class Hybrid:
    def main():
        obj = D()
        A.fun(obj) ⟶ A
        B.fun(obj) ⟶ A
        C.fun(obj) ⟶ C
        D.fun(obj) ⟶ C
```



Polymorphism in Python

Polymorphism:

- Defining an object(class) that shows different behavior(methods) with the same identity.
- Polymorphism is of 2 types
    - Compile time polymorphism
    - Runtime polymorphism

Compile time polymorphism:

- It is also called "Static binding".
- It is "Method Overloading" technique.
- Defining multiple methods with same name and different set of arguments is called "Overloading".
- Depends on input values, corresponding method executes.

Note: Python doesn't support method overloading. When we define a duplicate method, existing method will be replaced.

```
class Calc:
    def add(a,b):
        res=a+b
        print("Sum of 2 num's :", res)
        return

    def add(a,b,c): # replace exising add() method
        res=a+b+c
        print("Sum of 3 num's :", res)
        return

class Overload:
    def main():
        Calc.add(10,20,30)
        Calc.add(10,20) # error
        return

Overload.main()
```

How can we implement overloading in python?

- In other programming languages, we can define overloading by writing multiple methods either with different types of input or with different length of input.
- As python doesn't support data types, we can pass different types of data into same variables.

```
class Calc:
    def add(a,b):
        res=a+b
        print("Sum :", res)
        return

class Overload:
    def main():
        Calc.add(10,20)
        Calc.add(2.3,4.5)
        Calc.add("Python","Class")
        return

Overload.main()
```

Python supports variables arguments function. We can pass different length of arguments to a single method.

```
class Calc:
    def add(*arr):
        l = len(arr)
        sum = 0
        for ele in arr:
            sum = sum+ele
        print("Sum of",l,"elements :",sum)
        return

class Overload:
    def main():
        Calc.add(10,20)
        Calc.add(10,20,30)
        Calc.add(10,20,30,40,50)
        return

Overload.main()
```

Runtime Polymorphism:

- It is called "dynamic binding".
- It is method "overriding technique".
- Overriding is the concept of defining a method in Child class with the same name and same set of arguments in Parent class method.
- A Child object can shows the functionality of Parent and Child. Hence it is called Polymorphic

```
class Grand:
    def fun(self):
        print("Grand")
        return

class Parent(Grand):
    def fun(self):
        print("Parent")
        return

class Child(Parent):
    def fun(self):
        print("Child")
        return

class Override:
    def main():
        obj = Child()
        obj.fun()
        super(Child,obj).fun()
        super(Parent,obj).fun()
        return

Override.main()
```

Exception Handling in Python

Exception Handling:

- Exception is a "class"
- Exception is a "Runtime Error"
- When exception rises, the flow of execution will be terminated with informal information to the user.

```
class Add:
    def main():
        print("Enter 2 integers :")
        x = int(input())
        y = int(input())
        z = x+y
        print("Sum : ", z)
        print("End...")
        return

Add.main()
```

Note the followings:

- Exception handling is the concept of working with failure cases of logic.
- As a programmer, we need to analyze success cases and failure cases in the transaction to implement the code.

Default Exception handler:

- It is a pre-defined program.
- When exception raises, an object will be created with the complete information of that Error is called "Exception Object".
- It is recommended to handle every exception in the application.
- If we don't handle, the object will be transferred to "Default Exception Handler"

Handling the exceptions:

Try:

- Try block is used to place the doubtful code that may raise exception.
- If exception raises in try block, an exception object will be raised with the error information.

Except:

- Except block is used to collect and handle the exception object which is raised in try block.

Syntax:

```
try :
        ->Doubtful code...
except  <Exception_type>  var :
        ->Handling logic...
```

Reading 2 numbers and perfrom addition operation: Chance of getting ValueError if the user entered invalid input

```
class Demo:
    def main():
        try:
            print("Enter 2 numbers :")
            x = int(input())
            y = int(input())
            z = x+y
            print("Sum :",z)
        except ValueError:
            print("Exception : Invalid input")
        print("End")
        return
Demo.main()
```

try with multi except: One try block can have more than one except blocks to handle different types of exceptions occur in different lines of code. Only one except block executes among we defined.

```
class Division:
    def main():
        try:
            print("Enter 2 numbers :")
            x = int(input())
            y = int(input())
            print("Result :", x/y)

        except ValueError:
            print("Exception : Invalid input")

        except ZeroDivisionError:
            print("Exception : Denominator should not be zero")
        print("End")
        return

Division.main()
```

Exception class:

- "Exception" is pre-defined class.
- "Exception" is the Parent class of all other exception classes.
- Instead of handling multiple exceptions with number of except blocks, we can specify "Exception" type to handle all.
- We need to provide the common the error information to handle using "Exception" class.

Note: We can display the message of Exception object by collecting into variable in "except" block.

```
class Division:
    def main():
        try:
            print("Enter 2 numbers :")
            x = int(input())
            y = int(input())
            z = x/y
            print("Result :",z)

        except Exception as msg:
            print("Exception :",msg)

        return

Division.main()
```

Finally block: It is used to provide "Resource releasing logic". All resources (connected to program) must be closed from finally block.

Note: Finally block executes whether or not an exception has raised in the try block.

```
class Finally:
    def main():
        try:
            x = 10/5
            print("Try block")
        except Exception:
            print("Except block")
        finally:
            print("Finally block")
        return

Finally.main()
```

Finally block executes though exception occurs

```
class Finally:
    def main():
        try:
            x = 10/0
            print("Try block")

        except Exception:
            print("Except block")

        finally:
            print("Finally block")

        return

Finally.main()
```

Open and Close the File using Finally block:

- open() is pre-defined and it is used to open the file in specified path.
- If the file is not present, it raises Exception.

```
class Finally:
    def main():
        try:
            file = open("sample.txt")
            print("File opened...")
        except FileNotFoundError:
            print("Exception : No such file")
        return

Finally.main()
```

- When we connect any resource to the program, we must release that resource.
- close() function is pre-defined and it is used to release any resource.
- Closing statements must be in finally block.

```
class Finally:
    file = None
    def main():
        try:
            Finally.file = open("sample.txt")
            print("File opened...")
```

```
        except FileNotFoundError:
            print("Exception : No such file")

        finally:
            Finally.file.close()
            print("File closed...")
        return

Finally.main()
```

- In the above application, if the file is not present, close() function raises exception as it invokes on "None" value.
- We need to close the file only by checking whether it is pointing to any address on None.

```
class Finally:
    file = None
    def main():
        try:
            Finally.file = open("sample.txt")
            print("File opened...")

        except FileNotFoundError:
            print("Exception : No such file")

        finally:
            if Finally.file != None:
                Finally.file.close()
                print("File closed...")
        return

Finally.main()
```

Custom Exceptions:

- Python library is providing number of exception classes.
- As a programmer, we can define custom exceptions depends on application requirement.
- Every custom exception should extends the functionality of pre-defined Exception class.

raise:

- It is a keyword.
- It is used to raise Custom Exception explicitly by the programmer.

- Pre-defined exceptions will be raised automatically when problem occurs.
- If we don't handle the exception, Default Exception Handler handles.

```
class CustomError(Exception):
    def _init_(self,name):
        self.name=name
        return

class RaiseException:
    def main():
        obj = CustomError("Error-Msg")
        raise obj
        return

RaiseException.main()
```

Handling Custom Exception:

- Generally exception rises inside the function.
- We need to handle the exception while calling the function.
- When exception has raised, the object will be thrown to function calling area.

```
class CustomError(Exception):
    def _init_(self,name):
        self.name=name
        return

class Test:
    def fun():
        obj = CustomError("Message")
        raise obj
        return

class Access:
    def main():
        try:
            Test.fun()
        except CustomError as e:
            print("Exception :",e)
        return

Access.main()
```

Exceptions in Banking application:

- Runtime error is called Exception.
- When we perform the transaction, in case of any error in the middle of transaction called "Runtime error".
- We must define every error as Exception.
- The following example explains how to define Runtime Errors in Banking trasactions.

```
class LowBalanceError(Exception):
    def _init_(self,name):
        self.name = name
        return

class Account:
    def  __init__(self,balance):
        self.balance = balance
        return

    def withdraw(self,amount):
        print("Trying to withdraw :",amount)
        print("Avail bal :",self.balance)
        if amount <= self.balance:
            print("Collect cash :",amount)
            self.balance=self.balance-amount
        else:
            err=LowBalanceError("Low Balance")
            raise err
        return

class Bank:
    def main():
        amount = int(input("enter amount :"))
        acc = Account(amount)
        print("Balance is :",acc.balance)

        amount = int(input("Enter withdraw amt :"))
        try:
            acc.withdraw(amount)
        except LowBalanceError as e:
            print("Exception :",e)
        print("Final Balance is :",acc.balance)
        return

Bank.main()
```

Inner classes

Inner class: Defining a class inside another class. It is also called Nested class.

Syntax:

```
class Outer:
    .....
    logic
    .....
    class Inner:
        .....
        logic
        .....
```

Accessing static functionality:

- Static members we access using class name.
- Inner class can be accessed using Outer class name.

```
class Outer:
    def m1():
        print("Outer-m1")
        return

    class Inner:
        def m2():
            print("Inner-m2")
            return

class Access:
    def main():
        Outer.m1()
        Outer.Inner.m2()
        return

Access.main()
```

Accessing dynamic functionality:

- We can access dynamic member through object address.
- We create object for inner class with the reference of outer class only.

```
class Outer:
    def m1(self):
        print("Outer-m1")
        return

    class Inner:
        def m2(self):
            print("Inner-m2")
            return

class Access:
    def main():
        obj1 = Outer()
        obj1.m1()

        obj2 = obj1.Inner()
        obj2.m2()
        return

Access.main()
```

We create object directly to inner class as follows:

```
class Outer:
    class Inner:
        def fun(self):
            print("Inner-fun")
            return

class Access:
    def main():
        #obj1 = Outer()
        #obj2 = obj1.Inner()
        #obj2.fun()
        Outer().Inner().fun()
        return

Access.main()
```

Local inner classes:

- Defining a class inside the method.
- To access that class, first control should enter into that function.
- We invoke the functionality of local inner class from that function.

```
class Outer:
    def fun():
        print("Outer-fun")

        class Local:
            def fun():
                print("Outer-Local-fun")
                return

        Local.fun()
        return

class Access:
    def main():
        Outer.fun()
        return

Access.main()
```

We can define duplicate classes in different functions:

```
class Outer:
    def m1():
        print("Outer-m1")

        class Local:
            def fun():
                print("m1-Local-fun")
                return

        Local.fun()
        return

    def m2():
        print("Outer-m2")

        class Local:
            def fun():
```

```
            print("m2-Local-fun")
            return

        Local.fun()
        return

class  Access:
    def main():
        Outer.m1()
        Outer.m2()
        return

Access.main()
```

We can define a local inner class inside another local inner class. But it is complex to access the functionality.

```
class Outer:
    def fun(self):
        print("Outer-fun")

        class Local:
            def fun(self):
                print("Outer-Local-fun")

                class Inner:
                    def fun(self):
                        print("Outer-Local-Inner-fun")
                        return

                Inner().fun()
                return

        Local().fun()
        return

class Access:
    def main():
        Outer().fun()
        return

Access.main()
```

Python Modules

Importance of Modularity:

- When people write large programs they tend to break their code into multiple different files for ease of use, debugging and readability.
- In Python we use modules to achieve such goals.
- Modules are nothing but files with Python definitions and statements.
- The name of the file should be valid Python name (think about any variable name) and in lowercase

Pre-defined modules:

- **threading :** To implement Parallel processing
- **gc :** For Garbage collection
- **tkinter :** To implement GUI programming
- **time :** To find system time and data and to display in different formats
- **numpy :** One, two and Multi dimensional
- **re :** Regular expressions
- **mysql :** Python – MySQL database connectivity

connecting modules using import:

- import is a keyword.
- import is used to connect the modules to access their members.

Function based modules:

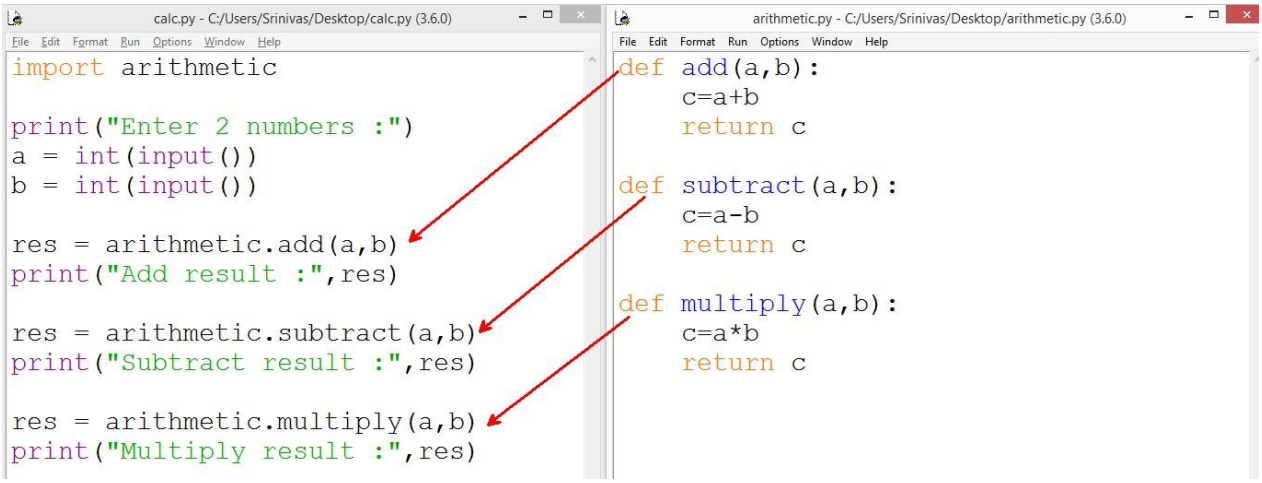
- A module cannot contain classes(object oriented programming).
- We have such type of library modules like time, data and so on.
- We access the functions using module name after import.

arithmetic.py:

```
def add(a,b):
    c=a+b
    return c

def subtract(a,b):
    c=a-b
    return c

def multiply(a,b):
    c=a*b
    return c
```

calc.py:

```
import arithmetic

print("Enter 2 numbers :")
a = int(input())
b = int(input())

res = arithmetic.add(a,b)
print("Add result :",res)

res = arithmetic.subtract(a,b)
print("Subtract result :",res)

res = arithmetic.multiply(a,b)
print("Multiply result :",res)
```



Why we need to call the function using module name after import?

- We can define members with same identity in different modules
- We access the duplicate members from different modules by using the identity of module while accessing.

one.py:

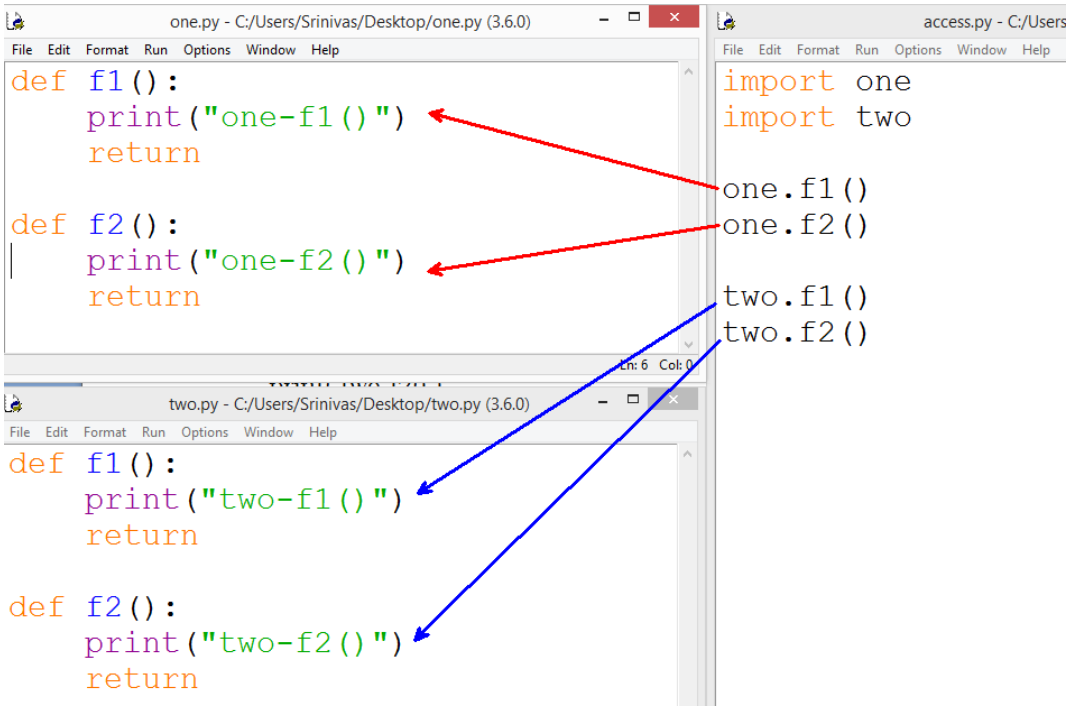
```
def f1():
    print("one-f1()")
    return

def f2():
    print("one-f2()")
    return
```

two.py:

```
def f1():
    print("two-f1()")
    return

def f2():
    print("two-f2()")
    return
```

access.py:

```
import one
import two

one.f1()
one.f2()

two.f1()
two.f2()
```



Class Based modules:

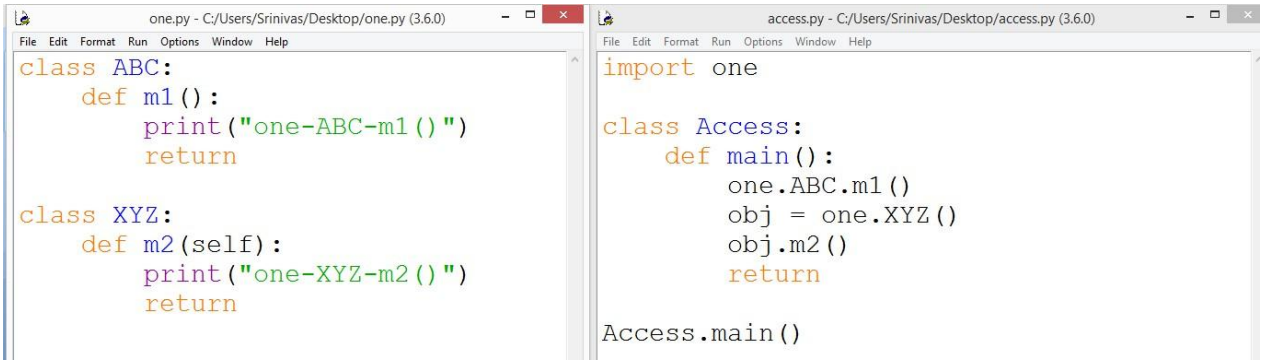
- A module is a collection of classes.
- A class is a collection of variables and methods
- To access the class members we need to import the module.

one.py:

```
class ABC:
    def m1():
        print("one-ABC-m1()")
        return

class XYZ:
    def m2(self):
        print("one-XYZ-m2()")
        return
```

access.py:

```
import one
class Access:
    def main():
        one.ABC.m1()
        obj = one.XYZ()
        obj.m2()
        return

Access.main()
```



from:

- "from is a keyword used to access one or more classes from the specified module.
- Note that, no need to specify the module name along with class name if we import using "from"

Syntax:

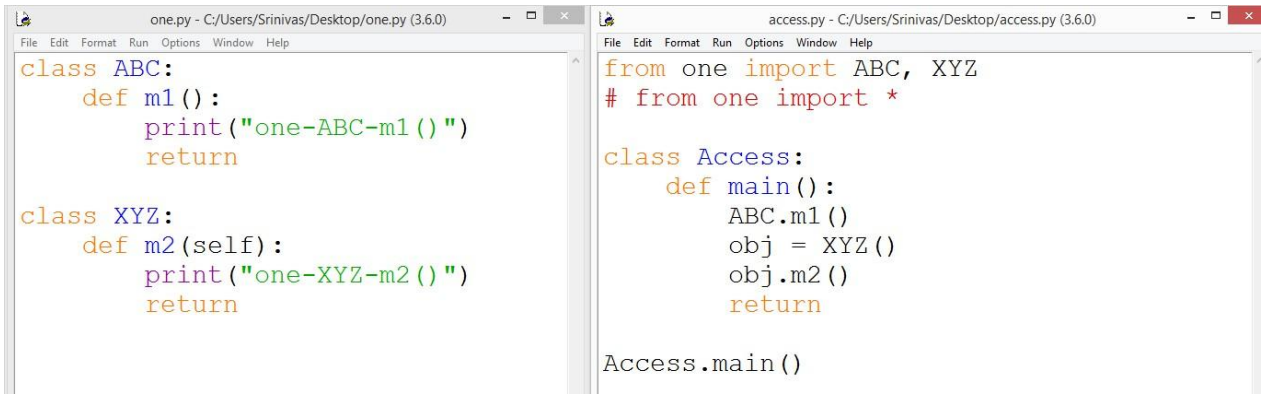
from module import class

Or

from module import *

Or

from module import class1, class2, class3



Accessing duplicate classes from different modules:

One.py:

