INDEX

DETAILED INDEX

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OOP's Part - 1

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What is Class:

- In Python every thing is an object. To create objects we required some Model or Plan or Blue print, which is nothing but class.
- We can write a class to represent properties (attributes) and actions (behaviour) of object.

- Properties can be represented by variables
- Actions can be represented by Methods.

- Hence class contains both variables and methods.

How to define a Class?

We can define a class by using class keyword.

Syntax:

```
class className:
  ''' documenttation string '''
   variables:instance variables,static and local variables
   methods: instance methods,static methods,class methods
```

Documentation string represents description of the class. Within the class doc string is always optional. We can get doc string by using the following 2 ways.

1) print(classname.__doc__)
2) help(classname)

Example:

```
1) class Student:
2)     """ This is student class with required data'''
3) print(Student.__doc__)
4) help(Student)
```

Within the Python class we can represent data by using variables.

There are 3 types of variables are allowed.

1) Instance Variables (Object Level Variables)
2) Static Variables (Class Level Variables)
3) Local variables (Method Level Variables)

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Within the Python class, we can represent operations by using methods. The following are various types of allowed methods

1) Instance Methods
2) Class Methods
3) Static Methods

Example for Class:

```
1)  class Student:
2)      '''Developed by durga for python demo'''
3)      def __init__(self):
4)          self.name='durga'
5)          self.age=40
6)          self.marks=80
7)
8)      def talk(self):
9)          print("Hello I am :",self.name)
10)         print("My Age is:",self.age)
11)         print("My Marks are:",self.marks)
```

What is Object:

Pysical existence of a class is nothing but object. We can create any number of objects for a class.

Syntax to Create Object: referencevariable = classname()

Example: s = Student()

What is Reference Variable?

The variable which can be used to refer object is called reference variable.
By using reference variable, we can access properties and methods of object.

Program: Write a Python program to create a Student class and Creates an object to it. Call the method talk() to display student details

```
1)  class Student:
2)
3)      def __init__(self,name,rollno,marks):
4)          self.name=name
5)          self.rollno=rollno
6)          self.marks=marks
7)
```


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```
8)     def talk(self):
9)         print("Hello My Name is:",self.name)
10)        print("My Rollno is:",self.rollno)
11)        print("My Marks are:",self.marks)
12)
13) s1=Student("Durga",101,80)
14) s1.talk()
```

Output:

```
D:\durgaclasses>py test.py
Hello My Name is: Durga
My Rollno is: 101
My Marks are: 80
```

Self Variable:

- self is the default variable which is always pointing to current object (like this keyword in Java)
- By using self we can access instance variables and instance methods of object.

Note:

1) self should be first parameter inside constructor
   def __init__(self):
2) self should be first parameter inside instance methods
   def talk(self):

Constructor Concept:

- Constructor is a special method in python.
- The name of the constructor should be __init__(self)
- Constructor will be executed automatically at the time of object creation.
- The main purpose of constructor is to declare and initialize instance variables.
- Per object constructor will be exeucted only once.
- Constructor can take atleast one argument(atleast self)
- Constructor is optional and if we are not providing any constructor then python will provide default constructor.

Example:

```
1)  def __init__(self,name,rollno,marks):
2)      self.name=name
3)      self.rollno=rollno
4)      self.marks=marks
```


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Program to demonistrate Constructor will execute only once per Object:

```
1)  class Test:
2)
3)      def __init__(self):
4)          print("Constructor exeuction...")
5)
6)      def m1(self):
7)          print("Method execution...")
8)
9)  t1=Test()
10) t2=Test()
11) t3=Test()
12) t1.m1()
```

Output

```
Constructor exeuction...
Constructor exeuction...
Constructor exeuction...
Method execution...
```

Program:

```
1)  class Student:
2)
3)      ''' This is student class with required data'''
4)      def __init__(self,x,y,z):
5)          self.name=x
6)          self.rollno=y
7)          self.marks=z
8)
9)      def display(self):
10)         print("Student Name:{}\nRollno:{} \nMarks:{}".format(self.name,self.rollno,self
    .marks))
11)
12) s1=Student("Durga",101,80)
13) s1.display()
14) s2=Student("Sunny",102,100)
15) s2.display()
```

Output