```
class ABC:
    def m1():
        print("one-ABC-m1()")
        return

class XYZ:
    def m2():
        print("one-XYZ-m2()")
        return
```

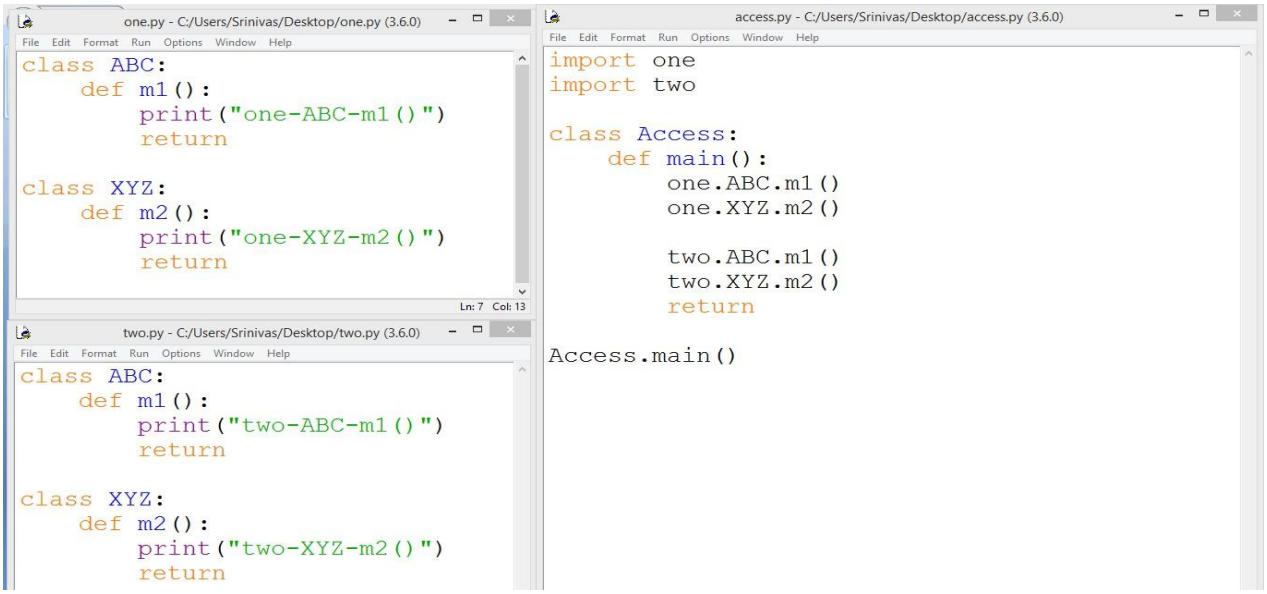
two.py:

```
class ABC:
    def m1():
        print("two-ABC-m1()")
        return

class XYZ:
    def m2():
        print("two-XYZ-m2()")
        return
```

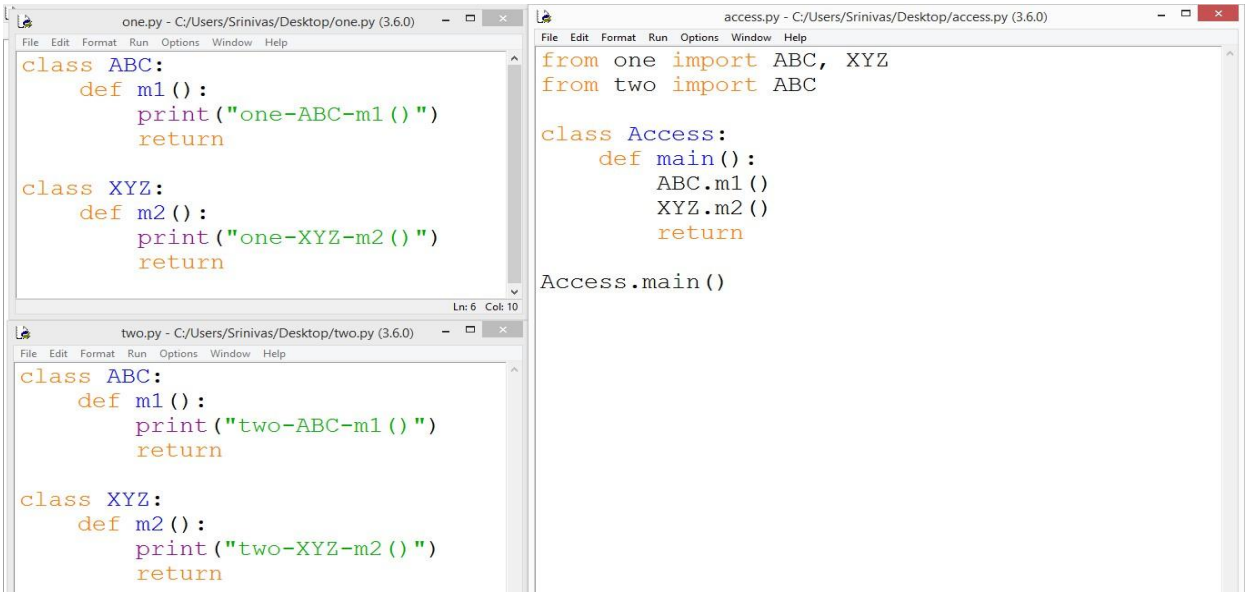
access.py:

```
import one
import two

class Access:
    def main():
        one.ABC.m1()
        one.XYZ.m2()
```

```
    two.ABC.m1()
    two.XYZ.m2()
    return

Access.main()
```



- When we import classes using 'from' keyword, we cannot work with duplicate classes from different modules.
- Duplicate class replace the existing class as follows

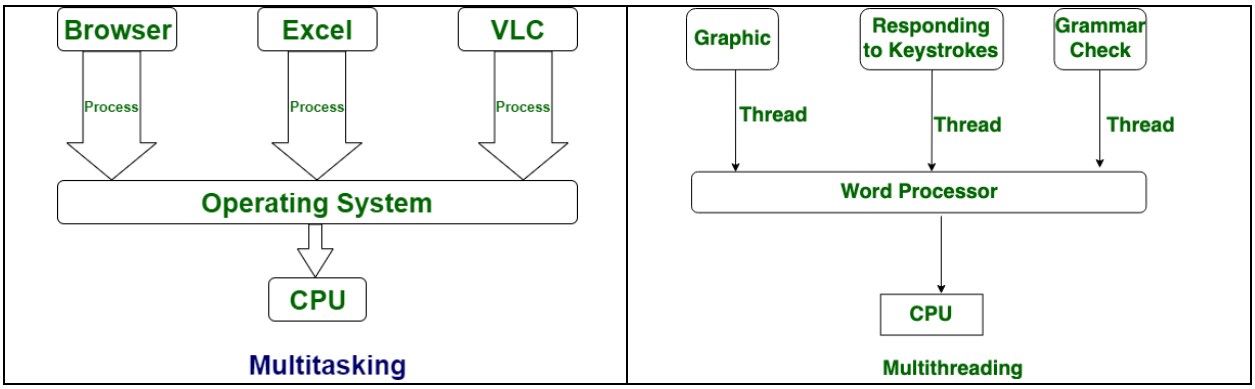


Multi threading

Multi-threading is a process of executing two or more threads(programs) simultaneously to utilize the processor maximum.

Multi-tasking:

- We can implement multi-tasking in two ways.
    - Program(process) based
    - Sub program(thread) based.



Note: Multi tasking is the concept of maximum utilization of Processor.

Multi threading:

- Task is a program(or process)
- Thread is a sub program (or sub process)
- We can execute multiple threads from single process.
- Using multi-threading, we can reduce the stress on processor.

Creating Thread:

- Python provides a threading module that allows you to create and manage threads in your program.
- To create a new thread, you can define a new class that extends the threading.Thread class and override the run() method.

```
# Example:
import threading

class MyThread(threading.Thread):
    def run(self):
        # Code to be executed in the new thread
```

You can start a new thread by creating an instance of the class and calling its start() method.

```
# Example:
my_thread = MyThread()
my_thread.start()
```

Single threaded application:

- Every python program is single threaded.
- In single threaded application, execution starts at main() and ends at same.
- Main() thread is called default thread.

```
class Numbers:
    def display(self):
        for i in range(50):
            print("i val :",i)
        return

class Default:
    def main():
        print("Starts @ main")
        obj = Numbers()
        obj.display()
        for j in range(50):
            print("j val :",j)
        print("Ends @ main")
        return

Default.main()
```

Multi threaded application:

- Define a Custom thread and execute along with Default thread.
- Every Custom thread inherits the functionality from "Thread" class.
- "Thread" class is belongs to "threading" module.
- We must define thread logic by overriding run() method of Thread class.

```
from threading import Thread
class Custom(Thread):
    def run(self):
        for i in range(50):
            print("Custom :" + str(i))
        return

class Default:
```

```
    def main():
        obj = Custom()
        obj.start()
        for j in range(50):
            print("Default :" + str(j))
        return

Default.main()
```

You can also create a thread using the threading.Thread() constructor and passing in a target function as an argument.

```
# Example:
import threading

def my_function():
    # Code to be executed in the new thread

my_thread = threading.Thread(target=my_function)
my_thread.start()
```

You can pass arguments to the target function using the args parameter.

```
# Example:
import threading

def my_function(arg1, arg2):
    # Code to be executed in the new thread

my_thread = threading.Thread(target=my_function, args=(arg1, arg2))
my_thread.start()
```

sleep():

- A pre-defined method belongs to "time" module.
- Sleep() method is used to stop the current thread execution for specified number of seconds.
- The following example explains clearly about sleep() method.

```
from threading import Thread
import time

class Custom(Thread):
    def run(self):
        for i in range(1,11):
```

```
            print("custom : " + str(i))
            time.sleep(1)
        return

class Default:
    def main():
        obj = Custom()
        obj.start()
        for i in range(1,11):
            print("default : " + str(i))
            time.sleep(1)
        return

Default.main()
```

- When multiple threads are execution, any thread can complete the execution first.
- The following example explains that Default thread execution may complete after Custom thread execution.
- The thread execution completely depends on the logic we defined in that thread.

```
from threading import Thread
import time
class Custom(Thread):
    def run(self):
        for i in range(1,11):
            print("custom : " + str(i))
            time.sleep(1)
        print("Custom thread execution completed")
        return

class Default:
    def main():
        print("Starts at Default thread")
        obj = Custom()
        obj.start()
        for i in range(1,11):
            print("default : " + str(i))
            time.sleep(0.3)
        print("Default thread execution completed")
        return

Default.main()
```

Can we call run() method directly?

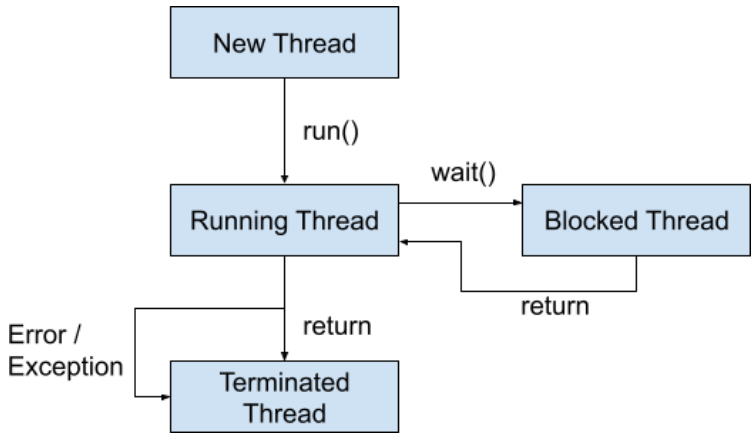
- run() method is pre-defined in Thread class with empty definition.
- Run() method override by programmer with custom thread logic.
- Start() method allocates separate thread space to execute run() logic parallel.
- If we call run() method directly, it will execute from the same thread space sequentially.

```
from threading import Thread
import time

class Custom(Thread):
    def run(self):
        for i in range(1,11):
            print("custom : " + str(i))
            time.sleep(1)
        return

class Default:
    def main():
        obj = Custom()
        obj.run()
        for i in range(1,11):
            print("default : " + str(i))
            time.sleep(1)
        return

Default.main()
```

Life cycle of Thread:

- Every thread executes according to Life cycle.
- Life cycle consists
    - Creation phase by programmer
    - Execution phase by scheduler(OS)
- As a programmer, we need to define and start the thread.
- All threads scheduled by the processor.
- Thread has many states
    - Runnable state
    - Running state
    - Waiting state
    - Dead state.
- Every thread should wait in the Queue until processor allocates the memory is called Runnable state.
- Once the memory has been allocated to thread, it moves to running state. In running state, thread execute independently.

- From the running state, the thread may fall into waiting state to read user input, sleep and join methods.
- Once the thread execution completed, it moves to dead state.



How to execute different logics from different threads?

- We can define run() method only once in a Thread class.
- To execute different logics, different run() methods need to override.
- It is possible by defining more than one thread class and override run() method in each class with different logic.

```
from threading import Thread
import time

class Custom1(Thread):
    def run(self):
        for i in range(1,11):
            print("custom1 :" + str(i))
            time.sleep(1)
        return

class Custom2(Thread):
    def run(self):
        for i in range(50,71):
            print("custom2 :" + str(i))
            time.sleep(1)
        return

class Custom3(Thread):
    def run(self):
```

```
        for i in range(100,90,-1):
            print("custom3 :"+str(i))
            time.sleep(3)
        return

class Default:
    def main():
        c1 = Custom1()
        c1.start()
        c2 = Custom2()
        c2.start()
        c3 = Custom3()
        c3.start()
        return

Default.main()
```

join() method:

- It is a dynamic method belongs the Thread class.
- It is used to stop current thread execution until joined thread moved to dead state.

```
from threading import Thread
import time

class Custom(Thread):
    def run(self):
        for i in range(1,11):
            print("custom : " + str(i))
            time.sleep(1)
        return

class Default:
    def main():
        print("Starts @ Default")
        c = Custom()
        c.start()
        c.join()
        print("Ends @ Default")
        return

Default.main()
```

Thread synchronization:

- The concept of allowing threads sequentially when these threads trying to access same resource parallel.
- "threading" module is providing "Lock" class to implement thread synchronization.
- Lock class is providing dynamic methods to lock specific logic in the function.
    - obj = Lock()
    - obj.acquire()
    - obj.release()

```
import time
from threading import Thread, Lock
class Numbers:
    x=0
    lock=Lock()
    def incrementX():
        Numbers.lock.acquire()
        Numbers.x = Numbers.x+1
        Numbers.lock.release()
        return

class Custom1(Thread):
    def run(self):
        for i in range(100000):
            Numbers.incrementX()
        return

class Custom2(Thread):
    def run(self):
        for i in range(100000):
            Numbers.incrementX()
        return

class Default:
    def main():
        t1 = Custom1()
        t2 = Custom2()
        t1.start()
        t2.start()
        t1.join()
        t2.join()
        print("Final x val : "+str(Numbers.x))
        return
Default.main()
```

Strings

String:

- String is a sequence of characters.
- We can specify strings using single, double or triple quotes.

Accessing strings: We can access the strings using indexing and slicing

Indexing:

- String array elements index starts with 0
- Using indexing, we can process each character.
- Python supports negative indexing from the end.
- Negative indexing starts with -1 from the end.

s = "python"

0	1	2	3	4	5
p	y	t	h	o	n
-6	-5	-4	-3	-2	-1

```
s = "python"
print("s[2] :", s[2])
print("s[-3] :", s[-3])

print("Length :", len(s))
print("s[len(s)-1] :", s[len(s)-1])
print("s[-len(s)] :", s[-len(s)])
```

Slicing: Accessing more than one character from the string.

Syntax : [lower : upper : step]

- Specifying the above values are optional
- Lower value by default 0
- Upper value by default len(string)
- Step value is 1 by default.

```
s = "python"
print("String is :",s)
print("s[:] :", s[:])
```

```
print("s[: :] :", s[: :])
print("s[0:6:1] :", s[0:6:1])
print("s[0:len(s)] :", s[0:len(s)])

s = "python"
print("String is :",s)
print("s[2:5] :", s[2:5])
print("s[-5:-2] :", s[-5:-2])
print("s[2:-2] :", s[2:-2])

s = "python"
print("String is :",s)
print("s[5:2:-1] :", s[5:2:-1])
print("s[-1:-5:-1] :", s[-1:-5:-1])
```

Boolean methods - String validation methods:

- String is an Object
- String object is providing pre-defined methods to validate the string.
- These methods are called Boolean methods, these methods always return a Boolean value (True or False)
- Some of the methods :

```
s1 = "abc"
print(s1,"is alpha :", s1.isalpha())
print(s1,"is alpha numeric :", s1.isalnum())
print(s1,"is digit :", s1.isdigit())

s1 = "1234"
print(s1,"is alpha :", s1.isalpha())
print(s1,"is alpha numeric :", s1.isalnum())
print(s1,"is digit :", s1.isdigit())

s1 = "abc123"
print(s1,"is alpha :", s1.isalpha())
print(s1,"is alpha numeric :", s1.isalnum())
print(s1,"is digit :", s1.isdigit())
```

```
s1 = "abc123$#"
print(s1,"is alpha numeric :", s1.isalnum())
print(s1,"is lower :", s1.islower())
```

Displaying Strings with Quotes: Generally a string can be represented in python using single or double quotes.

```
#Output : It is 'Python' online session
line = "It is 'Python' online session"
print(line)

#Output : It is "Python" tutorial
line = 'It is "Python" tutorial'
print(line)

# Output : She said, "It's a good one"
# line = "She said, "It's a good one"" -> Error :
# line = 'She said, "It's a good one"' -> Error :
line = '''She said, "It's a good one"'''
print(line)

#Escape characters
# \n = new line
# \t = tab space
# \\ = \
# \' = '
# \" = "

# Output : This is "Python" session
line = "This is \"Python\" session"
print(line)

# Output : Python's tutorial
line = "Python's tutorial"
print(line)
# Output : She said, "It's a good one"
line = 'She said, "It\'s a good one"'
print(line)
```

 # Output : She said, "It's a good one"

```
line = "She said, \"It's a good one\""
print(line)
```

Python Comments:

1. Single line comments
2. Multi line comments - Not supported

Single line comment:

- We use comments to describe the instruction of a program.
- We use # symbol preceded by description

 # Single line comment

Multi line comment:

- Python doesn't support multi line comments.
- Generally they call triple quotes as multi line comment but not correct.
- For example,

'''This
is
Multi line
comment '''

- The above declaration is a string and memory.
- If we collect that String value into any variable, we can display the content of that String.
- **For example:**

```
line = '''
This is
Multi line
Comment
in Python'''
print(line)
```

Comments do not get memory in any programming language as follows.

```
line = #single line comment
print(line)
```

Old Style formatting:

- We can display string after formatting
- Python supports C style of formatting using access specifiers.
- Format specifiers like int(%d), float(%f), String(%s) can be used.
- We can also concatenate strings using plus(+) operator.

String representation:

```
name = input("Enter your name : ")
print("Hello" , name)
print("Hello " + name)
print("Hello %s" %name)
```

String and Integer concatenation:

```
name = input("Enter your name : ")
age = int(input("Enter your age : "))
print(name , "age is :" , age)
print(name + " age is : " + str(age))
print("%s age is : %d" %(name,age))
```

Code:

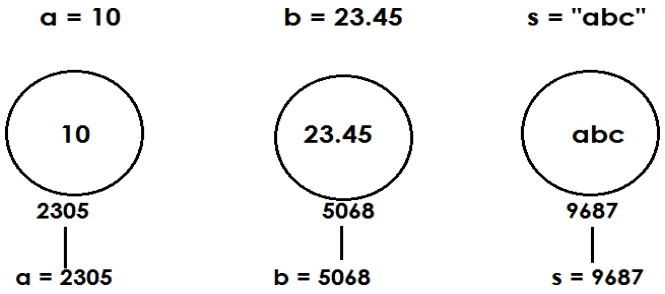
```
print("Enter Emp details : ")
no = int(input())
name = input()
salary = float(input())

print(name , "with id :" , no , "is taking salary :" , salary)
print(name + " with id : " + str(no) + " is taking salary : " + str(salary))
print("%s with id : %d is taking salary : %f" %(name, no, salary))
```

Float representation:

```
val = 34.567
print("Value is :", val)
print("Value is : %f" %val)
print("Value is : %.3f" %val)
print("Value is : %.2f" %val)
```

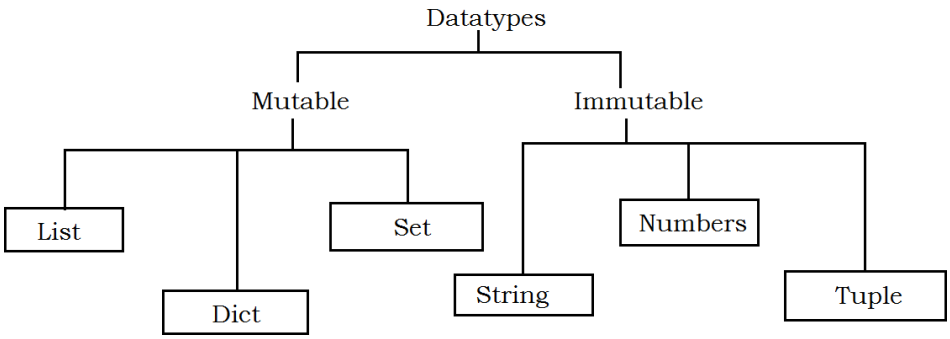
Immutability:

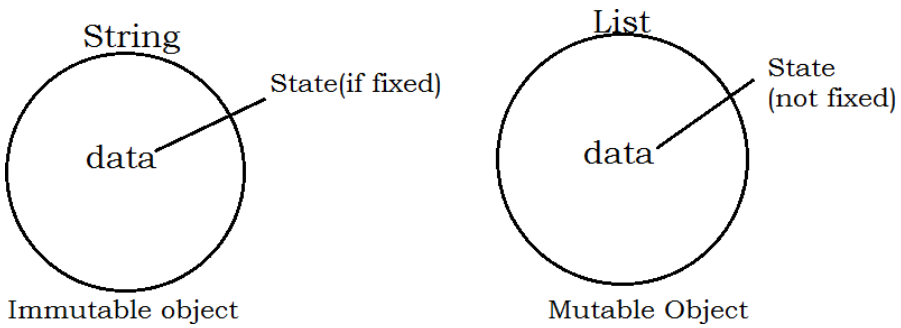
- Python is Object oriented programming language.
- Any information(Number, String or Collection) stores in Object format only.



- Object behavior is either Mutable or Immutable.
- **Immutable objects :** Numbers , Strings and Tuples
- **Mutable Objects :** Lists, Sets and Dictionaries

Data types divided into Mutable and Immutable objects as follows:





- Immutable objects nothing but constants. We cannot modify the contents of Object once created.

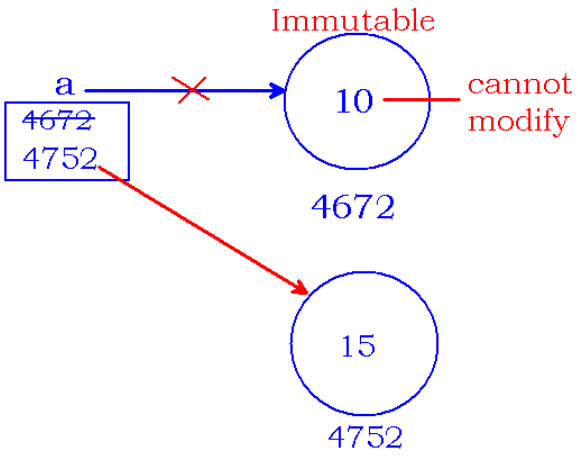
Numbers:

- Integers and Float values comes under Number type Objects.
- Once we assign any number to a variable that cannot be modified.
- If we try to modify the value, a new object will be creating with modified content.

Code:

```
a=10
print("a val :", a)
print("Loc :", id(a))

a=a+5
print("Modified a val :", a)
print("Loc :", id(a))
```

```
a=10
print("a val :", a)
print("Loc :", id(a))

a=a+5
print("Modified a val :", a)
print("Loc :", id(a))


Output:
    a val : 10
    Loc : 1631904672
    Modified a val : 15
    Loc : 1631904752
```



String Immutability:

```
s1="Hello"
s2="World"
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))
s1=s1+s2
print("Modified s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))
```

Output:

s1 val : Hello

s1 loc : 59401472

s2 val : World

s2 loc : 59401376

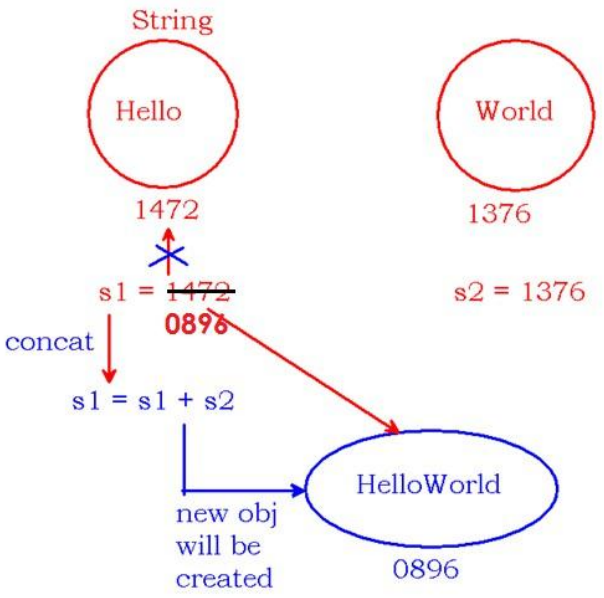
Modified s1 val : HelloWorld

s1 loc : 59410896

s2 val : World

s2 loc : 59401376

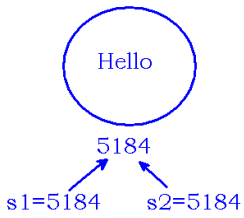
```
s1="Hello"
s2="World"
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))
s1=s1+s2
print("Modified s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))

Output:
s1 val : Hello
s1 loc : 59401472
s2 val : World
s2 loc : 59401376
Modified s1 val : HelloWorld
s1 loc : 59410896
s2 val : World
s2 loc : 59401376
```



When we try to create multiple String objects with the same content, duplicate objects will not be created. The address of object will be shared.

```
s1="Hello"
s2="Hello"
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))
```

```
s1="Hello"
s2="Hello"
print("s1 val :",s1)
print("s1 loc :",id(s1))

print("s2 val :",s2)
print("s2 loc :",id(s2))

Output:
s1 val : Hello
s1 loc : 58025184
s2 val : Hello
s2 loc : 58025184
```

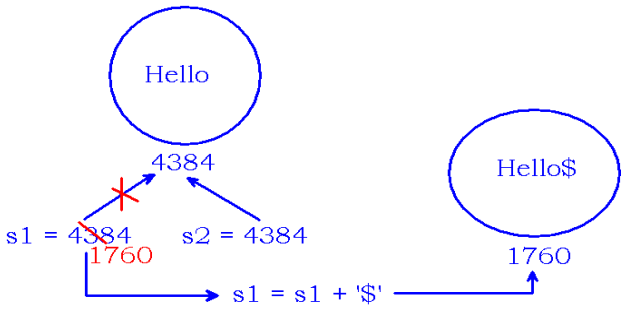


Does s2 effects when we modify s1 content in the above code?

- No, String object is Immutable. When the contents are same then only locations are same. When we modify the content, a new object will be created in another location.

```
s1="Hello"
s2="Hello"
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))
s1 = s1+'$'
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))
```

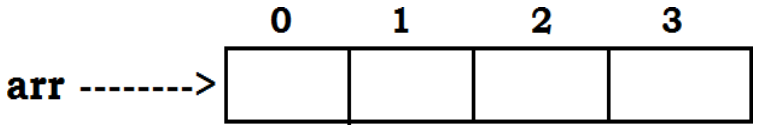
```
s1="Hello"
s2="Hello"
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))

s1 = s1+'$'
print("s1 val :",s1)
print("s1 loc :",id(s1))
print("s2 val :",s2)
print("s2 loc :",id(s2))

Output:
s1 val : Hello
s1 loc : 57304384
s2 val : Hello
s2 loc : 57304384
s1 val : Hello$
s1 loc : 57221760
s2 val : Hello
s2 loc : 57304384
```



Collection data types

Introduction:

- We use programming languages to develop applications.
- Applications are used to store and process the information.
- In the application, when we use set of elements, it is recommended to use collection type.
- If we can structure the data while storing, can access more effectively while processing.
- Basic data structure that store elements in consecutive locations is called array.



- Different algorithms were proposed to structure the information in application called Data structures and Algorithms.
- In some of the languages like C or C++, we need to implement these algorithms manually to structure the information in application.
- Python collections are pre defined implementations of these algorithms to structure the data.

Note: The complete functionality of all data structures and algorithms given as 4 simple collection objects.

1. List
2. Tuple
3. Set
4. Dictionary

Array v/s List:

- Python is not allowed the programmer to create traditional arrays for data processing.
- Python doesn't support Arrays.
- Array is static (Size is fixed) where as Python is dynamic. This is the one reason that why python is not allowed arrays.
- In any programming language only arrays can process one dimensional, two dimensional and multi dimensional data easily using indexing.

As Python doesn't support Arrays, we use third party modules (Numpy & Pandas) to process elements like arrays.

List Collection

List:

- List is a linear data structure.
- List is an Object contains multiple data items (elements).
- Square brackets are used to enclose the elements of List.
- The elements in List are separated with comma (,) operator.
- List can accept heterogeneous data elements.
- List is allowed to store duplicate elements.

Code:

```
l1 = [10,20,30,40,50]
print("L1 list :",l1)

l2 = [10,20,10,"abc",34.56]
print("L2 list :",l2)
```

Accessing Elements: We can access elements of List in 2 ways such as **Indexing & Slicing**.

Indexing:

- Python index starts from 0 to size-1.
- We can access only one element through indexing.
- Python supports negative indexing also
- Some of the examples as follow.

l = [10,20,30,40,50]

0	1	2	3	4
10	20	30	40	50
-5	-4	-3	-2	-1

Code:

```
l = [10,20,30,40,50]
print("List is :", l)
print("Length :", len(l))
print("l[2] :", l[2])
print("l[-2] :", l[-2])
print("l[len(l)-2] :", l[len(l)-2])
print("l[-(len(l)-3)] :", l[-(len(l)-3)])
```

Output:

```
List is : [10, 20, 30, 40, 50]
Length : 5
l[2] : 30
l[-2] : 40
l[len(l)-2] : 40
l[-(len(l)-3)] : 40
```

Slicing:

- To access more than one element at a time from the collection.
- Slicing representation is as same as range() object

Syntax:

[start-index : stop-index : step]

- Start index default value is 0
- Stop index default value is length-1
- Step value modified by 1
- When we don't specify the values of start, stop and step, it will consider default values and process all elements of List.
- Start index is includes where as stop index value excludes.

Code:

```
l = [10,20,30,40,50]
print("List is :", l)
print("Length :", len(l))
print("l[:] :", l[:])
print("l[: :] :", l[: :])
print("l[0:len(l):1] :", l[0:len(l):1])
print("l[0:5:2] :", l[0:5:2])
print("l[-5:-2] :", l[-5:-2])
```

Output:

```
List is : [10, 20, 30, 40, 50]
Length : 5
l[:] : [10, 20, 30, 40, 50]
l[: :] : [10, 20, 30, 40, 50]
l[0:len(l):1] : [10, 20, 30, 40, 50]
l[0:5:2] : [10, 30, 50]
l[-5:-2] : [10, 20, 30]
```

List methods:

- List is a pre-defined Object (class).
- List class is providing set of pre-defined methods(dynamic), we access using list object address.
- Using list functionality, we can process the list elements easily.
- The functionality is used to append, insert, remove, pop, sort, reverse and update the list as follows.

append(): Function that adds an element at the end of the List and returns the complete list with appended element.

```
l = [10,20,30]
print("List :", l)

l.append(40)
print("After append 40 :", l)
```

count(): Function that returns the specified element count in the List

```
l = [10, 20, 10, 40, 10]
print("List :", l)
print("Count of 10 :", l.count(10))
print("Count of 40 :", l.count(40))
print("Count of 50 :", l.count(50))
```

index():

- Function that returns index value of specified element.
- List supports duplicate elements.
- If the specified element is duplicated, it return first occurrence of index.
- Raises an exception if the specified element is not present in the list.

```
l = [10, 20, 10, 40, 20, 50]
print("List :", l)
print("index of 40 :", l.index(40))
print("index of 20 :", l.index(20))
print("index of 70 :", l.index(70))
```

Output:

```
List : [10, 20, 10, 40, 20, 50]
index of 40 : 3
index of 20 : 1
ValueError: 70 is not in list
```

Insert():

- Function that is used to insert element at specified index.
- After insertion, other elements in the list will shift to right.
- Element will be appended if the specified index is not present in that List.

```
l = [10,20,10,40]
print("List :", l)

print("insert 50 @ index : 2 :")
l.insert(2,50)
print("List :", l)

print("insert 70 @ index : -4 :")
l.insert(-4,70)
print("List :", l)

print("insert 90 @ index : 12 :") # append if out of bounds
l.insert(12,90)
print("List :", l)
```

Output:

```
List : [10, 20, 10, 40]
insert 50 @ index : 2 :
List : [10, 20, 50, 10, 40]
insert 70 @ index : -4 :
List : [10, 70, 20, 50, 10, 40]
insert 90 @ index : 12 :
List : [10, 70, 20, 50, 10, 40, 90]
```

Deleting elements:

- We can remove the elements of List in many ways.
- List object is providing different methods to remove elements.

pop([index]) :

- Removes the last element from the List when we don't specify the index.
- Index argument is optional
- We can remove the element by specifying its index also
- Raises Exception if the specified index is not present.

Code:

```
l = [10, 20, 30, 40, 50]
print("List is :", l)
```

```
print("pop() :", l.pop())
print("List is :", l)

print("pop(1) :", l.pop(1))
print("List is :", l)

print("pop(4) :", l.pop(4))
print("List is :", l)
```

Output:

```
List is : [10, 20, 30, 40, 50]
pop() : 50
List is : [10, 20, 30, 40]
pop(1) : 20
List is : [10, 30, 40]
IndexError: pop index out of range
```

remove(element):

- Removes specified element from the List.
- List allows duplicates.
- Remove the first occurrence of element if the element is duplicated.
- Raises Exception if the specified element is not present in the list.

```
l = [10, 20, 30, 40, 50, 20]
print("List is :", l)
print("remove(30) :")
l.remove(30)
print("List is :", l)
print("remove(20) :")
l.remove(20)
print("List is :", l)
print("remove(70) :")
l.remove(70)
print("List is :", l)
```

Output:

```
List is : [10, 20, 30, 40, 50, 20]
remove(30) :
List is : [10, 20, 40, 50, 20]
remove(20) :
List is : [10, 40, 50, 20]
remove(70) : ValueError: list.remove(x): x not in list
```

clear():

- Removes all elements of List.
- Return an empty List.
- The memory allocated to list will not be de-allocated.

Code:

```
l = [10,20,30,40,50]
print("List is :", l)

print("clear list :")
l.clear()
print("List is :", l)

print("append(20) :")
l.append(20)
print("List is :", l)
```

Output:

```
List is : [10, 20, 30, 40, 50]
clear list :
List is : []
append(20) :
List is : [20]
```

del:

- It is a keyword.
- It is used to release the memory of Object(here list variable)

Code:

```
l = [10,20,30,40,50]
print("List is :", l)

print("del list :")
del l
print("List is :", l)
```

Output:

```
List is : [10, 20, 30, 40, 50]
del list :
NameError: name 'l' is not defined
```

extend():

- It is used to merge lists.
- One list will be appended to another list
- List1 will be modified where as List2 remains same.

Code:

```
l1 = [10, 20, 30]
print("L1 is :", l1)

l2 = [23.45, 56.78]
print("L2 is :", l2)

print("l1 extends l2 :")
l1.extend(l2)
print("L1 after extend :", l1)
```

copy():

- A function that is used to copy all elements of List to another list.
- Returns a duplicate copy of specified list.
- Copied list get different memory location.
- List is Mutable (we will discuss later). Hence the location must be different for duplicate Lists.

Code:

```
src = [10,20,30]
print("Source list is :", src)
print("Source list location :", id(src))

cpy = src.copy()
print("Copied list is :", cpy)
print("Copied list location :", id(cpy))
```

Output:

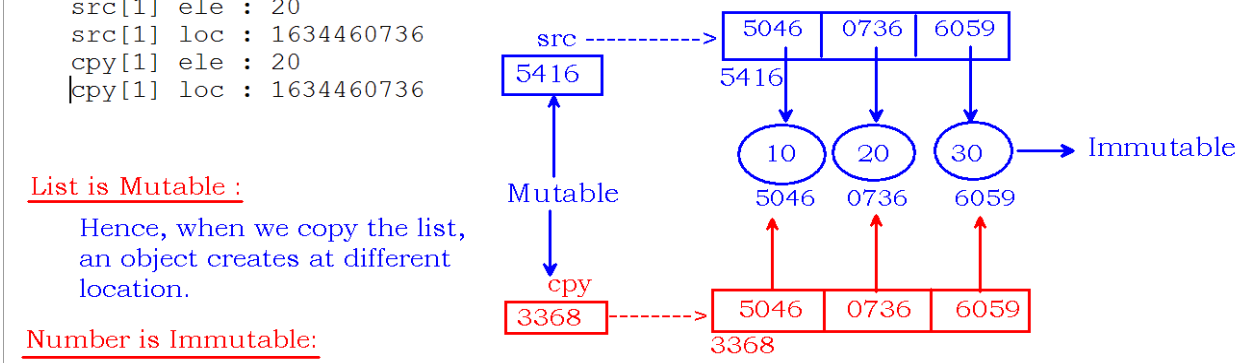
```
Source list is : [10, 20, 30]
Source list location : 58932360
Copied list is : [10, 20, 30]
Copied list location : 14314432
```

Note: Only Lists get different memory locations with same set of elements. The duplicates in both the Lists have same memory locations as follows.

Code:

```
src = [10,20,30]
print("Source list location :", id(src))

cpy = src.copy()
print("Copied list location :", id(cpy))

print("src[1] ele :", src[1])
print("src[1] loc :", id(src[1]))

print("cpy[1] ele :", cpy[1])
print("cpy[1] loc :", id(cpy[1]))
```

```
Output:
    Source list location : 60595416
    Copied list location : 60663368
    src[1] ele : 20
    src[1] loc : 1634460736
    cpy[1] ele : 20
    cpy[1] loc : 1634460736
```



List is Mutable :

Hence, when we copy the list, an object creates at different location.

Number is Immutable:

Hence, the content of both lists having same numbers. So that locations remains same.

List Operations using operators:

- Lists can be concatenated using + operator. List repetition is possible using * operator.
- "in" operator is used to test whether the element is present or not in the list.
- "in" operator can be used to iterate the list using 'for' loop.
- "not in" operator can be used to check whether the element is not present or not in the List.

Code:

```
print("List operations using operators :")
a1 = [1,2,3]
a2 = [4,5,6]
print("a1 list :", a1)
print("a2 list :", a2)

print("a1=a1+a2 :")
```

```
a1=a1+a2
print("a1 list :", a1)

print("a2 list :", a2)
print("a2=a2*3 :")
a2 = a2*3
print("a2 list :", a2)

print("a1 list :", a1)
print("5 is present :", 5 in a1)
print("7 is present :", 7 in a1)

print("20 is not present :", 20 not in a1)
print("6 is not present :", 6 not in a1)
```

Output:

```
List operations using operators :
a1 list : [1, 2, 3]
a2 list : [4, 5, 6]
a1=a1+a2 :
a1 list : [1, 2, 3, 4, 5, 6]
a2 list : [4, 5, 6]
a2=a2*3 :
a2 list : [4, 5, 6, 4, 5, 6, 4, 5, 6]
a1 list : [1, 2, 3, 4, 5, 6]
5 is present : True
7 is present : False
20 is not present : True
6 is not present : False
```

sort():

- sort all elements in the specified list
- All elements in the list should be of same type
- Heterogeneous elements list cannot sort.

Code:

```
a1 = [10, 40, 20, 50, 30]
print("a1 List is :",a1)
a1.sort()
print("Sorted a1 list is :", a1)

a2 = [34.56, 23, "abc"]
```

```
print("a2 List is :",a2)
a2.sort() # sorting possible only on homogenous data elements
print("Sorted a2 list is :", a2)
```

Output:

```
a1 List is : [10, 40, 20, 50, 30]
Sorted a1 list is : [10, 20, 30, 40, 50]
a2 List is : [34.56, 23, 'abc']
TypeError: '<' not supported between instances of 'str' and 'int'
```

reverse(): Reverse the elements in specified list.

```
a1 = [10, 40, 20, 50, 30]
print("a1 List is :",a1)
a1.reverse()
print("Reversed a1 list is :", a1)
a2 = [34.56, 23, "abc"]
print("a2 List is :",a2)
a2.reverse()
print("Reversed a2 list is :", a2)
```

Built in Functions can be used with List as follows:

all() : return True if all elements of the List are true (or if the list is empty)

```
>>> a = [1, 2, 0]
>>> all(a)
False
>>> a = [1, 2, 3]
>>> all(a)
True
>>> a = []
>>> all(a)
True
```

any() : Return True if any one of List element is True. Returns False if the List is empty.

```
>>> arr = [1,2,0]
>>> any(arr)
True
>>> arr = [1,2,3]
>>> any(arr)
True
>>> arr = []
>>> any(arr)
False
```

list():

- List is a class.
- list() is a constructor
- list() is used to construct any empty list object.