```
Student Name:Durga
Rollno:101
Marks:80
```


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Student Name:Sunny
Rollno:102
Marks:100

Differences between Methods and Constructors

Method	Constructor
1) Name of method can be any name	1) Constructor name should be always __init__
2) Method will be executed if we call that method	2) Constructor will be executed automatically at the time of object creation.
3) Per object, method can be called any number of times.	3) Per object, Constructor will be executed only once
4) Inside method we can write business logic	4) Inside Constructor we have to declare and initialize instance variables

Types of Variables:

Inside Python class 3 types of variables are allowed.

1) Instance Variables (Object Level Variables)
2) Static Variables (Class Level Variables)
3) Local variables (Method Level Variables)

1) Instance Variables:

- If the value of a variable is varied from object to object, then such type of variables are called instance variables.
- For every object a separate copy of instance variables will be created.

Where we can declare Instance Variables:

1) Inside Constructor by using self variable
2) Inside Instance Method by using self variable
3) Outside of the class by using object reference variable

1) Inside Constructor by using Self Variable:

We can declare instance variables inside a constructor by using self keyword. Once we creates object, automatically these variables will be added to the object.

```
1)  class Employee:
2)
3)    def __init__(self):
4)       self.eno=100
5)       self.ename='Durga'
```


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```
6)      self.esal=10000
7)
8)  e=Employee()
9)  print(e.__dict__)
```

Output: {'eno': 100, 'ename': 'Durga', 'esal': 10000}

2) Inside Instance Method by using Self Variable:

We can also declare instance variables inside instance method by using self variable. If any instance variable declared inside instance method, that instance variable will be added once we call taht method.

```
1)  class Test:
2)
3)      def __init__(self):
4)          self.a=10
5)          self.b=20
6)
7)      def m1(self):
8)          self.c=30
9)
10) t=Test()
11) t.m1()
12) print(t.__dict__)
```

Output: {'a': 10, 'b': 20, 'c': 30}

3) Outside of the Class by using Object Reference Variable:

We can also add instance variables outside of a class to a particular object.

```
1)  class Test:
2)
3)      def __init__(self):
4)          self.a=10
5)          self.b=20
6)      def m1(self):
7)          self.c=30
8)
9)  t=Test()
10) t.m1()
11) t.d=40
12) print(t.__dict__)
```

Output {'a': 10, 'b': 20, 'c': 30, 'd': 40}

How to Access Instance Variables:

We can access instance variables with in the class by using self variable and outside of the class by using object reference.

```
1)  class Test:
2)
3)      def __init__(self):
4)          self.a=10
5)          self.b=20
6)      def display(self):
7)      print(self.a)
8)      print(self.b)
9)
10) t=Test()
11) t.display()
12) print(t.a,t.b)
```

Output

```
10
20
10 20
```

How to delete Instance Variable from the Object:

1) **Within a class we can delete instance variable as follows**

   `del self.variableName`

2) **From outside of class we can delete instance variables as follows**

   `del objectreference.variableName`

```
1)  class Test:
2)      def __init__(self):
3)          self.a=10
4)          self.b=20
5)          self.c=30
6)          self.d=40
7)      def m1(self):
8)          del self.d
9)
10) t=Test()
11) print(t.__dict__)
12) t.m1()
13) print(t.__dict__)
14) del t.c
15) print(t.__dict__)
```


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Output

```
{'a': 10, 'b': 20, 'c': 30, 'd': 40}
{'a': 10, 'b': 20, 'c': 30}
{'a': 10, 'b': 20}
```

Note: The instance variables which are deleted from one object,will not be deleted from other objects.

```
1)  class Test:
2)      def __init__(self):
3)          self.a=10
4)          self.b=20
5)          self.c=30
6)          self.d=40
7)
8)  t1=Test()
9)  t2=Test()
10) del t1.a
11) print(t1.__dict__)
12) print(t2.__dict__)
```