```
arr = list()
print("List is :", arr)
print("Length :", len(arr))
print("Any :", any(arr))
```

Output:

```
List is : []
Length : 0
Any : False
```

We can append elements to empty list by reading at runtime.

```
arr = list()
print("Initially :", arr)
print("Enter 5 elements :")
for i in range(5):
    ele = input()
    arr.append(ele)
print("Later :", arr)
```

Output:

```
Initially : []
Enter 5 elements :
10
23.42
g
abc
10
Later : ['10', '23.42', 'g', 'abc', '10']
```

Sum of list elements:

```
print("Sum of list elements")
arr = list()
n = int(input("Enter size : "))
print("Enter %d elements :" %n)
for i in range(n):
    ele = int(input())
    arr.append(ele)
```

```
#logic
res=0
for ele in arr:
    res=res+ele
print("Sum is :", res)
```

Output:

```
Sum of list elements
Enter size : 5
Enter 5 elements :
6
4
2
8
3
Sum is : 23
```

max() : Returns the largest element from the List
min() : Returns minimum element from List
sorted() : Returns a new sorted list of elements (doesn't sort the list itself)
sum() : Returns the sum of all elements in the List

```
>>> List = [6, 3, 8, 2, 9]
>>> min(List)
2
>>> max(List)
9
>>> sum(List)
28
>>> sorted(List)
[2, 3, 6, 8, 9]
>>> print(List)
[6, 3, 8, 2, 9]
```

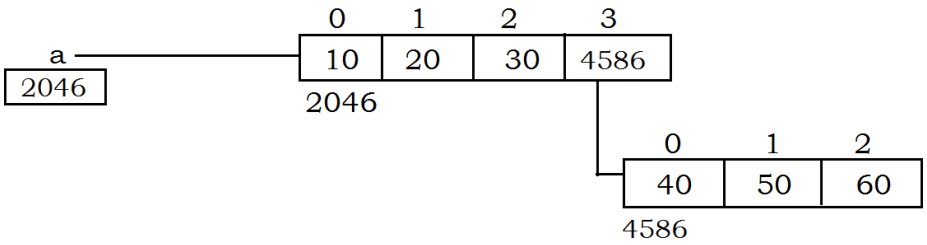
Note: We can process elements of collection using Iterators.

```
# Using for loop:
arr = [10,20,30,40,50]
print("Elements are :")
for ele in arr :
    print(ele)
```

Nested Lists:

- Defining a List as an element inside another list.
- List is an object; hence we connect the nested list by storing the address.

a = [10,20,30,[40,50,60]]




```
a = [10,20,30,[40,50,60]]
print("List is :", a)

# access using indexing
print("a[1] :",a[1])
print("a[3] :",a[3])

# negative indexing
print("a[-2] :", a[-2])
print("a[-1] :", a[-1])

# using len()
print("len(a) :", len(a))
print("a[len(a)-1] :", a[len(a)-1])
```

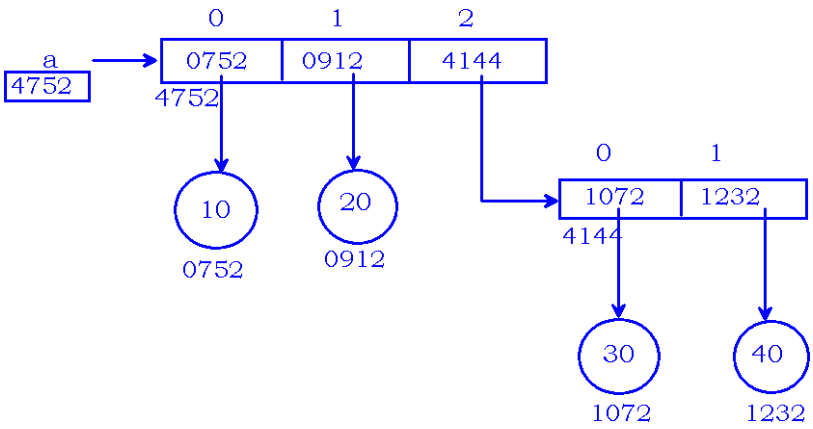
```
a = [10,20,30,[40,50,60]]
print("List is :", a)

# access sub list
print("a[3][0] :", a[3][0])
print("a[-1][0] :", a[-1][0])
print("a[3][-3] :", a[3][-3])
print("a[-1][-3] :", a[-1][-3])

# using len()
print("len(a[-1]) :", len(a[-1]))
print("a[len(a)-1] :", a[len(a)-1])
print("a[len(a)-1][len(a[-1])-1])   :",a[len(a)-1][len(a[-1])-1])
```

- Using index, we can access only one element at a time.
- Through slicing, we can access multiple elements either from list or sub list.

```
a = [10,20,30,[40,50,60]]
print("List is :", a)

# list slicing
print("a[:] :", a[:])
print("a[: :] :", a[: :])
print("a[0:len(a):1] :", a[0:len(a):1])
print("a[2:len(a)] :", a[2:len(a)])

a = [10,20,30,[40,50,60]]
print("List is :", a)

# sub list slicing
print("a[-1][:] :", a[-1][:])
print("a[-1][1:3] :", a[-1][1:3])
print("a[len(a)-1][0:len(a[-1])] :", a[len(a)-1][0:len(a[-1])])
```

- Every element in python is an Object.
- An address will store into the location instead of value.

```
a = [10,20,[30,40]]
print(id(a))
print(id(a[0]))
print(id(a[1]))
print(id(a[2]))
print(id(a[2][0]))
print(id(a[2][1]))
```

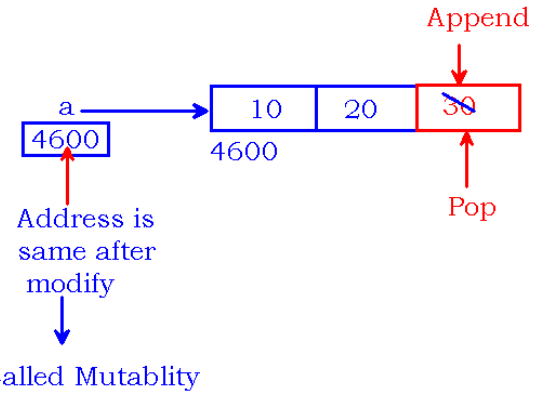


List Mutability:

- List is Mutable
- Mutable object can be modified.
- Address remains same after modification of Mutable object

```
a = [10, 20]
print("List is :",a)
print("Address :",id(a))
a.append(30)
print("After append, List is :",a)
print("Address :",id(a))
a.pop()
print("After pop, List is :",a)
print("Address :",id(a))
```

```
Output:
List is : [10, 20]
Address : 61554600
After append, List is : [10, 20, 30]
Address : 61554600
After pop, List is : [10, 20]
Address : 61554600
```

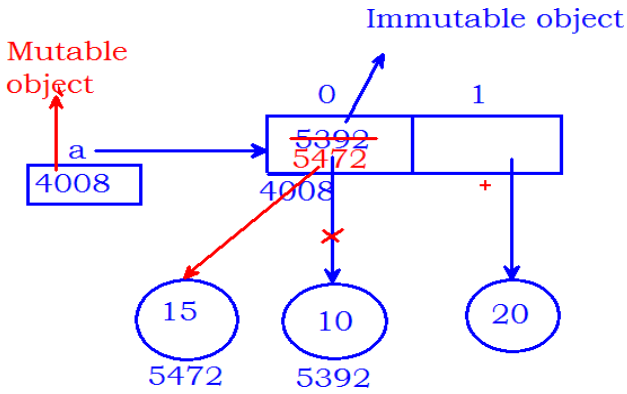


- In Python, Strings, Integers, Floats all elements are Immutable objects.
- Immutable object get another location when we modify.

```
a = [10,20]
print("List is :", a)
print("Address of a :",id(a))
print("a[0] :", a[0])
print("a[0] address :", id(a[0]))

a[0]=a[0]+5
print("List is :", a)
print("Address of a :",id(a))
print("a[0] :", a[0])
print("a[0] address :", id(a[0]))
```

Output:

```
List is : [10, 20]
Address of a : 54494008
a[0] : 10
a[0] address : 1647965392
List is : [15, 20]
Address of a : 54494008
a[0] : 15
a[0] address : 1647965472
```

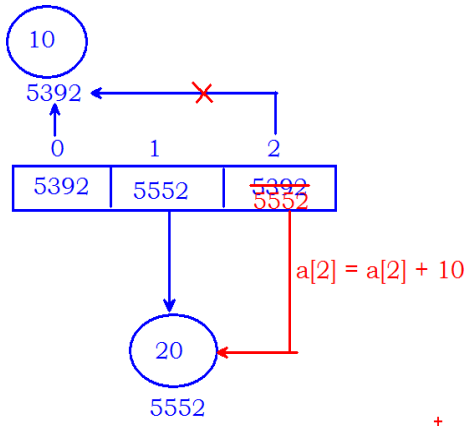


- Immutable objects cannot be duplicated.
- Contents with same values will share the memory.

```
a = [10, 20, 10]
print("List is :", a)
print("id(a[0]) :",id(a[0]))
print("id(a[1]) :",id(a[1]))
print("id(a[2]) :",id(a[2]))

a[2]=a[2]+10
print("id(a[1]) :",a[2])
print("id(a[2]) :",id(a[2]))
```

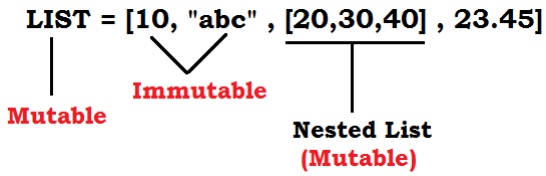
Output:

```
List is : [10, 20, 10]
id(a[0]) : 1647965392
id(a[1]) : 1647965552
id(a[2]) : 1647965392
id(a[1]) : 20
id(a[2]) : 1647965552
```



- List is Mutable - We can modify the List
- List elements either Mutable or Immutable

LIST = [10, "abc" , [20,30,40] , 23.45]



tuple:

- It is an ordered collection
- It allows duplicates
- It allows heterogeneous elements
- tuple can be represented using ( )

```
t = (10, 20, 30, 40, 50)
print(t)
t = (10, 20, 10, "abc", 23.45)
print(t)
```

Output:

```
(10, 20, 30, 40, 50)
(10, 20, 10, 'abc', 23.45)
```

Tuple elements can be processed using indexing or slicing.

```
t = (10, 20, 30, 40, 50)
print("Tuple :",t)
print("t[2] :", t[2])
print("t[-4] :", t[-4])
```

```
print("Length :", len(t))
print("t[0:len(t):2] :", t[0:len(t):2])
```

Output:

```
Tuple : (10, 20, 30, 40, 50)
t[2] : 30
t[-4] : 20
Length : 5
t[0:len(t):2] : (10, 30, 50)
```

Note: Tuple is Immutable object. Once the object has been created, cannot be modified.

We can modify the List as well as List elements as follows: List object is providing modification methods such as append(), pop(), remove(), reverse(), sort()…..

```
a = [10, 20, 30]
print("List is :",a)
a.append(40) #modifying list
print("List is :",a)
a.remove(20)
print("List is :",a)
a[0]=a[0]+5 #modifying list element
print("List is :",a)
```

Output:

```
List is : [10, 20, 30]
List is : [10, 20, 30, 40]
List is : [10, 30, 40]
List is : [15, 30, 40]
```

- Tuple cannot be modified.
- Modification methods are not present in Tuple Object (Immutable)
- Only 2 methods are present in the tuple object.

```
t = (10, 20, 30)
print(t[0])
10
t[0]=t[0]+5
TypeError: 'tuple' object does not support item assignment
```

- Tuple elements either Mutable or Immutable.
- Hence we can store a List(Mutable) inside the Tuple.
- We can modify the List(Mutable) which inside the Tuple.

Code:

```
t = (10,20,[30,40])
print("t[2] :", t[2])
t[2].append(50)
print("After append :", t)
t[2].remove(30)
print("After removal :", t)
print("t[2][1] :", t[2][1])
t[2][1]=t[2][1]+5
print("After modify list element :", t)
```

Output:

```
t[2] : [30, 40]
After append : (10, 20, [30, 40, 50])
After removal : (10, 20, [40, 50])
t[2][1] : 50
After modify list element: (10, 20, [40, 55])
```

List	Tuple
List is Mutable	Tuple is Immutable
List elements either Mutable or Immutable	Tuple elements either Mutable or Immutable
List is ordered and allow duplicates	Tuple is ordered and allow duplicates
List allow heterogeneous elements	Tuple allow heterogeneous elements
List elements can access using Indexing and slicing	Tuple elements can access using indexing and slicing
Modification methods are present – append(), pop(), remove()….	Modification methods not present – only index() and count() are given
List and List element can modify	Tuple and Tuple elements cannot modify

Set:

- Set is not an ordered collection
- Set element will be processed randomly on access.
- Set can be represented by { }

```
s = {10, 20, 30, 40, 50}
print(s)
{40, 10, 50, 20, 30}
```

We can store heterogeneous elements into set

```
s = {10, 2.3, "abc"}
print(s)
{2.3, 'abc', 10}
```

Set elements are unique. Duplicates will be removed automatically at the time of creation.

```
s = {10, 20, 10, 20, 30}
print(s)
{10, 20, 30}
```

- Set doesn't support indexing.
- Set elements are random; hence we cannot access a particular element through indexing.

```
s = {10,20,30}
print(s[1])
TypeError: 'set' object does not support indexing
```

Set functionality:

- 'set' is a class.
- 'set' object providing pre-defined functions to process the elements

```
s = {10,20,30,40,50}
print("Set :",s)
s.add(60)
print("Set after adding :",s)
s.discard(20)
s.discard(40)
print("Set after deleting :",s)
```

Output:

```
Set : {40, 10, 50, 20, 30}
Set after adding : {40, 10, 50, 20, 60, 30}
Set after deleting : {10, 50, 60, 30}
```

- Set is Mutable. Hence it is allowed to modify the set after creation.
- add() & discard() function in the above example explains how to modify the set after creation.

```
s = {10,20,30}
print("Set :", s)
print("Address :", id(s))

s.add(40)
s.discard(10)
print("Set after modify :",s)
print("Address after modify :", id(s))
```

Output:

```
Set : {10, 20, 30}
Address : 54403960
Set after modify : {40, 20, 30}
Address after modify : 54403960
```

- Set is allowed to store only Immutable objects.
- Immutable objects are - Numbers, Strings and Tuple
- Mutable objects - list , set ...

```
s = {10, 2.34, (10, 20, 30)}
print(s)
{2.34, 10, (10, 20, 30)}
```

Note: Trying to store a list(mutable) inside the Set result Error

```
>>> s = {10,[20,30]}
TypeError: unhashable type: 'list'
```

Set cannot store inside another set(Mutable):

```
s = {10,{20,30}}
TypeError: unhashable type: 'set'
```

- Set Object is providing pre-defined functionality to perform all mathematical set operations such as union, intersection, difference, symmetric_difference and so one.
- We can also perform the same set operations using operators.

```
s1 = {1,2,3,4}
s2 = {3,4,5,6}
print("s1 :",s1)
```

```
print("s2 :",s2)

print("Union :", s1.union(s2))
print("Union :", s1|s2)

print("Intersection :", s1.intersection(s2))
print("Intersection :", s1&s2)

print("Difference : ", s1.difference(s2))
print("Difference : ", s1-s2)

print("Symmetric difference :", s1.symmetric_difference(s2))
print("Symmetric difference :", s1^s2)
```

Output:

```
s1 : {1, 2, 3, 4}
s2 : {3, 4, 5, 6}
Union : {1, 2, 3, 4, 5, 6}
Union : {1, 2, 3, 4, 5, 6}
Intersection : {3, 4}
Intersection : {3, 4}
Difference :  {1, 2}
Difference :  {1, 2}
Symmetric difference : {1, 2, 5, 6}
Symmetric difference : {1, 2, 5, 6}
```

We can construct the collection of object by calling constructor.

```
my_list = list()
my_set = set()
```

- We can construct one collection object by passing another collection as an input.
- If we pass List as input to Set, all duplicates will be removed.

```
my_list = [10, 20, 30, 20, 10]
print("List is :", my_list)
my_set = set(my_list)
print("Set is :", my_set)
```

Output:

```
List is : [10, 20, 30, 20, 10]
Set is : {10, 20, 30}
```

type():

- A pre-defined function that returns identity of class if we specify an Object.
- We can create collection object in 2 ways.

```
#List construction:
#1. Initializing with empty list
l1 = [ ]
print(type(l1))
```

output:

```
<class 'list'>
```

```
#2. Calling constructor
l2 = list()
print(type(l2))
```

output:

```
<class 'list'>
```

#Tuple construction:

#1. Initializing with empty list

```
t1 = ()
print(type(t1))
<class 'tuple'>
```

#2. Calling constructor

```
t2 = tuple()
print(type(t2))
<class 'tuple'>
```

Set construction:

- Empty set can be constructed only through constructor.
- Direct assignment of empty set becomes dictionary.
- We represent the elements of Dictionary using { }

```
s = set()
print(type(s))
s = { }
print(type(s))
```

Output:

```
<class 'set'>
<class 'dict'>
```

When we remove all elements from List or Tuple it will show the empty collection using symbols

```
l = [10, 20, 30, 40]
print(l)
l.clear()
print(l)
```

Output:

```
[10, 20, 30, 40]
[]
```

But when we empty a set it will show the collection type using its identity.

```
s = {10, 20, 30, 40}
print(s)
s.clear()
print(s)
```

Output:

```
{40, 10, 20, 30}
set()
```

- Set is allowed to store only Immutable objects such as Numbers, Strings and Tuples.
- List should not be the element of Set because it is Mutable object.

```
s = {10,20,(30,40)}
print(s)
s = {10,20,[30,40]}
print(s)
```

Output:

```
{10, 20, (30, 40)}
TypeError: unhashable type: 'list'
```

Can we store a set inside another set?

- Not allowed.
- Set is Mutable – we can modify the set after creation
- Set elements must be Immutable.
- We cannot a store a set(mutable) inside another set(allows only immutable)

```
s = {10, 20, {30, 40}}
print(s)
```

Output: TypeError: unhashable type: 'set'

Dictionary:

- Set of elements(key, value pairs) represents using { }
- Set stores the elements(only values) directly
    - **set = {ele1 , ele2 , ele3.....}**
- Dictionary stores the elements using keys.
    - **dict = {key : ele , key : ele , key : ele }**
- Dictionary is an ordered collection.

```
emp = {101:"amar", 102:"annie", 103:"hareen"}
print("Dictionary :", emp)
```

Output: Dictionary : {101: 'amar', 102: 'annie', 103: 'hareen'}

Elements can be heterogeneous. Keys can be heterogeneous

```
d = {10:"abc", "xyz":2.34, 1.23:None}
print(d)
```

Output: {10: 'abc', 'xyz': 2.34, 1.23: None}

Keys must be unique. When we store the data using duplicate key, existing data will be replaced.

```
accounts ={101:"harin", 102:"kiritin", 102:"ramya"}
print(accounts)
```

- Elements can be duplicated.
- for example, in Banking application, we process the accounts using account numbers.
- Account numbers are unique (keys)
- Account data can be duplicates (name, pin, balance.)

```
accounts ={101:"harin", 102:"kiritin", 103:"harin"}
print(accounts)
```

Dictionary object is providing set of functions which are used process elements of that dictionary.

```
accounts ={101:"harin", 102:"kiritin", 103:"ramya", 104:"annie"}
print("Accounts :", accounts)
#list of keys will be returned
print("Keys :", accounts.keys())
#returns list of values
print("Values :", accounts.values())
accounts.pop(102)
print("After removal of 102 :", accounts)
accounts.popitem()
```

```
print("After removal of last inserted element :", accounts)
print("Value at 103 :", accounts.get(103))
```

Output:

```
Accounts : {101: 'harin', 102: 'kiritin', 103: 'ramya', 104: 'annie'}
Keys : dict_keys([101, 102, 103, 104])
Values : dict_values(['harin', 'kiritin', 'ramya', 'annie'])
After removal of 102 : {101: 'harin', 103: 'ramya', 104: 'annie'}
After removal of last inserted element : {101: 'harin', 103: 'ramya'}
Value at 103 : ramya
```

We can iterate the dictionary using keys. For loop can iterate all keys of input dictionary.