Output

```
{'b': 20, 'c': 30, 'd': 40}
{'a': 10, 'b': 20, 'c': 30, 'd': 40}
```

If we change the values of instance variables of one object then those changes won't be reflected to the remaining objects, because for every object we are separate copy of instance variables are available.

```
1)  class Test:
2)      def __init__(self):
3)          self.a=10
4)          self.b=20
5)
6)  t1=Test()
7)  t1.a=888
8)  t1.b=999
9)  t2=Test()
10) print('t1:',t1.a,t1.b)
11) print('t2:',t2.a,t2.b)
```

Output

```
t1: 888 999
t2: 10 20
```


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2) Static Variables:

- If the value of a variable is not varied from object to object, such type of variables we have to declare with in the class directly but outside of methods. Such types of variables are called Static variables.
- For total class only one copy of static variable will be created and shared by all objects of that class.
- We can access static variables either by class name or by object reference. But recommended to use class name.

Instance Variable vs Static Variable:

Note: In the case of instance variables for every object a seperate copy will be created,but in the case of static variables for total class only one copy will be created and shared by every object of that class.

```
1)  class Test:
2)      x=10
3)      def __init__(self):
4)          self.y=20
5)
6)  t1=Test()
7)  t2=Test()
8)  print('t1:',t1.x,t1.y)
9)  print('t2:',t2.x,t2.y)
10) Test.x=888
11) t1.y=999
12) print('t1:',t1.x,t1.y)
13) print('t2:',t2.x,t2.y)
```

Output

```
t1: 10 20
t2: 10 20
t1: 888 999
t2: 888 20
```

Various Places to declare Static Variables:

1) In general we can declare within the class directly but from out side of any method
2) Inside constructor by using class name
3) Inside instance method by using class name
4) Inside classmethod by using either class name or cls variable
5) Inside static method by using class name

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```
1)  class Test:
2)      a=10
3)      def __init__(self):
4)          Test.b=20
5)      def m1(self):
6)          Test.c=30
7)      @classmethod
8)      def m2(cls):
9)          cls.d1=40
10)         Test.d2=400
11)     @staticmethod
12)     def m3():
13)         Test.e=50
14) print(Test.__dict__)
15) t=Test()
16) print(Test.__dict__)
17) t.m1()
18) print(Test.__dict__)
19) Test.m2()
20) print(Test.__dict__)
21) Test.m3()
22) print(Test.__dict__)
23) Test.f=60
24) print(Test.__dict__)
```

How to access Static Variables:

1) inside constructor: by using either self or classname
2) inside instance method: by using either self or classname
3) inside class method: by using either cls variable or classname
4) inside static method: by using classname
5) From outside of class: by using either object reference or classname

```
1)  class Test:
2)      a=10
3)      def __init__(self):
4)          print(self.a)
5)          print(Test.a)
6)      def m1(self):
7)          print(self.a)
8)          print(Test.a)
9)      @classmethod
10)     def m2(cls):
11)         print(cls.a)
12)         print(Test.a)
```


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```
13)    @staticmethod
14)    def m3():
15)        print(Test.a)
16) t=Test()
17) print(Test.a)
18) print(t.a)
19) t.m1()
20) t.m2()
21) t.m3()
```

Where we can modify the Value of Static Variable:

Anywhere either with in the class or outside of class we can modify by using classname. But inside class method, by using cls variable.

```
1)  class Test:
2)      a=777
3)      @classmethod
4)      def m1(cls):
5)          cls.a=888
6)      @staticmethod
7)      def m2():
8)          Test.a=999
9)  print(Test.a)
10) Test.m1()
11) print(Test.a)
12) Test.m2()
13) print(Test.a)
```

Output

777
888
999

*****

If we change the Value of Static Variable by using either self OR Object Reference Variable:

If we change the value of static variable by using either self or object reference variable, then the value of static variable won't be changed, just a new instance variable with that name will be added to that particular object.

```
1)  class Test:
2)      a=10
3)      def  m1(self):
4)          self.a=888
```