```
accounts ={101:"harin", 102:"kiritin", 103:"ramya", 104:"annie"}
print("Account numbers are :")
for accno in accounts:
    print(accno)
print("Account holder names are :")
for accno in accounts:
    name = accounts.get(accno)
    print(name)
```

Format the above program using string format specifiers:

```
accounts ={101:"harin", 102:"kiritin", 103:"ramya", 104:"annie"}
print("Account details are :")
for accno in accounts:
    name = accounts.get(accno)
    print("%d --> %s" %(accno, name))
```

Update(): A pre-defined method is used to update the dictionary

```
keys = [101, 102, 103, 104]
values = ["harin","kiritin","ramya","annie"]
accounts = dict() #create an empty dictionary
for i in range(len(keys)):
    key = keys[i]
    value = values[i]
    accounts.update({key:value})
print("Account details are :")
for accno in accounts:
    name = accounts.get(accno)
    print("%d --> %s" %(accno, name))
```

Lambda Expressions

Lambda expressions:

- Expression is a line of code.
- Expression is a collection of operands and operators.
- 'lambda' is a keyword.
- 'lambda' expressions are used to define a function with single line

Generally we define function as follows:

```
def display(name):
    print("Hello %s" %name)
    return

display("Amar")
```

We define above function with lambda expression as follows:

```
display = lambda name : print("Hello %s" %name)
display("Amar")
```

Biggest of 2 numbers code snippet:

```
def big(a,b):
    if a>b:
        return a
    else:
        return b
print("Big one is :" , big(10,20))
```

Writing the above code using lambda expression:

```
big = lambda a, b :  a if a>b else b
print("Big one is :" , big(10,20))
```

Even number program code:

```
def even(num):
    if num%2==0:
        return True
    else:
        return False

print("4 is even : ", even(4))
print("7 is even : ", even(7))
```

Lambda expression foe above code:

```
even = lambda num : num%2==0
print("4 is even : ", even(4))
print("7 is even : ", even(7))
```

Biggest of 3 numbers code:

```
def big(a,b,c):
    if a>b and a>c:
        return a
    elif b>c:
        return b
    else:
        return c

print(big(10,30,20))
print(big(30,40,50))
```

Lambda expression:

```
big = lambda a,b,c : a if a>b and a>c else b if b>c else c
print(big(10,30,20))
print(big(30,40,50))
```

Leap year program:

- 4 divisibles - leap
- 400 divisibles - leap
- 100 divisibles - not leap

```
def leap(n):
    if n%400==0:
        return "leap"
    elif n%4==0 and n%100!=0:
        return "leap"
    else:
        return "not"

print("16 is :",leap(16))
print("31 is :",leap(31))
print("200 is :",leap(200))
print("2400 is :",leap(2400))
```

Try to Write the Lambda expression:

Command Line arguments

- In machine, all programs run by OS.
- We can run every program manually from OS environment
- Command prompt(DOS) is called OS environment.

Note: Passing input(arguments) from the command line while invoking the application is called Command line arguments.

Run Python code from command line:

- OS invokes python interpreter then interpreter executes the code.
- Python interpreter is dependent to OS(at the time of installation, we download python based on OS)

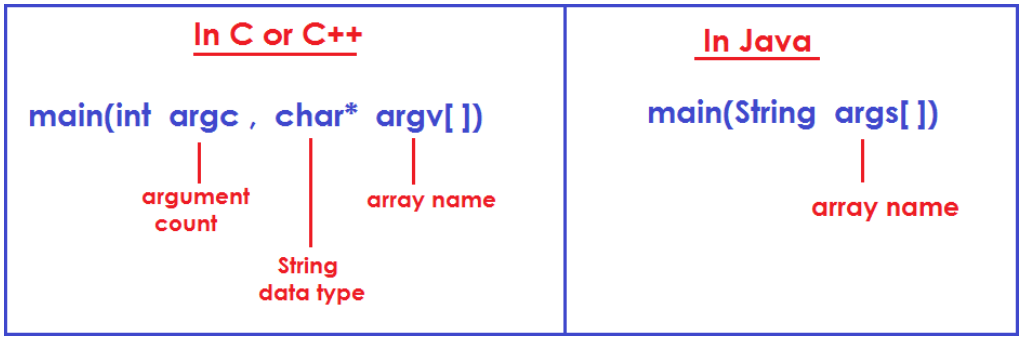
Code:

```
class CmdLine:
    def main():
        print("Manaul execution of Python script")
        return

CmdLine.main()
```

Run:

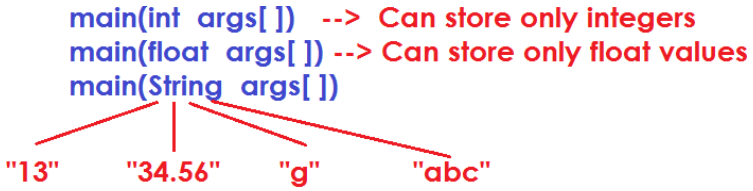
```
C:\Users\Srinivas>cd desktop

C:\Users\Srinivas\Desktop>python script.py
Manaul execution of Python script
```

- In other languages such as C, C++ and Java; Program execution starts from main() method.
- Main() is responsible for collecting all these input arguments into a String type array.
- Arguments will be in String format.



Why command line arguments are String type?

- Only a String can able to store any kind of data (int, float, char, string..)
- We collect the input into String type and process by converting into corresponding type using conversion methods.



Conversions before process:

```
x = int("13")
y = float("34.56")
```

Note: In python programming, main() method is optional. Main() is not responsible to collect arguments. All command line arguments will store into "argv" list object automatically.

sys.argv:

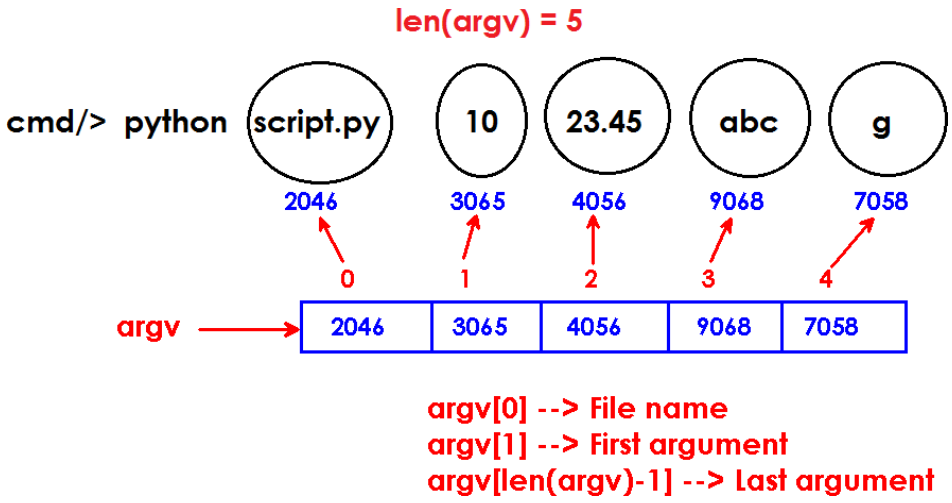
- 'sys' is a pre-defined module
- 'argv' is a list belongs to 'sys' module.
- 'argv' holds command line arguments implicitly.

How can we pass command line arguments?

At command line, we can pass arguments by leaving the spaces between arguments followed by file name

cmd/> python file.py arg1 arg2 arg3

Memory allocation:



Python provides various ways to dealing with command line arguments.
The 3 command types are:

1. Using sys.argv
2. Using getopt module
3. Using argparse module

Code:

```
import sys
class CmdLine:
    def main():
        count = len(sys.argv)
        print("Arguments count :",count)
        return

CmdLine.main()
```

Run:

```
C:\Users\Srinivas\Desktop>python script.py
Arguments count : 1

C:\Users\Srinivas\Desktop>python script.py 10 20 30 40 50
Arguments count : 6

C:\Users\Srinivas\Desktop>python script.py 10 23.45 abc
Arguments count : 4
```

Display arguments: (including file name)

```
import sys
class CmdLine:
    def main():
        arr = sys.argv # 'argv' address will store into 'arr'
        if len(arr)==1:
            print("No arguments to display")
        else:
            print("Arguments are :")
            for ele in arr:
                print(ele)
        return

CmdLine.main()
```

Run:

```
C:\Users\Srinivas\Desktop>python script.py
No arguments to display

C:\Users\Srinivas\Desktop>python script.py 10 23.45 abc
Arguments are :
script.py
10
23.45
abc
```

Display arguments: (excluding file name)

```
import sys
class CmdLine:
    def main():
        arr = sys.argv
        if len(arr)==1:
            print("No arguments to display")
        else:
            print("Arguments are :")
            for i in range(1, len(arr)):
                print(arr[i])
        return

CmdLine.main()
```

Run:

```
C:\Users\Srinivas\Desktop>python script.py 10 20 30 40 50
Arguments are :
10
20
30
40
50
```

Program to take input(2 numbers) from command line and divide

```
import sys
class Divide:
    def main():
        try:
            arr = sys.argv
            s1 = arr[1]
            s2 = arr[2]

            x = int(s1)
            y = int(s2)
```

```
        z = x/y
        print("Result :",z)

    except IndexError :
        print("Exception : Insufficient values")

    except ValueError :
        print("Exception : Invalid Input")

    except ZeroDivisionError :
        print("Exception : Division by zero")

    return
Divide.main()
```

```
C:\Users\Srinivas\Desktop>python script.py
Exception : Insufficient values

C:\Users\Srinivas\Desktop>python script.py 10 abc
Exception : Invalid Input

C:\Users\Srinivas\Desktop>python script.py 10 0
Exception : Division by zero

C:\Users\Srinivas\Desktop>python script.py 5 2
Result : 2.5
```

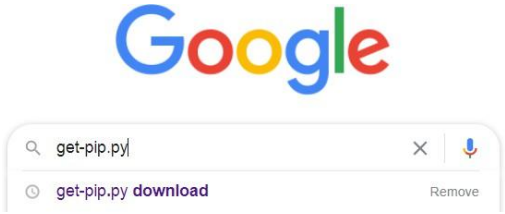
Above code can be written as:

```
import sys
class Divide:
    def main():
        arr = sys.argv
        if len(arr)>2:
            try:
                res = int(arr[1])/int(arr[2])
                print("Result :", res)
            except Exception as msg:
                print("Exception :", msg)
        else:
            print("Insufficient input")

        return

Divide.main()
```

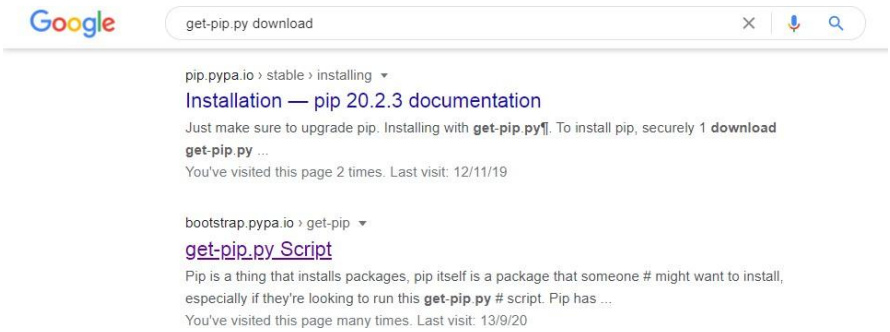
pip

pip:

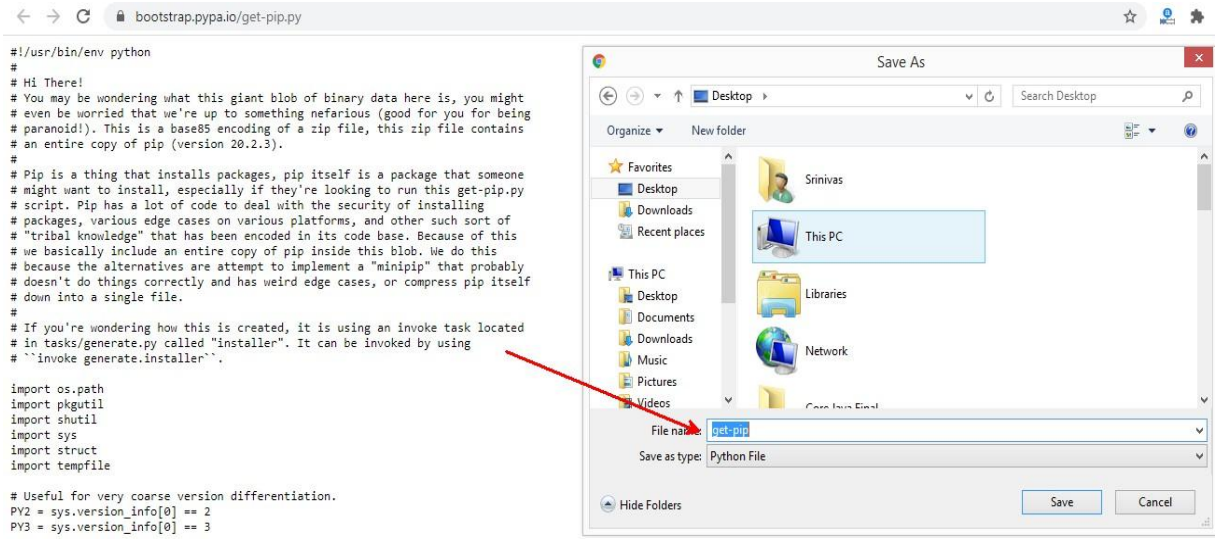
- PIP is a package manager.
- It is also called Python Package Installer (PyPI)
- A pre-defined script that can install every third party module or package of Python into system easily.
- We need to install pip first.
- Download get-pip.py file and run as script.



Open the link which is showing get-pip.py Script:



Save the content of script with same name:



Run from command line as a Script – Maintain data connection:

- get-pip.py program collect the required information from the internet in the process of installation.
- At the time of installation, in case any old version exists will be un installed automatically.

```
C:\Users\Srinivas\Desktop>python get-pip.py
Collecting pip
  Downloading pip-20.2.3-py2.py3-none-any.whl (1.5 MB)
     |████████████████████████████████| 1.5 MB 1.1 MB/s
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 20.1.1
    Uninstalling pip-20.1.1:
      Successfully uninstalled pip-20.1.1
Successfully installed pip-20.2.3
```

Installing other packages using PIP

Installing mysql and connector:

cmd/> pip install mysqlclient
cmd/> pip install mysql-connector-python

```
C:\Users\Srinivas\Desktop>pip install mysql-connector-python
Requirement already satisfied: mysql-connector-python in c:\u
naconda3\lib\site-packages (8.0.11)
```

Installing Numpy and Pandas:

- The important modules to process the information like one dimensional, two dimensional and Multi dimensional.
- These modules must be installed before use.

cmd:/ pip install numpy
dmd:/ pip install pandas

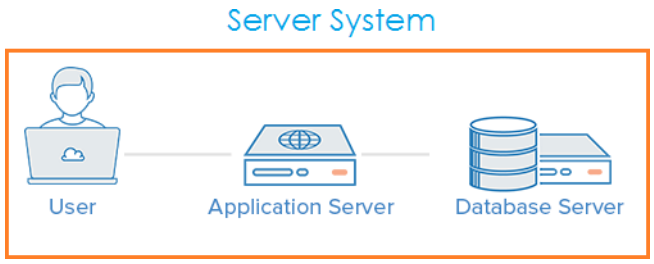
```
C:\Users\Srinivas\Desktop>pip install numpy
Requirement already satisfied: numpy in c:\users\srinivas\app
-packages (1.11.3)

C:\Users\Srinivas\Desktop>pip install pandas
Requirement already satisfied: pandas in c:\users\srinivas\ap
e-packages (0.19.2)
```

Database Connectivity

Introduction:

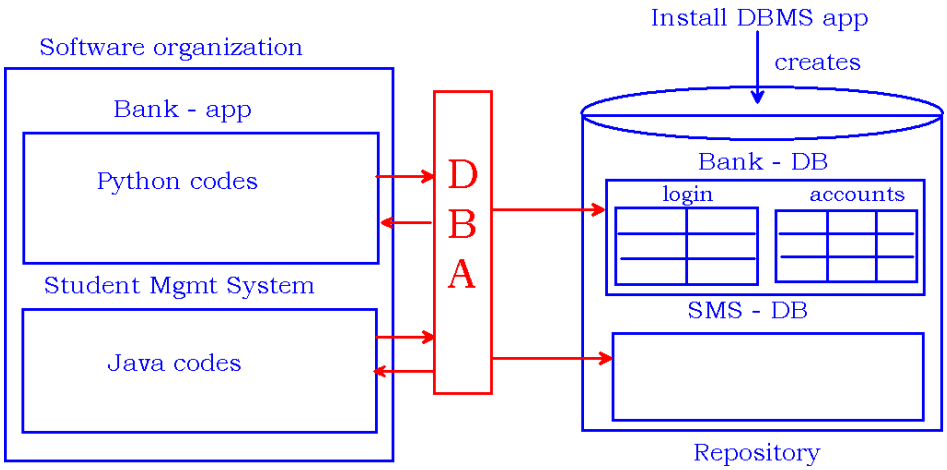
- We use programming languages to develop applications
- Applications are used to store(maintain) information for processing.
- We can store information in 2 ways
    - File System
    - Database management systems
- Traditional file system is not secured and structured.
- DBMS is an application – It is object oriented, structured and secured.

To develop complete application, we use follow the architecture called 3-tier architecture:



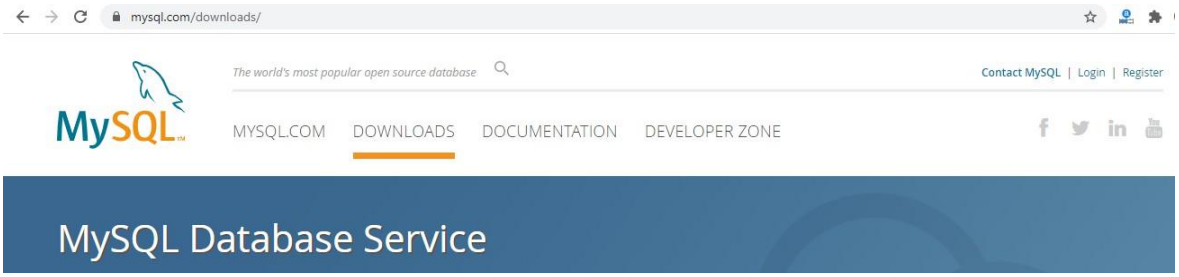
DBMS:

- DBMS(for example, mysql) is an application software.
- Database Repository is a collection of Databases.
- Database is a collection of Tables & Table is a collection of records
- Record is a collection of fields.
- We need to maintain separate database to each application.



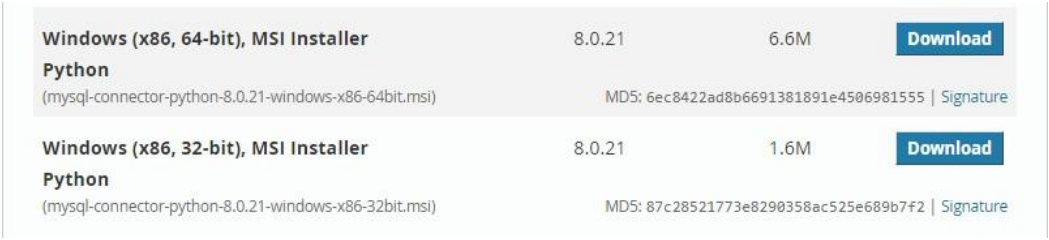
Python-MySQL connectivity:

- MySQL is simple and open source.
- Download and install the MySQL server

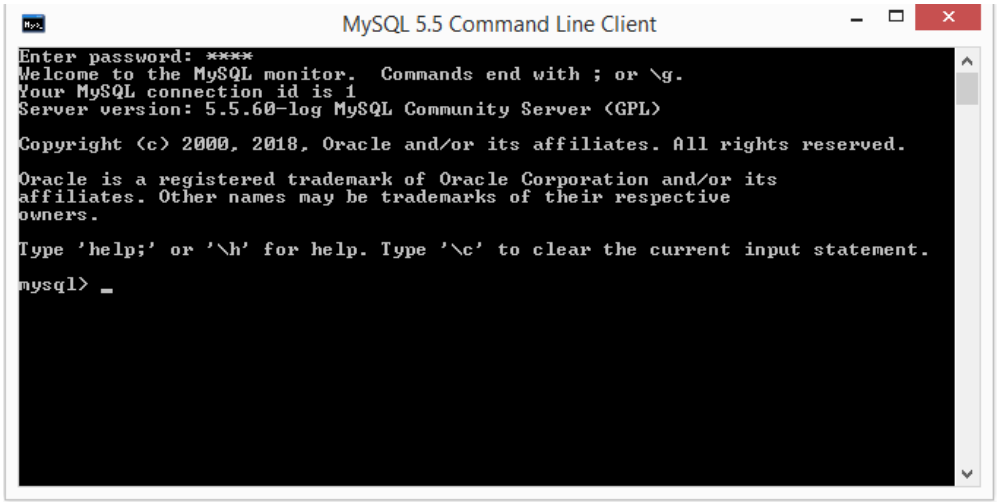


Python-MySQL-Connector:

- After installation of MySQL, we need to install connector from the same website.
- Connector installs a package which contains pre-defined programs to implement Python-Database connection applications.
- MySQL connection programs are not directly available with Python installation.
- Connector installation provides mysql.connector package which contains pre-defined programs for connection, to execute sql statements in communication.



Opening Client:



Executing SQL commands: Mainly we use 3 types of SQL statements to communicate with database

1. DDL commands : Data Definition languages
    a. Create or Drop tables

2. DML commands : Data Manipulation language
    a. Insert records into table
    b. Update records
    c. Delete records

3. DRL commands : Data retrieval language
    a. Select – fetching the data

Query to show all databases:
mysql> show databases;