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```
5)  t1=Test()
6)  t1.m1()
7)  print(Test.a)
8)  print(t1.a)
```

Output

```
10
888
```

```
1)   class Test:
2)      x=10
3)      def __init__(self):
4)         self.y=20
5)
6)  t1=Test()
7)  t2=Test()
8)  print('t1:',t1.x,t1.y)
9)  print('t2:',t2.x,t2.y)
10) t1.x=888
11) t1.y=999
12) print('t1:',t1.x,t1.y)
13) print('t2:',t2.x,t2.y)
```

Output

```
t1: 10 20
t2: 10 20
t1: 888 999
t2: 10 20
```

```
1)  class Test:
2)     a=10
3)     def __init__(self):
4)        self.b=20
5)  t1=Test()
6)  t2=Test()
7)  Test.a=888
8)  t1.b=999
9)  print(t1.a,t1.b)
10) print(t2.a,t2.b)
```

Output

```
888 999
888 20
```

```
1)  class Test:
2)      a=10
3)      def __init__(self):
4)          self.b=20
5)      def m1(self):
6)          self.a=888
7)          self.b=999
8)
9)  t1=Test()
10) t2=Test()
11) t1.m1()
12) print(t1.a,t1.b)
13)         print(t2.a,t2.b)
```

Output

```
888 999
10 20
```

```
1)  class Test:
2)      a=10
3)      def __init__(self):
4)          self.b=20
5)      @classmethod
6)      def m1(cls):
7)          cls.a=888
8)          cls.b=999
9)
10) t1=Test()
11) t2=Test()
12) t1.m1()
13) print(t1.a,t1.b)
14) print(t2.a,t2.b)
15) print(Test.a,Test.b)
```

Output

```
888 20
888 20
888 999
```

How to Delete Static Variables of a Class:

1) We can delete static variables from anywhere by using the following syntax
   del classname.variablename

2) But inside classmethod we can also use cls variable
   del cls.variablename

```
1)  class Test:
2)      a=10
3)      @classmethod
4)      def m1(cls):
5)          del cls.a
6)  Test.m1()
7)  print(Test.__dict__)
```

Example:

```
1)  class Test:
2)      a=10
3)      def __init__(self):
4)          Test.b=20
5)          del Test.a
6)      def m1(self):
7)          Test.c=30
8)          del Test.b
9)      @classmethod
10)     def m2(cls):
11)         cls.d=40
12)         del Test.c
13)     @staticmethod
14)     def m3():
15)         Test.e=50
16)         del Test.d
17) print(Test.__dict__)
18) t=Test()
19) print(Test.__dict__)
20) t.m1()
21) print(Test.__dict__)
22) Test.m2()
23) print(Test.__dict__)
24) Test.m3()
25) print(Test.__dict__)
26) Test.f=60
27) print(Test.__dict__)
```

```
28) del Test.e
29) print(Test.__dict__)
```

****Note:

- By using object reference variable/self we can read static variables, but we cannot modify or delete.
- If we are trying to modify, then a new instance variable will be added to that particular object.
- t1.a = 70
- If we are trying to delete then we will get error.

Example:

```
1)  class Test:
2)     a=10
3)
4)  t1=Test()
5)  del t1.a     ===>AttributeError: a
```

We can modify or delete static variables only by using classname or cls variable.

```
1)  import sys
2)  class Customer:
3)     """ Customer class with bank operations.. """
4)     bankname='DURGABANK'
5)     def __init__(self,name,balance=0.0):
6)        self.name=name
7)        self.balance=balance
8)     def deposit(self,amt):
9)        self.balance=self.balance+amt
10)       print('Balance after deposit:',self.balance)
11)    def withdraw(self,amt):
12)       if amt>self.balance:
13)          print('Insufficient Funds..cannot perform this operation')
14)          sys.exit()
15)       self.balance=self.balance-amt
16)       print('Balance after withdraw:',self.balance)
17)
18) print('Welcome to',Customer.bankname)
19) name=input('Enter Your Name:')
20) c=Customer(name)
21) while True:
22)    print('d-Deposit \nw-Withdraw \ne-exit')
23)    option=input('Choose your option:')
```