```
+----------------------------+
| Database                   |
+----------------------------+
| banking                    |
| python                     |
+----------------------------+
```

mysql> create database student;
mysql> show databases;

```
+----------------------------+
| Database                   |
+----------------------------+
| banking                    |
| python                     |
| student                    |
+----------------------------+
```

mysql> use student;
Database changed

mysql> show tables;
Empty set (0.02 sec)

mysql> create table account(num int, name varchar(20), balance int);
mysql> show tables;

```
+----------------------------+
| Tables_in_student |
+----------------------------+
  | account          |
+----------------------------+
```

Inserting records:

```
mysql> insert into account values(101, 'amar', 5000);
mysql> insert into account values(102, 'annie', 9000);
mysql> insert into account values(103, 'hareen', 7000);
```

mysql> select * from account;

```
+----------+-------------+---------------+
| num  | name   | balance |
+----------+-------------+---------------+
  |  101 | amar   |    5000 |
  |  102 | annie  |    9000 |
  |  103 | hareen |    7000 |
+----------+-------------+---------------+
```

mysql> select name from account;

```
+-------------+
| name   |
+-------------+
 | amar   |
 | annie  |
| hareen |
+-------------+
```

mysql> select * from account where num=103;

```
+----------+-------------+---------------+
| num  | name   | balance |
+----------+-------------+---------------+
  |  103 | hareen |    7000 |
+----------+-------------+---------------+
```

mysql> select name,balance from account where num=102;

```
+-----------+--------------+
| name  | balance |
+-----------+--------------+
 | annie |    9000 |
+-----------+--------------+
```

mysql> update account set balance=balance+1500 where num=101;
mysql> select * from account;

```
+---------+-------------+--------------+
| num  | name   | balance |
+---------+-------------+--------------+
  |  101 | amar   |    6500 |
  |  102 | annie  |    9000 |
  |  103 | hareen |    7000 |
+---------+-------------+--------------+
```

mysql> delete from account where num=102;
mysql> select * from account;

```
+---------+-------------+--------------+
| num  | name   | balance |
+---------+-------------+--------------+
  |  101 | amar   |    6500 |
  |  103 | hareen |    7000 |
+---------+-------------+--------------+
```

mysql> delete from account;
mysql> select * from account;
Empty set (0.00 sec)

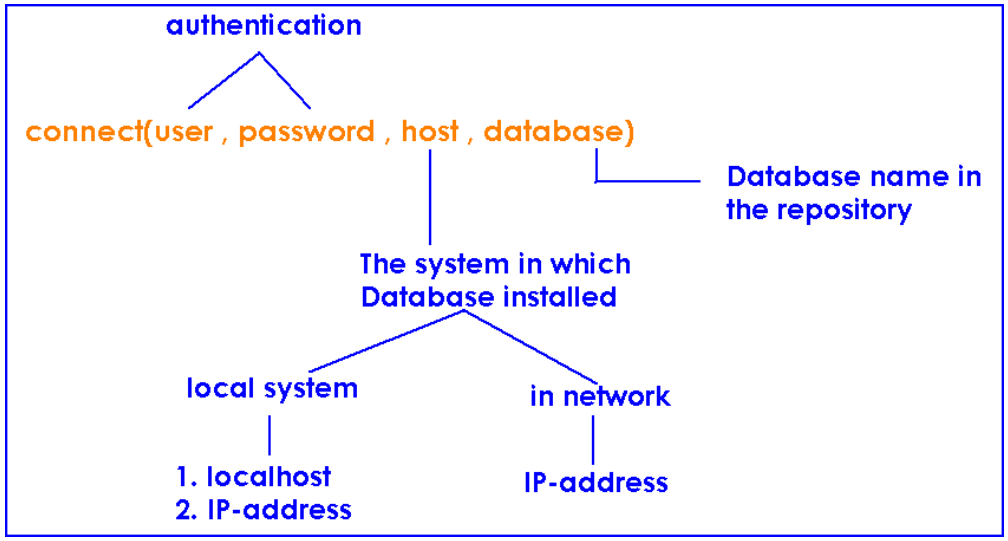
mysql> drop table account;
mysql> show tables;
Empty set (0.00 sec)

mysql.connector:

- connector is a sub module in mysql package.
- It is available only when we install python-mysql-connector.
- After installation, we are checking whether the module has installed or not by importing.

connect():

- It is belongs to connector module.
- It returns connection object if the specified input is valid.
- Input arguments are username, password, host address and database name.



- On success, returns connection object
- On failure, raises as exception

Connecting to Database:

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")

        except Exception as msg:
```

```
        print("Exception :",msg)

    finally:
        if DB.con != None:
            DB.con.close()
            print("Database released")

    return
DB.main()
```

Output:

```
C:\Users\Srinivas\Desktop>python script.py
Connected to database
Database released
```

Executing SQL statements

DDL commands:

Create:

- Once connection is ready, we need to get cursor object.
- Cursor() method belongs to connection object.
- On call, it returns cursor object.

execute():

- Pre-defined method belongs to cursor object.
- Using execute() method, we can execute any query in the database.

Code:

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()
```

```
        query = "create table account(no int, name varchar(20), balance int)"
        cur.execute(query)
        print("Table created successfully")

    except Exception as msg:
        print("Exception :",msg)

    finally:
        if DB.con != None:
            DB.con.close()
            print("Database released")

    return

DB.main()
```

Output:

```
C:\Users\Srinivas\Desktop>python script.py
Connected to database
Table created successfully
Database released
```

In database:

```
mysql> show tables;
Empty set (0.07 sec)

mysql> show tables;
+-------------------+
| Tables_in_student |
+-------------------+
| account           |
+-------------------+
1 row in set (0.00 sec)
```

Inserting records:

- 'insert' is DML command.
- DML commands such as insert, delete and update transactions need to commit after execution.
- commit() method belongs to connection object.
- Without commit the DML transaction, the database will not be effected.

Code:

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()

            query = "insert into account values(101, 'amar', 7000)"
            cur.execute(query)
            print("Record inserted... ")

            DB.con.commit()
            print("Transaction committed")

        except Exception as msg:
            print("Exception :",msg)

        finally:
            if DB.con != None:
                DB.con.close()
                print("Database released")

        return

DB.main()
```

Output:

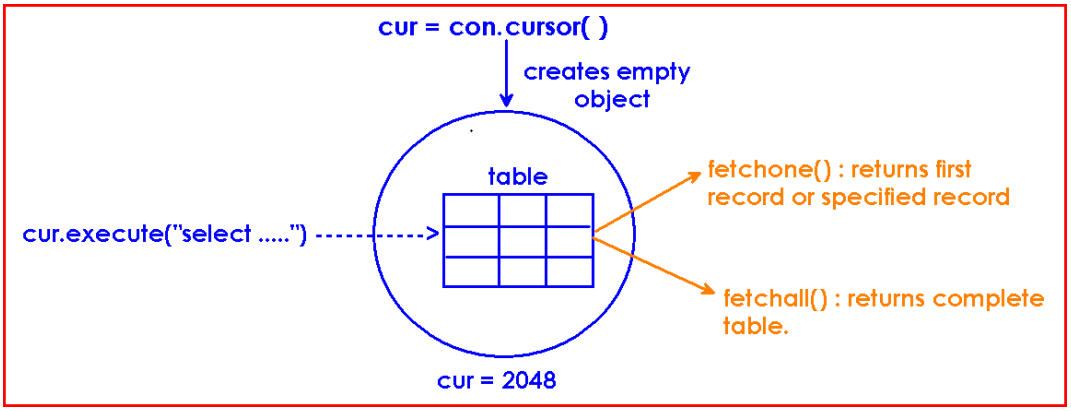
```
C:\Users\Srinivas\Desktop>python script.py
Connected to database
Record inserted....
Transaction committed
Database released
```

In database:

```
mysql> select *from account;
+------+------+---------+
| no   | name | balance |
+------+------+---------+
|  101 | amar |    7000 |
+------+------+---------+
1 row in set (0.00 sec)
```

Fetching information from the table:

- cursor() object is empty as soon as it has created.
- When we execute any "select" query, the information returned by the query will store into cursor object.
- Cursor object is providing 2 functions fetchone() and fetchall() to get the information.
- fetchone(): returns either first record of specified record(where clause)
- fetchall(): returns all records from that table.



Fetching first record:

```
mysql> select *from account;
+------+-------+---------+
| no   | name  | balance |
+------+-------+---------+
|  101 | amar  |    7000 |
|  102 | annie |    6000 |
+------+-------+---------+
2 rows in set (0.00 sec)
```

Code:

```
import mysql.connector
class DB:
    con = None
    def main():
```

```
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()

            query = "select * from account"
            cur.execute(query)

            record = cur.fetchone()
            print("First record details : ", record)

        except Exception as msg:
            print("Exception :",msg)

        finally:
            if DB.con != None:
                DB.con.close()
                print("Database released")

        return
DB.main()
```

Output:

```
Connected to database
First record details :  (101, 'amar', 7000)
Database released
```

Fetching the details of specified record using where clause:

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
```

```
            cur = DB.con.cursor()

            query = "select * from account where no=102"
            cur.execute(query)

            record = cur.fetchone()
            print("102 record details : ")
            print("Account Number :", record[0])
            print("Name :", record[1])
            print("Balance :", record[2])

        except Exception as msg:
            print("Exception :",msg)

        finally:
            if DB.con != None:
                DB.con.close()
                print("Database released")

        return

DB.main()
```

Output:

```
Connected to database
102 record details :
Account Number : 102
Name : annie
Balance : 6000
Database released
```

Fetching the complete table information:

- Table is in two dimensional format.
- A set of records will be returned as an object.
- Using for loop, we can access records
- Using nested for loop; we can process fields of each record.

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()

            query = "select * from account"
            cur.execute(query)

            table = cur.fetchall()
            print("Table details :")
            for record in table:
                print(record)

        except Exception as msg:
            print("Exception :",msg)

        finally:
            if DB.con != None:
                DB.con.close()
                print("Database released")

        return

DB.main()
```

Output:

```
Connected to database
Table details :
(101, 'amar', 7000)
(102, 'annie', 6000)
(103, 'hareen', 9000)
Database released
```

Using nested loop, we can process each record elements as follows:

```
        query = "select * from account"
        cur.execute(query)

        table = cur.fetchall()
        print("Table details :")
        for record in table:
            for field in record:
                print(field)
```

Update the table record:

Before update, the table:

```
mysql> select *from account;
+------+--------+---------+
| no   | name   | balance |
+------+--------+---------+
|  101 | amar   |    7000 |
|  102 | annie  |    6000 |
|  103 | hareen |    9000 |
+------+--------+---------+
3 rows in set (0.00 sec)
```

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()

            query = "update account set balance = balance+1500 where no=102"
            cur.execute(query)

            DB.con.commit()
            print("Record updated")

        except Exception as msg:
            print("Exception :",msg)
```

```
    finally:
        if DB.con != None:
            DB.con.close()
            print("Database released")

    return
DB.main()
```

Output:

Connected to database
Record updated
Database released

Table after updation:

```
mysql> select *from account;
+------+--------+---------+
| no   | name   | balance |
+------+--------+---------+
|  101 | amar   |    7000 |
|  102 | annie  |    7500 |
|  103 | hareen |    9000 |
+------+--------+---------+
3 rows in set (0.00 sec)
```

Static Query v/s Dynamic Query:

- In all the above applications, we executed static queries.
- Static queries always execute with fixed set of values.
- Dynamic queries need to construct at runtime.
- We collect the user input to perform database operations and construct the query dynamically based on the input values.
- We can construct the Query(string) in 2 ways
    - Using concatenation
    - Using format specifiers

Static Queries:

1. ins_query = "insert into account values(101, 'amar', 5000)"
2. sel_query = "select * from account where no=102"
3. upd_query = "update account set balance=balance+3000 where no=103"
4. del_query = "delete from account where no=104"

Dynamic Queries:

Construct delete query by collecting record number as input:

```
num = int(input("Enter record num to delete : "))
del_query = "delete from account where no=" + str(num)
print(del_query)
        # or
del_query = "delete from account where no=%d" %num
print(del_query)
```

Fetching specific record by reading the record number from end user:

```
import mysql.connector
class DB:
   con = None
   def main():
      try :
         DB.con = mysql.connector.connect(user='root', password='root',
                                 host='127.0.0.1', database='student')
         print("Connected to database")
         cur = DB.con.cursor()

         num = int(input("Enter account number : "))
         # query = "select * from account where no=%d" %num
         query = "select * from account where no=" + str(num)
         cur.execute(query)

         record = cur.fetchone()
         print("Details are : ", record)

      except Exception as msg:
         print("Exception :",msg)

      finally:
         if DB.con != None:
            DB.con.close()
            print("Database released")

      return
DB.main()
```

Output:

```
C:\Users\Srinivas\Desktop>python script.py
Connected to database
Enter account number : 102
Details are :  (102, 'annie', 7500)
Database released
```

Update(change balance of) specific record by collecting record number and balance to set from the end user:

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                    host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()

            num = int(input("Enter account number : "))
            amt = int(input("Enter deposit amount : "))

            #query = "update account set balance = balance+%d where no=%d" %d(amt,num)
            query = "update account set balance=balance+" + str(amt) + " where no=" + str(num)
            cur.execute(query)

            DB.con.commit()
            print("Record updated")

        except Exception as msg:
            print("Exception :",msg)

        finally:
            if DB.con != None:
                DB.con.close()
                print("Database released")

        return

DB.main()
```

Output:

Connected to database
Enter account number : 101
Enter deposit amount : 1200
Record updated
Database released

In database:

```
mysql> select *from account;
+------+--------+---------+
| no   | name   | balance |
+------+--------+---------+
|  101 | amar   |    7000 |
|  102 | annie  |    7500 |
|  103 | hareen |    9000 |
+------+--------+---------+
3 rows in set (0.13 sec)

mysql> select *from account;
+------+--------+---------+
| no   | name   | balance |
+------+--------+---------+
|  101 | amar   |    8200 |
|  102 | annie  |    7500 |
|  103 | hareen |    9000 |
+------+--------+---------+
3 rows in set (0.00 sec)
```

Insert(all details) record into table by collecting no, name and balance.

```
import mysql.connector
class DB:
    con = None
    def main():
        try :
            DB.con = mysql.connector.connect(user='root', password='root',
                                host='127.0.0.1', database='student')
            print("Connected to database")
            cur = DB.con.cursor()

            print("Enter Account details : ")
            num = int(input("Account Num : "))
            name = input("Name : ")
            bal = int(input("Balance : "))

            # query = "insert into account values(%d,'%s',%d)" %(num,name,bal)
            query = "insert into account values(" + str(num) + ",'" + name + "'," + str(bal) + ")"
            print("Query is :", query)
```

```
            cur.execute(query)
            print("Record inserted ...")

            DB.con.commit()
            print("Transaction committed")

        except Exception as msg:
            print("Exception :",msg)

        finally:
            if DB.con != None:
                DB.con.close()
                print("Database released")

        return

DB.main()
```

In database:

```
mysql> select *from account;
+------+--------+---------+
| no   | name   | balance |
+------+--------+---------+
|  101 | amar   |    8200 |
|  102 | annie  |    7500 |
|  103 | hareen |    9000 |
+------+--------+---------+
3 rows in set (0.00 sec)

mysql> select *from account;
+------+--------+---------+
| no   | name   | balance |
+------+--------+---------+
|  101 | amar   |    8200 |
|  102 | annie  |    7500 |
|  103 | hareen |    9000 |
|  104 | satya  |    8500 |
+------+--------+---------+
4 rows in set (0.00 sec)
```

tkinter – GUI

tkinter:

- "tkinter" is a pre-defined module.
- "tkinter" providing set of classes to implement GUI programming.
- GUI programming is "Windows" based.
- "Tk" class belongs to "tkinter" module. Instantiation(Object Creation) of Tk class results a Window(Frame)

Creating Frame:

```
from tkinter import Tk
root = Tk()
```

Defining Custom Frame by inheriting the functionality:

```
from tkinter import Tk
class MyFrame(Tk):
    pass

class Create:
    def main():
        obj = MyFrame()
        return

Create.main()
```

Components:

- Components such as Buttons, Labels, Entry fields, Checkboxes provided as pre-defined classes.
- Component classes belong to "tkinter" module only.
- Object creation of Component class results the Component.
- We need to arrange the component on the Frame using Layout structure.

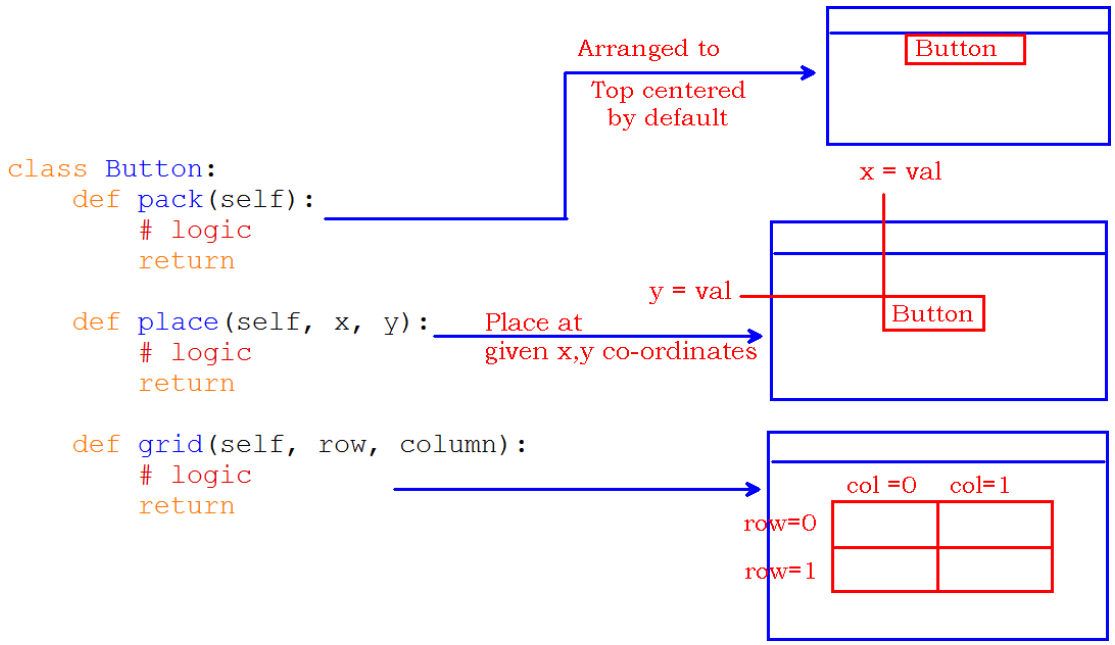
Layout:

- The arrangement of components on window.
- Python library is pre-defined layout structures.
- Every Component class has dynamic functionality to layout that component.

Create Button:

```
from tkinter import Tk, Button
root = Tk()
root.title("GUI")
b = Button(root, text="Click Me")
```

Note: In the above application, Button is not displayed on Frame. After creation of Button, we need to arrange that Button on Frame using Layout functionality.



pack(): A function that arranges the component top centered to window.

```
from tkinter import Tk, Button
root = Tk()
root.title("GUI")
b = Button(root, text="Click Me")
b.pack()
```

geometry():

- A function is belongs to Tk class
- It is used to set Width & Height of Frame
- It is dynamic function; hence we need to call on object.
    - **geometry("width x height")**

```
from tkinter import Tk, Button
root = Tk()
root.title("GUI")
root.geometry("500x300")
b = Button(root, text="Click Me")
b.pack()
```

Events:

- Event is an Action which is performed on component
- For example,
    - clicking a button.
    - Select checkbox
    - Select radiobutton
- When action performed on Button, it executes the function which is specified by "command" argument of that Button.

```
from tkinter import Tk, Button

def display():
    print("Button clicked")
    return

root = Tk()
root.title("GUI")
root.geometry("500x300")

b = Button(root, text="Click Me", command=display)
b.pack()
```

- We can set properties such as Font, Color, Background color to components.
- We can set properties using pre-defined arguments of that Component.