```
24)  if option=='d' or option=='D':
25)      amt=float(input('Enter amount:'))
26)      c.deposit(amt)
27)  elif option=='w' or option=='W':
28)      amt=float(input('Enter amount:'))
29)      c.withdraw(amt)
30)  elif option=='e' or option=='E':
31)      print('Thanks for Banking')
32)      sys.exit()
33)  else:
34)      print('Invalid option..Plz choose valid option')
```

Output:

```
D:\durga_classes>py test.py
Welcome to DURGABANK
Enter Your Name:Durga
d-Deposit
w-Withdraw
e-exit

Choose your option:d
Enter amount:10000
Balance after deposit: 10000.0
d-Deposit
w-Withdraw
e-exit

Choose your option:d
Enter amount:20000
Balance after deposit: 30000.0
d-Deposit
w-Withdraw
e-exit

Choose your option:w
Enter amount:2000
Balance after withdraw: 28000.0
d-Deposit
w-Withdraw
e-exit

Choose your option:r
Invalid option..Plz choose valid option
d-Deposit
w-Withdraw
```

e-exit

Choose your option:e
Thanks for Banking

3) Local Variables:

- Sometimes to meet temporary requirements of programmer,we can declare variables inside a method directly,such type of variables are called local variable or temporary variables.
- Local variables will be created at the time of method execution and destroyed once method completes.
- Local variables of a method cannot be accessed from outside of method.

```
1)  class Test:
2)      def m1(self):
3)          a=1000
4)          print(a)
5)      def m2(self):
6)          b=2000
7)          print(b)
8)  t=Test()
9)  t.m1()
10) t.m2()
```

Output

1000
2000

```
1)  class Test:
2)      def m1(self):
3)          a=1000
4)          print(a)
5)      def m2(self):
6)          b=2000
7)          print(a)    #NameError: name 'a' is not defined
8)          print(b)
9)  t=Test()
10) t.m1()
11) t.m2()
```


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Types of Methods:

Inside Python class 3 types of methods are allowed

1) **Instance Methods**
2) **Class Methods**
3) **Static Methods**

1) Instance Methods:

- **Inside method implementation if we are using instance variables then such type of methods are called instance methods.**
- **Inside instance method declaration, we have to pass self variable. def m1(self):**
- **By using self variable inside method we can able to access instance variables.**
- **Within the class we can call instance method by using self variable and from outside of the class we can call by using object reference.**

```
1)  class Student:
2)      def __init__(self,name,marks):
3)          self.name=name
4)          self.marks=marks
5)      def display(self):
6)          print('Hi',self.name)
7)          print('Your Marks are:',self.marks)
8)      def grade(self):
9)          if self.marks>=60:
10)             print('You got First Grade')
11)         elif self.marks>=50:
12)             print('Yout got Second Grade')
13)         elif self.marks>=35:
14)             print('You got Third Grade')
15)         else:
16)             print('You are Failed')
17) n=int(input('Enter number of students:'))
18) for i in range(n):
19)     name=input('Enter Name:')
20)     marks=int(input('Enter Marks:'))
21)     s= Student(name,marks)
22)     s.display()
23)     s.grade()
24)     print()
```

Ouput:

```
D:\durga_classes>py test.py
Enter number of students:2
```


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```
Enter Name:Durga
Enter Marks:90
Hi Durga
Your Marks are: 90
You got First Grade

Enter Name:Ravi
Enter Marks:12
Hi Ravi
Your Marks are: 12
You are Failed
```

Setter and Getter Methods:

We can set and get the values of instance variables by using getter and setter methods.

Setter Method:

setter methods can be used to set values to the instance variables. setter methods also known as mutator methods.

Syntax:

```
def  setVariable(self,variable):
       self.variable=variable
```

Example:

```
def  setName(self,name):
       self.name=name
```

Getter Method:

Getter methods can be used to get values of the instance variables. Getter methods also known as accessor methods.