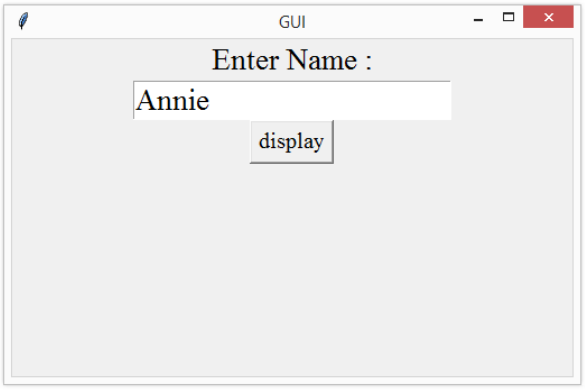
```
from tkinter import Tk, Button

def display():
    print("Button clicked")
    return
```

```
root = Tk()
root.title("GUI")
root.geometry("500x300")

b = Button(root, text="Click Me", bg="light blue",
        fg="red", font="Times 30", command=display)
b.pack()
```

Code:

```
from tkinter import Tk, Label, Entry, Button

def disp():
    name = e.get()
    print("Hello %s, welcome" %name)
    return

root = Tk()
root.title("GUI")
root.geometry("500x300")

l = Label(root, text="Enter Name :", font="Times 20")
l.pack()

e = Entry(root, font="Times 20")
e.pack()

b = Button(root, text="display",  font="Times 15", command=disp)
b.pack()
```

```
>>> Hello Amar, welcome
Hello Annie, welcome
```



place() function is used to place the component at specified x, y co-ordinates

```
from tkinter import Tk, Label, Entry, Button

def fun():
    print("Button clicked")
    return

root = Tk()
root.title("GUI")
root.geometry("500x300")
b = Button(root, text="click", font="Times 20", command=fun)
b.place(x=200, y=100)
```

grid():

- Layout method belongs to component object.
- grid() method arrange the components in table(rows and columns) format.
- We need to specify row value and column value of component

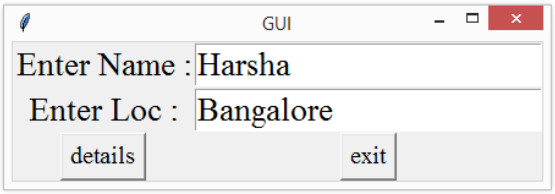
Code:

```
from tkinter import *

def details():
    name = e1.get()
    loc = e2.get()
    print("%s live in %s" %(name,loc))
    return

root = Tk()
root.title("GUI")

l1 = Label(root, text="Enter Name :", font="Times 20")
l2 = Label(root, text="Enter Loc :", font="Times 20")

e1 = Entry(root, font="Times 20")
e2 = Entry(root, font="Times 20")

b1 = Button(root, text="details", font="Times 15", command=details)
b2 = Button(root, text="exit", font="Times 15", command=quit)

l1.grid(row=0, column=0)
e1.grid(row=0, column=1)
```

```
l2.grid(row=1,  column=0)
e2.grid(row=1, column=1)
b1.grid(row=2, column=0)
b2.grid(row=2, column=1)
```

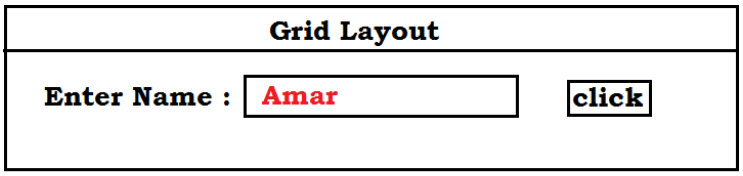
Output:

```
>>> Hareen live in Hyderbad
Harsha live in Bangalore
```



Code:

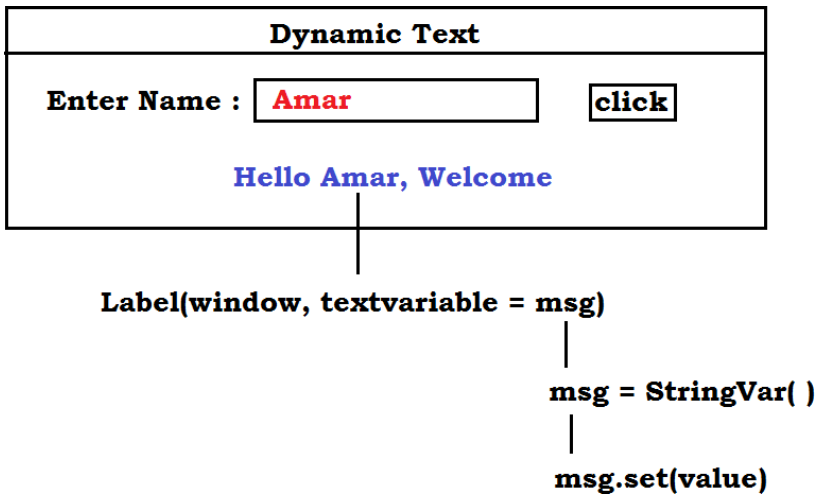
```
from tkinter import Tk, Label, Button, Entry
def func():
    name = e.get()
    print("Hello " + name + ", welcome to GUI")
    return

window = Tk()
window.title("Grid Layout")

l = Label(window, text="Enter Name :", font="Times 25")
l.grid(row=0, column=0)

e = Entry(window, font="Times 25", fg="red")
e.grid(row=0, column=1)

b = Button(window, text="Click", font="Times 20", command=func)
b.grid(row=0, column=2)
```



Output : Hello Amar, Welcome to GUI

StringVar class:

- It is belongs to tkinter module
- It is used to set dynamic text(values) to components
- To assign StringVar object we use "textvariable" argument of that component instead of "text" argument.



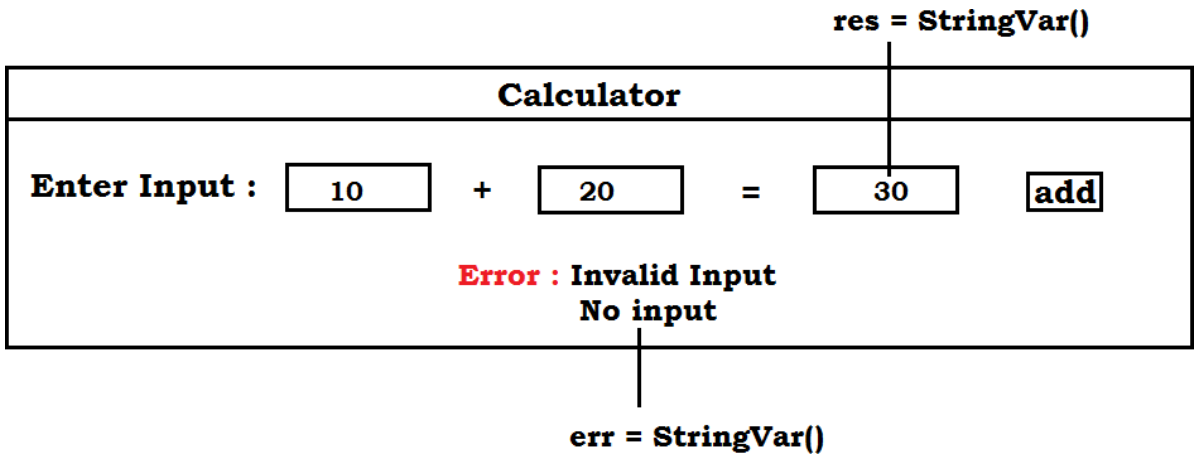

```
from tkinter import Tk, Label, Button, Entry, StringVar
def func():
    name = e.get()
    msg.set("Hello " + name + ", Welcome")
    return

window = Tk()
msg = StringVar()
window.title("Dynamic Text")
window.geometry("750x300")

l = Label(window, text="Enter Name :", font="Times 20")
l.place(x=50, y=50)

e = Entry(window, font="Times 20", fg="red")
e.place(x=250, y=50)

b = Button(window, text="Click", font="Times 15", command=func)
b.place(x=600, y=50)
```

```
res = Label(window, textvariable=msg, font="Times 20", fg="blue")
res.place(x=150, y=175)
```

Output:

Simple calculator program:

- We use 2 StringVar objects
- First one(res) is used to display the result in Entry field.
- Second one(err) is used to display error in case any.

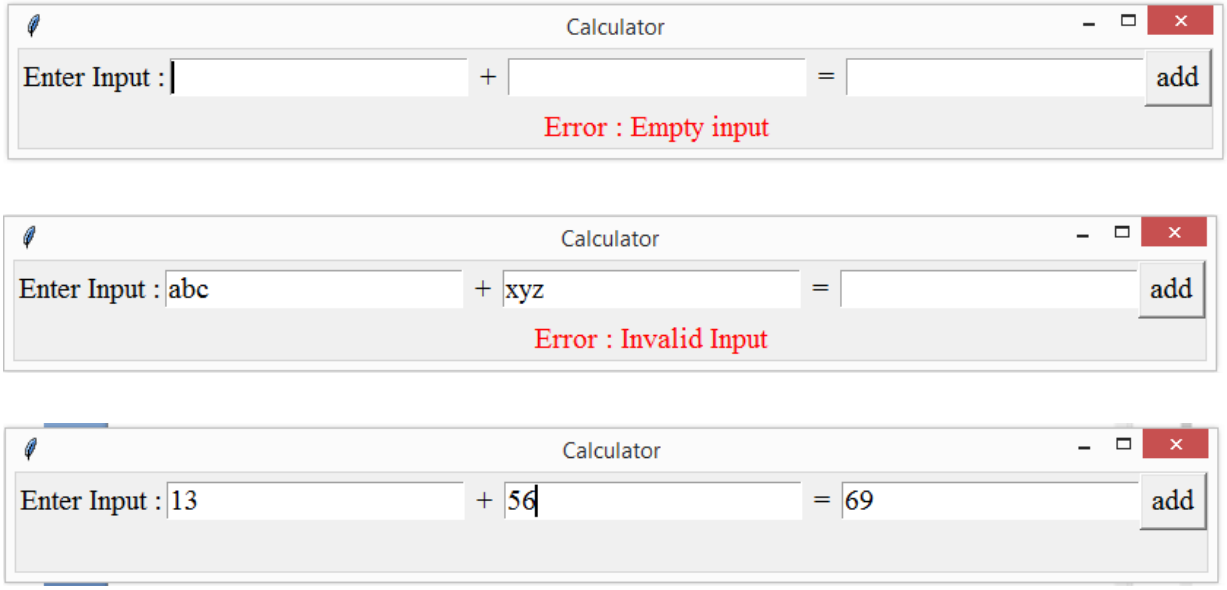


Code:

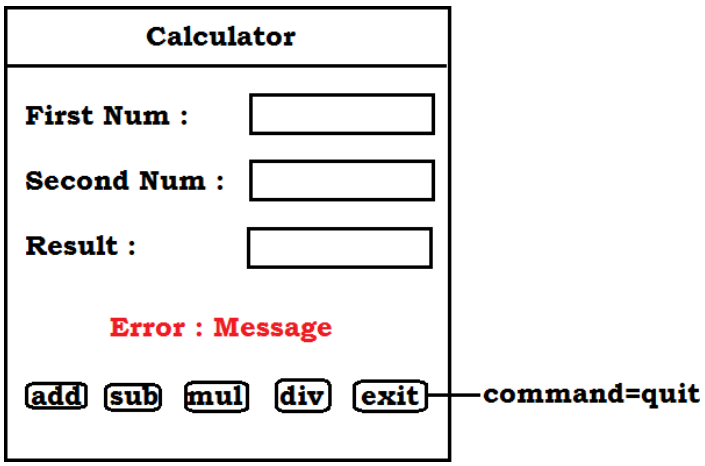
```
from tkinter import *

def add():
    s1 = e1.get()
    s2 = e2.get()

    if len(s1)==0 or len(s2)==0 :
```

```
        err.set("Error : Empty input")
    else:
        try :
            x = int(s1)
            y = int(s2)
            z = x+y
            err.set("")
            res.set(str(z))

        except ValueError :
            err.set("Error : Invalid Input")
    return

window = Tk()
window.title("Calculator")

err = StringVar()
res = StringVar()

l1 = Label(window, text="Enter Input :", font="Times 15")
l1.grid(row=0, column=0)

e1 = Entry(window, font="Times 15")
e1.grid(row=0, column=1)

l2 = Label(window, text=" + ", font="Times 15")
l2.grid(row=0, column=2)

e2 = Entry(window, font="Times 15")
e2.grid(row=0, column=3)

l3 = Label(window, text=" = ", font="Times 15")
l3.grid(row=0, column=4)

e3 = Entry(window, font="Times 15", textvariable=res)
e3.grid(row=0, column=5)

b1 = Button(window, text="add", font="Times 15", command=add)
b1.grid(row=0, column=6)

l4 = Label(window, textvariable=err, font="Times 15", fg="red")
l4.grid(row=1, column=3)
```

Output:



Write code for the following calculator program:



Regular expressions

Regular Expression:

- Regular expression is a set of characters or set of operators and special symbols.
- Regular expressions are used to process Strings.
- Regular expressions are used to filter required information.

"re" is a pre-defined module provides functions to perform regular expressions.
"re" is providing :

1. match()
2. search()
3. findall()
4. split()
5. compile()
6. sub()

match( ) :

- It is used to test whether the input string starts with given "pattern" or not.
- On success, it returns match object.
- On failure, it returns None

```
import re
line = "Java and Python gives Jython"
res = re.match(r'Java' , line)
print("Success : ",res)
res = re.match(r'Python' , line)
print("Failure : ",res)
```

search() :

- It is used to find specified pattern in the input string.
- On success, it returns match object.
- On failure, it returns None

```
import re
line = "Java and Python gives Jython"
res = re.search(r'hon' , line)
print("Success : ",res)
```

start() and end() : search object providing pre-defined functionality to get start index and end index of specified pattern.

```
import re
line = "Java and Python gives Jython"
found = re.search(r'Python' , line)
if found :
    print("Pattern found")
    print("Pattern starts @ :",found.start())
    print("Pattern ends @ :",found.end())
else :
    print("Pattern not found")
```

findall():

- It returns a list of duplicates patterns available in the given input string.
- It returns a list.
- On failure, it returns empty list.

```
import re
line = "Java and Python gives Jython"
l = re.findall(r'on' , line)
print("List :" , l)
print("Count :", len(l))
```

split() :

- It is used to split the string into tokens(words).
- It returns a list of tokens.
- We can process the list using its functionality.

```
import re
line = "Java and Python gives Jython"
tokens = re.split(r' ' , line)
print("Tokens :" , tokens)
print("Count :" , len(tokens))
print("Index of Python :" , tokens.index('Python'))
```

Display tokens using loop:

```
import re
line = "Java and Python gives Jython"
tokens = re.split(r' ' , line)
print("List of tokens :")
for element in tokens:
    print(element)
```

Note : We can use any "delimeter" to split the input string.

```
import re
line = "RAMAYANA"
a1 = re.split(r'A' , line)
print("List : " , a1)
a2 = re.split(r'A' , line , 2)
print("List : " , a2)
```

compile() :

- We can construct a pattern object with a specified pattern.
- Pattern object can be used to perform all the other operations easily.
- Instead of specifying the same pattern everywhere, we just call 're' functionality on pattern object.

```
import re
line = "Java and Python gives JavaPython"
found = re.match(r'Python' , line)

if found:
    print("String starts with specified pattern")
else:
    print("String not starts with Python")

found = re.search(r'Python' , line)
if found:
    print("Pattern found @ index : " , found.start())
else:
    print("Search failed")

duplicates = re.findall(r'Python' , line)
if duplicates :
    print("Duplicates present for Python")
```

Above program can be written using compile() object.

```
import re
line = "Java and Python gives JavaPython"
pattern = re.compile("Python")
found = pattern.match(line)
if found:
    print("String starts with specified pattern")
else:
    print("String not starts with Python")
```

```
found = pattern.search(line)
if found:
    print("Pattern found @ index : " , found.start())
else:
    print("Search failed")
duplicates = pattern.findall(line)
if duplicates :
    print("Duplicates present for Python")
```

Note : It is possible to construct a regular expression with operators and special symbols also.

Split the string into characters : (include and exclude spaces)

```
import re
line = "Python and R"
res = re.findall(r'.' , line)
print(res)
res = re.findall(r'\w' , line)
print(res)
```

Split the string into words : (include and exclude spaces)

```
import re
line = "Python and R"
res = re.findall(r'\w*' , line)
print(res)
res = re.findall(r'\w+' , line)
print(res)
```

Mail IDs extraction :

```
import re
data = "abc@gmail.com xyz@yahoo.in nit@online.in"
res = re.findall(r'@\w+' , data)
print(res)
res = re.findall(r'@(\w+)' , data)
print(res)
res = re.findall(r'@\w+.\w+' , data)
print(res)
res = re.findall(r'@\w+.(\w+)' , data)
print(res)
```

Date extraction :

```
import re
data = "ab12-04-1987 23-ab09-2003 31-03-2005ab"
res = re.findall(r'\d{2}-\d{2}-\d{4}' , data)
print(res)
```

Datetime and Calendar Modules

Display the current date and time:

```
import datetime
now = datetime.datetime.now()
print("Current date and time:")
print(now)
```

Display the current date:

```
import datetime
date = datetime.date.today()
print("Today's date:")
print(date)
```

Display the current time:

```
import datetime
time = datetime.datetime.now().time()
print("Current time:")
print(time)
```

Create a date object from a string:

```
import datetime
date_str = "2022-05-01"
date_obj = datetime.datetime.strptime(date_str, "%Y-%m-%d").date()
print("Date object:")
print(date_obj)
```

Calculate the difference between two dates:

```
import datetime
date1 = datetime.date(2022, 5, 1)
date2 = datetime.date(2023, 5, 1)
delta = date2 - date1
print("Days between the two dates:")
print(delta.days)
```

Convert a date to a string:

```
import datetime
date = datetime.date.today()
date_str = date.strftime("%Y-%m-%d")
print("Date as string:")
print(date_str)
```

Convert a time object to a string:

```
import datetime
time = datetime.datetime.now().time()
time_str = time.strftime("%H:%M:%S")
print("Time as string:")
print(time_str)
```

Display a calendar for a specific year and month:

```
import calendar
year = 2023
month = 5
cal = calendar.month(year, month)
print(cal)
```

Display the calendar for an entire year:

```
import calendar
year = 2023
cal = calendar.calendar(year)
print(cal)
```

Determine if a year is a leap year:

```
import calendar
year = 2024
is_leap = calendar.isleap(year)
if is_leap:
    print(f"{year} is a leap year.")
else:
    print(f"{year} is not a leap year.")
```

Determine the first weekday of a specific year:

```
import calendar
year = 2023
weekday = calendar.firstweekday()
print(f"The first weekday of {year} is {weekday}.")
```

OS Module

OS Module:

- The os module in Python provides a way of interacting with the underlying operating system.
- It allows you to perform various operations such as navigating the file system, creating and deleting directories, changing permissions, and much more.

Get the current working directory:

```
import os
cwd = os.getcwd()
print(f"Current working directory: {cwd}")
```

List the files in a directory:

```
import os
dir_path = "/path/to/directory"
files = os.listdir(dir_path)
print(f"Files in {dir_path}:")
for file in files:
    print(file)
```

Create a new directory:

```
import os
dir_path = "/path/to/new/directory"
os.mkdir(dir_path)
print(f"Created directory: {dir_path}")
```

Rename a file:

```
import os
old_file_path = "/path/to/old/file"
new_file_path = "/path/to/new/file"
os.rename(old_file_path, new_file_path)
print(f"Renamed file from {old_file_path} to {new_file_path}")
```

Delete a file:

```
import os
file_path = "/path/to/file"
os.remove(file_path)
print(f"Deleted file: {file_path}")
```

Change the current working directory:

```
import os
os.chdir("/new/working/directory")
print(f"Changed working directory to: {os.getcwd()}")
```

Check if a file exists:

```
import os
file_path = "/path/to/file"
if os.path.exists(file_path):
    print(f"{file_path} exists.")
else:
    print(f"{file_path} does not exist.")
```

Check if a path is a directory:

```
import os
dir_path = "/path/to/directory"
if os.path.isdir(dir_path):
    print(f"{dir_path} is a directory.")
else:
    print(f"{dir_path} is not a directory.")
```

Nested Functions, Decorators and Closures

Nested Function: A nested function is a function defined inside another function. The nested function has access to the variables in the outer function's scope.

```
def outer():
    print("Outer")

    def inner():
        print("Inner")
        return

    inner()
    return

outer()
```

Accessing non local variables of outer function from inner function:

```
def outer(x):
    print("Outer")

    def inner():
        print("Inner")
        print("x val : " , x)
        return

    inner()
     return

 outer(10)
```

Closure:

- A closure is a function object that remembers values in the enclosing scope even if they are not present in memory.
- It is a record that stores a function together with an environment
- A closure is created by returning a function object that accesses a variable in its enclosing scope.

```
def outer(msg):

    def inner():
        print(msg)
```

```
        return

    return inner

print_msg = outer("Hello")
print_msg()
```

Decorator:

- A decorator is a special kind of function that takes another function and extends or modifies its behavior without changing its source code.
- A decorator is defined using the @decorator_name syntax and is applied to a function by placing it above the function definition.
- Decorators can be used to add logging, timing, validation, and other functionality to a function without modifying the function's code directly.

```
def my_decorator(func):
    def wrapper():
        print("Before the function is called.")
        func()
        print("After the function is called.")
    return wrapper

@my_decorator
def say_hello():
    print("Hello!")

say_hello()
```

Python Numpy Tutorial

Introduction to Numpy:

- Python is a great general-purpose programming language.
- With the help of a few popular libraries (numpy, scipy, matplotlib) it becomes a powerful environment for scientific computing.
- NumPy is a module for Python.
- The name is an acronym for "Numeric Python" or "Numerical Python".
- It is an extension module for Python, mostly written in C.
- This makes sure that the precompiled mathematical and numerical functions and functionalities of Numpy guarantee great execution speed.
- NumPy enriches the programming language Python with powerful data structures, implementing multi-dimensional arrays and matrices.
- The implementation is even aiming at huge matrices and arrays, better know under the heading of "big data".