Syntax:

```
def  getVariable(self):
     return self.variable
```

Example:

```
def  getName(self):
      return self.name
```

```
1)  class Student:
2)      def setName(self,name):
3)          self.name=name
4)
```


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```
5)     def getName(self):
6)         return self.name
7)
8)     def setMarks(self,marks):
9)         self.marks=marks
10)
11)    def getMarks(self):
12)        return self.marks
13)
14) n=int(input('Enter number of students:'))
15) for i in range(n):
16)    s=Student()
17)    name=input('Enter Name:')
18)    s.setName(name)
19)    marks=int(input('Enter Marks:'))
20)    s.setMarks(marks)
21)
22)    print('Hi',s.getName())
23)    print('Your Marks are:',s.getMarks())
24)    print()
```

Output:

```
D:\python_classes>py test.py
Enter number of students:2

Enter Name:Durga
Enter Marks:100
Hi Durga
Your Marks are: 100

Enter Name:Ravi
Enter Marks:80
Hi Ravi
Your Marks are: 80
```

2) Class Methods:

- Inside method implementation if we are using only class variables (static variables), then such type of methods we should declare as class method.
- We can declare class method explicitly by using @classmethod decorator.
- For class method we should provide cls variable at the time of declaration
- We can call classmethod by using classname or object reference variable.

```
1)  class Animal:
2)      lEgs=4
3)      @classmethod
4)      def walk(cls,name):
5)          print('{} walks with {} lEgs...'.format(name,cls.lEgs))
6)  Animal.walk('Dog')
7)  Animal.walk('Cat')
```

Output

```
D:\python_classes>py test.py
Dog walks with 4 lEgs...
Cat walks with 4 lEgs...
```

Program to track the Number of Objects created for a Class:

```
1)  class Test:
2)      count=0
3)      def __init__(self):
4)          Test.count =Test.count+1
5)      @classmethod
6)      def noOfObjects(cls):
7)          print('The number of objects created for test class:',cls.count)
8)
9)  t1=Test()
10) t2=Test()
11) Test.noOfObjects()
12) t3=Test()
13) t4=Test()
14) t5=Test()
15) Test.noOfObjects()
```

3) Static Methods:

- In general these methods are general utility methods.
- Inside these methods we won't use any instance or class variables.
- Here we won't provide self or cls arguments at the time of declaration.
- We can declare static method explicitly by using @staticmethod decorator
- We can access static methods by using classname or object reference

```
1)  class DurgaMath:
2)
3)      @staticmethod
4)      def add(x,y):
5)          print('The Sum:',x+y)
6)
```


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```
7)     @staticmethod
8)     def product(x,y):
9)         print('The Product:',x*y)
10)
11)    @staticmethod
12)    def average(x,y):
13)        print('The average:',(x+y)/2)
14)
15) DurgaMath.add(10,20)
16) DurgaMath.product(10,20)
17) DurgaMath.average(10,20)
```

Output

```
The Sum: 30
The Product: 200
The average: 15.0
```

Note:

- In general we can use only instance and static methods.Inside static method we can access class level variables by using class name.
- Class methods are most rarely used methods in python.

Passing Members of One Class to Another Class:

We can access members of one class inside another class.

```
1)  class Employee:
2)      def __init__(self,eno,ename,esal):
3)          self.eno=eno
4)          self.ename=ename
5)          self.esal=esal
6)      def display(self):
7)          print('Employee Number:',self.eno)
8)          print('Employee Name:',self.ename)
9)          print('Employee Salary:',self.esal)
10) class Test:
11)     def modify(emp):
12)         emp.esal=emp.esal+10000
13)         emp.display()
14) e=Employee(100,'Durga',10000)
15)         Test.modify(e)
```


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Output

```
D:\python_classes>py test.py
Employee Number: 100
Employee Name: Durga
Employee Salary: 20000
```

In the above application, Employee class members are available to Test class.

Inner Classes

Sometimes we can declare a class inside another class, such type of classes are called inner classes.

Without existing one type of object if there is no chance of existing another type of object, then we should go for inner classes.

Example: Without existing Car object there is no chance of existing Engine object. Hence Engine class should be part of Car class.

```
class Car:
    .....
    class Engine:
    ......
```

Example: Without existing university object there is no chance of existing Department object

```
class University:
    .....
    class Department:
    ......
```

Example: Without existing Human there is no chance of existin Head. Hence Head should be part of Human.

```
class Human:
   class Head:
```

Note: Without existing outer class object there is no chance of existing inner class object. Hence inner class object is always associated with outer class object.

Demo Program-1:

```
1)  class Outer:
2)      def __init__(self):
3)          print("outer class object creation")
4)      class Inner:
5)          def __init__(self):
6)              print("inner class object creation")
7)          def m1(self):
8)              print("inner class method")
9)  o=Outer()
10) i=o.Inner()
11) i.m1()
```

Output

```
outer class object creation
inner class object creation
inner class method
```

Note: The following are various possible syntaxes for calling inner class method

```
1)  o = Outer()
    i = o.Inner()
    i.m1()

2) i = Outer().Inner()
   i.m1()

3) Outer().Inner().m1()
```

Demo Program-2:

```
1)  class Person:
2)      def __init__(self):
3)          self.name='durga'
4)          self.db=self.Dob()
5)      def display(self):
6)          print('Name:',self.name)
7)      class Dob:
8)          def __init__(self):
9)              self.dd=10
10)             self.mm=5
11)             self.yy=1947
12)         def display(self):
13)             print('Dob={}/{}/{}'.format(self.dd,self.mm,self.yy))
```


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```
14) p=Person()
15) p.display()
16) x=p.db
17) x.display()
```

Output

```
Name: durga
Dob=10/5/1947
```

Demo Program-3:

Inside a class we can declare any number of inner classes.

```
1)  class Human:
2)
3)      def __init__(self):
4)          self.name = 'Sunny'
5)          self.head = self.Head()
6)          self.brain = self.Brain()
7)      def display(self):
8)          print("Hello..",self.name)
9)
10)     class Head:
11)         def talk(self):
12)             print('Talking...')
13)
14)     class Brain:
15)         def think(self):
16)             print('Thinking...')
17)
18) h=Human()
19) h.display()
20) h.head.talk()
21) h.brain.think()
```

Output

```
Hello.. Sunny
Talking...
Thinking...
```


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Garbage Collection

- In old languages like C++, programmer is responsible for both creation and destruction of objects.Usually programmer taking very much care while creating object, but nEglecting destruction of useless objects. Because of his nEglectance, total memory can be filled with useless objects which creates memory problems and total application will be down with Out of memory error.

- But in Python, We have some assistant which is always running in the background to destroy useless objects.Because this assistant the chance of failing Python program with memory problems is very less. This assistant is nothing but Garbage Collector.
- Hence the main objective of Garbage Collector is to destroy useless objects.

- If an object does not have any reference variable then that object eligible for Garbage Collection.

How to enable and disable Garbage Collector in our Program:

By default Gargbage collector is enabled, but we can disable based on our requirement. In this context we can use the following functions of gc module.

1) gc.isenabled() ➔ Returns True if GC enabled

2) gc.disable()➔ To disable GC explicitly

3) gc.enable()➔ To enable GC explicitly

```
1) import gc
2) print(gc.isenabled())
3) gc.disable()
4) print(gc.isenabled())
5) gc.enable()
6) print(gc.isenabled())
```

Output

```
True
False
True
```


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Destructors:

- Destructor is a special method and the name should be __del__
- Just before destroying an object Garbage Collector always calls destructor to perform clean up activities (Resource deallocation activities like close database connection etc).
- Once destructor execution completed then Garbage Collector automatically destroys that object.

Note: The job of destructor is not to destroy object and it is just to perform clean up activities.