Installing other modules using pip:

cmd/> pip install <module-name>

 # Create one dimensional array from a list

```
import numpy as np

list1 = [0,1,2,3,4]
arr1d = np.array(list1)

print(type(arr1d))
print(arr1d)
```

Numpy – Ndarray Object

- ndarray() constructor is used to create an empty array
- ndarray() is belongs to NUMPY module.
- We need to specify the shape of array and type of array in the construction.

We can specify the type in the construction of Array:

```
importnumpy as np
arr = np.ndarray(shape=(5),dtype=int)
print("Size :",arr.size)
print("Datatype :",arr.dtype)
```

Display elements using for-loop :

```
import numpy as np

my_list = [0,1,2,3,4]
my_arr = np.array(my_list)

print("Elements : ")
for ele in my_arr :
        print(ele)
```

Create one dimensional array from a list

```
import numpy as np
my_list = [0,1,2,3,4]
my_array = np.array(my_list)
        print(my_array)
```

 # Create two dimensional array from a nested list

```
import numpy as np
my_list = [[1,2,3],[4,5,6],[7,8,9]]
my_array = np.array(my_list)
print(my_array)
```

NumPy – Data Types

- In the definition of variable, it is recommended to specify its data type.
- Python object type need not be specified.
- If we don't specify the type of elements which are storing in NUMPY object, it will consider a default type.

Code:

```
importnumpy as np
arr = np.ndarray(shape=(5))
print("Size :",arr.size)
print("Datatype :",arr.dtype)
```

You may also specify the data type by setting the dtype argument. Some of the most commonly used numpy dtypes are: 'float', 'int', 'bool', 'str' and 'object'.

```
import numpy as np
my_list = [[1,2,3],[4,5,6],[7,8,9]]
my_array = np.array(my_list, dtype=float)
print(my_array)
```

The decimal point after each number is indicative of the float datatype. You can also convert it to a different datatype using the astype method.

```
import numpy as np
my_list = [[1,2,3],[4,5,6],[7,8,9]]
float_array = np.array(my_list, dtype=float)
print(float_array)
int_array = float_array.astype(int)
print(int_array)
```

 # Convert to int then to str datatype

```
import numpy as np
my_list = [[1,2,3],[4,5,6],[7,8,9]]
float_array = np.array(my_list, dtype=float)
str_array = float_array.astype(int).astype(str)
print(str_array)
```

We can check the size, dimension and type of elements using pre-defined variables of array object.

```
import numpy as np
my_list = [[1,2,3],[4,5,6],[7,8,9]]
my_array = np.array(my_list)
print(my_array)
print('Shape : ', my_array.shape)
print('Datatype : ', my_array.dtype)
print('Size : ', my_array.size)
print('Num Dimensions : ', my_array.ndim)
```

We can extract a set of elements from the array as follows :

```
import numpy as np
my_list = [[1,2,3],[4,5,6],[7,8,9]]

my_array = np.array(my_list)
print(my_array)

print("2x2 Array ")
res = my_array[:2,:2]
print(res)

print("2x3 Array ")
res = my_array[:2,:3]
print(res)
```

```
print("3x2 Array ")
res = my_array[:3,:2]
print(res)
```

Display the elements of 2 Dimensional array:

```
import numpy as np

my_list = [[1,2,3],[4,5,6],[7,8,9]]
my_array = np.array(my_list)

print("Elements : ")
for i in range(3):
    for j in range(3):
        print(my_array[i,j], end=' ')
    print()
```

Matrix addition program:

```
import numpy as np

# Define two matrices
a = np.array([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
b = np.array([[9, 8, 7], [6, 5, 4], [3, 2, 1]])

# Add the matrices
c = a + b

# Print the result
print(c)
```

Python - Pandas

Introduction

- Pandas is a package/Module.
- Pandas is an open source
- Pandas is a collection (data structure).
- Pandas widely used in data analysis tools.
- Panda's library uses most of the functionalities of Numpy library.

Pandas deals with 3 types of structures.

- Series: 1Dimensional data structure
- Data Frame: 2 Dimensional
- Panel: 3 Dimensional

Creating Series object: By default the datatype of series object is float like numpy array.

```
import pandas
s = pandas.Series()
print(s)
```

- In pandas, collection elements automatically get its index.
- If we store any object type(string), the dtype converts into object from default type(float).
- Every element in series is associated with default index value starts from 0.

```
import pandas as pd
import numpy as np
arr = np.array(['a', 'b', 'c', 'd', 'e'])
s = pd.Series(arr)
print(s)
```

Output:

```
0  a
1  b
2  c
3  d
4  e
dtype: object
```

dtypes:

- If we store integers, the dtype become int
- If we store integers and floats, the dtype become float
- If we store integers, floats, Strings…, the dtype become 'Object'

```
import pandas as pd
import numpy as np
arr = np.array([10, 20, 30, 40, 50])
s = pd.Series(arr)
print(s)
```

Output:

```
0    10
1    20
2    30
3    40
4    50
dtype: int32
```

```
import pandas as pd
import numpy as np
arr = np.array([10, 23.45, 30, "python"])
s = pd.Series(arr)
print(s)
```

Output:

```
0        10
1     23.45
2        30
3    python
dtype: object
```

- Series elements automatically assigned with index values starts with 0.
- We can specify the index explicitly.
- By using the argument 'index' of Series constructor, we can set index values.

```
import pandas as pd
import numpy as np
arr = np.array(['a', 'b', 'c', 'd', 'e'])
s = pd.Series(arr, index=[1,2,3,4,5])
print(s)
```

Output:

```
1    a
2    b
3    c
4    d
5    e
dtype: object
```

Keys can be heterogeneous. When we specify the key set explicitly, we can provide different types of keys for different elements.

```
import pandas as pd
import numpy as np
arr = np.array(['a', 'b', 'c', 'd', 'e'])
s = pd.Series(arr, index=[10,23.45,'g',"key",20])
print(s)
```

Output:

```
10      a
23.45   b
g       c
key     d
20      e
dtype: object
```

Keys can be duplicated. We can see the accessibility of elements using duplicate keys later.

```
import pandas as pd
import numpy as np
arr = np.array(['a', 'b', 'c', 'd', 'e'])
s = pd.Series(arr, index=[10, 20, 10, 20, 10])
print(s)
```

Output:

```
10   a
20   b
10   c
20   d
10   e
dtype: object
```

- We can create series object from dictionary.
- Dictionary is a collection of keys and values.
- Dictionary keys become index in Pandas object.
- Values become elements in pandas object.

```
import pandas as pd
dictionary = {10:'A', 20:'B', 30:'C', 40:'D'}
s = pd.Series(dictionary)
print(s)
```

Output:

```
10   A
20   B
30   C
40   D
dtype: object
```

Storing Scalar values into Series object:

```
import pandas as pd
s = pd.Series(5, index=[1,2,3,4,5])
print(s)
```

Output:

```
1   5
2   5
3   5
4   5
5   5
dtype: int64
```

We can process elements using loops:

- When we iterate elements using for loop, it returns only elements instead of index values.
- Internally it process elements using their index only.

```
import pandas as pd
import numpy as np
List = [10,20,30,40,50]
arr = np.array(List)
series = pd.Series(arr)

print("Series object elements :")
for ele in series:
    print(ele)
```

Output:

```
Series object elements :
10
20
30
40
50
```

Access elements using indexing:

```
import pandas as pd
import numpy as np
arr = np.array([10,20,30,40,50])
series = pd.Series(arr)

print("Series elements through indexing :")
print(series[2])
print(series[4])
```

Output:

Series elements through indexing :
30
50

- We can process elements through slicing.
- When we don't specify the bounds, all elements will be processed.
- We can use negative indexing also to access the elements.

```
import pandas as pd
import numpy as np
arr = np.array([10,20,30,40,50])
series = pd.Series(arr)

print("Series elements through slicing :")
print(series[:])
print()

print(series[1:4])
print()
```

- We can access elements with any type of index value.
- If the index is string type, we must specify the index value in quotes.

```
import pandas as pd
import numpy as np
arr = np.array([10,20,30,40,50])
series = pd.Series(arr, index=['a', 'b', 'c', 'd', 'e'])
print(series['a'])
print(series['d'])
```

Output: 10 40

When we access elements with duplicate keys, it display all elements associated with duplicate keys.

```
import pandas as pd
import numpy as np
arr = np.array(['a', 'b', 'c', 'd', 'e'])
series = pd.Series(arr, index=[10,20,10,20,10])
print(series[10])
print(series[20])
```

Output:

```
10    a
10    c
10    e
dtype: object
20    b
20    d
dtype: object
```

Python – Data Frames:

- A data frame is a two dimensional data structure.
- In a frame, data is aligned in 2 dimensional format(rows & columns)
- DataFrame class is pre-defined in pandas module.
- By calling the constructor, we can create DataFrame object.

```
import pandas as pd
frame = pd.DataFrame()
print(frame)
```

Output:

```
Empty DataFrame
Columns: []
Index: []
```

- Indexing is applicable by default to rows.
- We generally assign column name for 2 dimensional data.
- The following table makes you understand that labels required only for columns.

	Columns			
	Emp-ID	Name	Salary	Dept. no
Rows	1			
	2			
	3			

By default, indexing is applicable for both rows and columns:

- We create simple frame from 2 dimensional data.
- We use nested list to create the frame.

```
import pandas as pd
data = [[10,"abc"],[20,"xyz"],[30,"lmn"]]
frame = pd.DataFrame(data)
print(frame)
```

Output:

```
   0    1
0  10  abc
1  20  xyz
2  30  lmn
```

When we specify one dimensional list to create the frame, each element consider as one row.

```
import pandas as pd
data = [10,20,30,40,50]
frame = pd.DataFrame(data)
print(frame)
```

Output:

```
    0
0  10
1  20
2  30
3  40
4  50
```

- **We can set identities only to columns not to the rows.**
- Row values represent index values.
- DataFrame constructor is providing only 'columns' argument by which we can specify the names.

```
import pandas as pd
data = [[21,'amar'],[19,'annie'],[22,'hareen']]
frame = pd.DataFrame(data, columns=['Age', 'Name'])
print(frame)
```

Output:

```
   Age    Name
0   21    amar
1   19   annie
2   22  hareen
```

We can specify the datatype in the construction of Frame object.

```
import pandas as pd
data = [[21,'amar'],[19,'annie'],[22,'hareen']]
frame = pd.DataFrame(data, columns=['Age', 'Name'], dtype=float)
print(frame)
```

Output:

```
   Age    Name
0  21.0    amar
1  19.0   annie
2  22.0  hareen
```

- We can construct the DataFrame from dictionary object.
- Column name we specify as key and Column values we must specify as List.
- By using comma separator, we can give number of columns in a single set/dictionary.

```
import pandas as pd
data = {'Name':['Syam', 'Ricky', 'Raksha', 'Kiritin'], 'Age':[21, 19, 23, 21]}
frame = pd.DataFrame(data)
print(frame)
```

Output:

```
   Age     Name
0   21     Syam
1   19    Ricky
2   23   Raksha
3   21  Kiritin
```

Python - MatPlotLib

Matplotlib:

- Open source module(package)
- Need to install using PIP.
- Matplotlib providing functionality for data visualization

Note: Compare to theoretical representation, we are easily understand visual representation. If the things are more visualized then we can understand easily.

Visualization:

- Graphics provides an excellent approach for representing the data.
- The final results of anything are recommended to represent as a graph.
- With little knowledge of python pre-defined module called matplotlib, we can easily plot graphs.

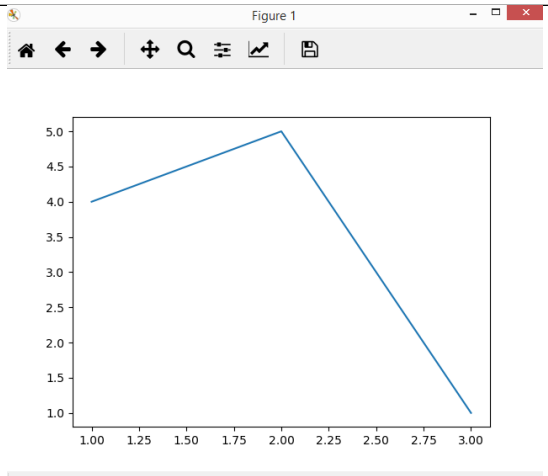
Pyplot:

- A module belongs to matplotlib package.
- Need to import from matplotlib
- Using plot() method of pyplot module, we can plot graphs

Plot():

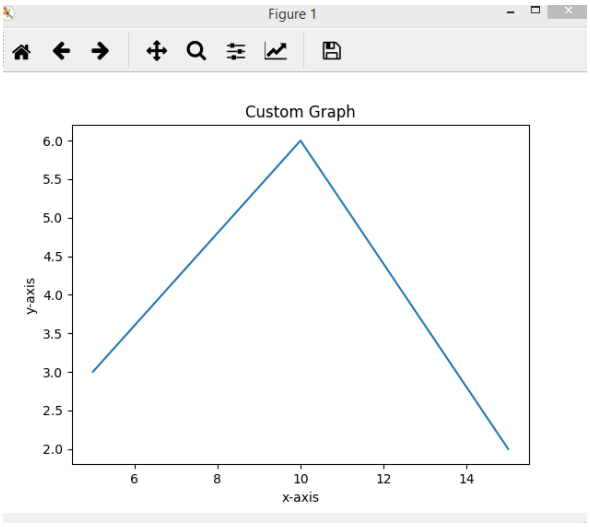
- A method belongs to pyplot
- Plot() takes x-axis and y-axis values to plot.
- Show() method must be called to display the graph

```
from matplotlib import pyplot
x = [1, 2, 3]
y = [4, 5, 1]
pyplot.plot(x,y)
pyplot.show()
```



- It is possible to set title to the Graph.
- We also give labels to x-axis and y-axis

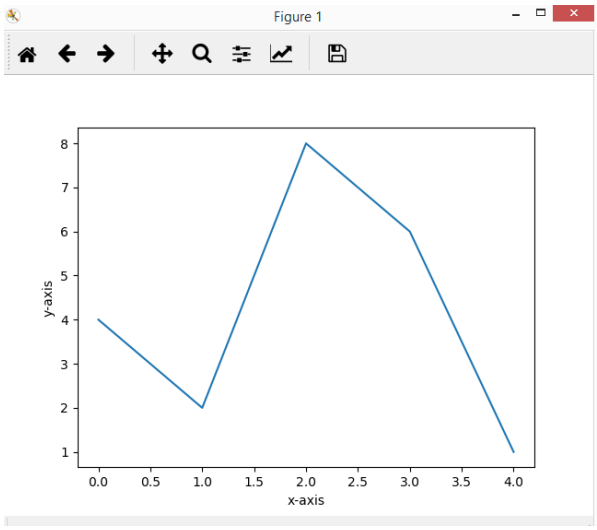
```
from matplotlib import pyplot as plt
x = [5, 10, 15]
y = [3, 6, 2]
plt.plot(x,y)
plt.title("Custom Graph")
plt.ylabel("y-axis")
plt.xlabel("x-axis")
plt.show()
```



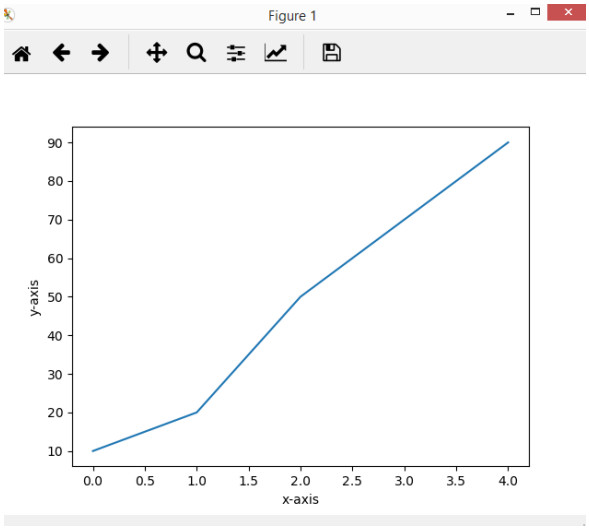
Notes:

- If we give only one set of values to generate the graph, it plots the x-axis range automatically.
- What we provided will assume as sequence of y-axis values.
- X axis range starts with 0

```
from matplotlib import pyplot as plt
data = [4, 2, 8, 6, 1]  # assume as y-axis
plt.plot(data)
plt.ylabel("y-axis")
plt.xlabel("x-axis")
plt.show()
```




```
from matplotlib import pyplot as plt
data = [10, 20, 50, 70, 90]
plt.plot(data)
plt.ylabel("y-axis")
plt.xlabel("x-axis")
plt.show()
```



Format the plot:

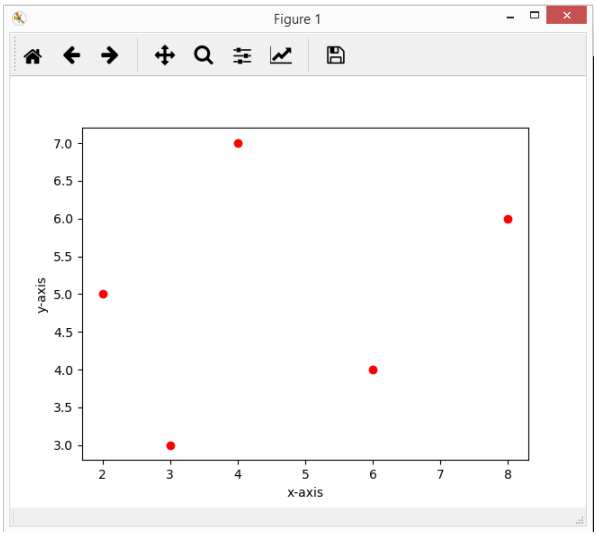
- With the optional third argument, we can represent the format string.
- Format string is the combination and color and line type of plot.
- Default format string is 'b-'
- 'b-' represents solid blue color line.

B : Blue marker

'ro' : Red circle
'-g' : Green solid line
'_' : dashed with default color

Colors:
G – green
R – red
C – cyan
M – magenta
Y – yellow
K – black
W – white

```
from matplotlib import pyplot as plt
x = [3,6,2,8,4]
y = [3,4,5,6,7]
plt.plot(x, y, 'ro')
plt.ylabel("y-axis")
plt.xlabel("x-axis")
plt.show()
```



Garbage Collection

Garbage Collection:

- Python is fully Object Oriented Programming Language.
- In OOP application, data stores in the form of Objects.
- We access the objects information using references.
- Garbage collection is the mechanism of deleting unreferenced objects.
- An object is said to be eligible for Garbage Collection when no pointer is pointing to that object.
- In python garbage collection mechanism is much faster compare to other languages.

In the following program, object get different memory locations

```
class Test:
    def _init_(self):
        print("Constructed :",id(self))
        return

class GCDemo:
    def main():
        x = Test()
        y = Test()
        z = Test()
        return

GCDemo.main()
```

As soon the object is unused, GC will destroy that object. The same memory is allocated to newly created object.

```
class Test:
    def _init_(self):
        print("Constructed :",id(self))
        return

class GCDemo:
    def main():
        Test()
        Test()
        Test()
        return

GCDemo.main()
```

- Defining a variable inside the function is called Local variable.
- Local variable memory is not permanent
- Local variable will be deleted as soon as function execution completed.
- If the local variable is pointing to any object, then the object become unreferenced once local variable memory will be released.
- The object pointing by local variables will be deleted as soon as function execution completes.

```
class Test:
    def fun():
        x = []
        x.append(10)
        print("Address of x :", id(x))
        return

class GCDemo:
    def main():
        Test.fun()
        Test.fun()
        Test.fun()
        return

GCDemo.main()
```

- If the object is pointing to itself is called 'self referenced object'.
- "self" is pointing objects will not garbage collected as soon as they are unreferenced.

```
class Test:
    def fun():
        x = []
        x.append(x)
        print("Address of x :", id(x))
        return

class GCDemo:
    def main():
        Test.fun()
        Test.fun()
        Test.fun()
        return

GCDemo.main()
```

Manual Garbage collection:

- In the above application, self referenced objects will not be garbage collected as soon as they are unreferenced.
- To destroy such type of object manual garbage collection is required.
- We can reuse the memory quickly by deleting the unused objects.
- 'gc' is a pre-defined module providing functionality to implement manual garbage collection.
- collect() method of gc module is used to destroy objects

```
import time
class Test:
    def fun():
        x = []
        x.append(x)
        print("Address of x :", id(x))
        return
class GCDemo:
    def main():
        for i in range(20):
            Test.fun()
            time.sleep(1)
        return
GCDemo.main()
```

- In the above application, all objects get different memory.
- These unused objects will be deleted with manual garbage collection as follows

```
import time
import gc
class Test:
    def fun():
        x = []
        x.append(x)
        print("Address of x :", id(x))
        return
class GCDemo:
    def main():
        for i in range(20):
            Test.fun()
            gc.collect()
            time.sleep(1)
        return

GCDemo.main()
```