```
1)  import time
2)  class Test:
3)      def __init__(self):
4)          print("Object Initialization...")
5)      def __del__(self):
6)          print("Fulfilling Last Wish and performing clean up activities...")
7)
8)  t1=Test()
9)  t1=None
10) time.sleep(5)
11) print("End of application")
```

Output

```
Object Initialization...
Fulfilling Last Wish and performing clean up activities...
End of application
```

Note: If the object does not contain any reference variable then only it is eligible fo GC. ie if the reference count is zero then only object eligible for GC.

```
1)  import time
2)  class Test:
3)      def __init__(self):
4)          print("Constructor Execution...")
5)      def __del__(self):
6)          print("Destructor Execution...")
7)
8)  t1=Test()
9)  t2=t1
10) t3=t2
11) del t1
12) time.sleep(5)
13) print("object not yet destroyed after deleting t1")
14) del t2
```

```
15) time.sleep(5)
16) print("object not yet destroyed even after deleting t2")
17) print("I am trying to delete last reference variable...")
18)         del t3
```

Example:

```
1)  import time
2)  class Test:
3)      def __init__(self):
4)          print("Constructor Execution...")
5)      def __del__(self):
6)          print("Destructor Execution...")
7)
8)  list=[Test(),Test(),Test()]
9)  del list
10) time.sleep(5)
11) print("End of application")
```

Output

```
Constructor Execution...
Constructor Execution...
Constructor Execution...
Destructor Execution...
Destructor Execution...
Destructor Execution...
End of application
```

How to find the Number of References of an Object:

sys module contains getrefcount() function for this purpose.

`sys.getrefcount (objectreference)`

```
1)  import sys
2)  class Test:
3)      pass
4)  t1=Test()
5)  t2=t1
6)  t3=t1
7)  t4=t1
8)  print(sys.getrefcount(t1))
```

Output 5

Note: For every object, Python internally maintains one default reference variable self.

OOP's Part - 2

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Agenda

- ❖ Inheritance
- ❖ Has-A Relationship
- ❖ IS-A Relationship
- ❖ IS-A vs HAS-A Relationship
- ❖ Composition vs Aggregation

- ❖ Types of Inheritance
  - Single Inheritance
  - Multi Level Inheritance
  - Hierarchical Inheritance
  - Multiple Inheritance
  - Hybrid Inheritance
  - Cyclic Inheritance

- ❖ Method Resolution Order (MRO)
- ❖ super() Method

Using Members of One Class inside Another Class:

We can use members of one class inside another class by using the following ways

1) By Composition (Has-A Relationship)
2) By Inheritance (IS-A Relationship)

1) By Composition (Has-A Relationship):

- By using Class Name or by creating object we can access members of one class inside another class is nothing but composition (Has-A Relationship).
- The main advantage of Has-A Relationship is Code Reusability.

Demo Program-1:

```
1)  class Engine:
2)      a=10
3)      def __init__(self):
4)          self.b=20
5)      def m1(self):
```


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```
6)        print('Engine Specific Functionality')
7)  class Car:
8)     def __init__(self):
9)        self.engine=Engine()
10)    def m2(self):
11)       print('Car using Engine Class Functionality')
12)       print(self.engine.a)
13)       print(self.engine.b)
14)       self.engine.m1()
15) c=Car()
16) c.m2()
```

Output:

```
Car using Engine Class Functionality
10
20
Engine Specific Functionality
```

Demo Program-2:

```
1)  class Car:
2)     def __init__(self,name,model,color):
3)        self.name=name
4)        self.model=model
5)        self.color=color
6)     def getinfo(self):
7)        print("Car Name:{} , Model:{} and Color:{}".format(self.name,self.model,self.c
    olor))
8)
9)  class Employee:
10)    def __init__(self,ename,eno,car):
11)       self.ename=ename
12)       self.eno=eno
13)       self.car=car
14)    def empinfo(self):
15)       print("Employee Name:",self.ename)
16)       print("Employee Number:",self.eno)
17)       print("Employee Car Info:")
18)       self.car.getinfo()
19) c=Car("Innova","2.5V","Grey")
20) e=Employee('Durga',10000,c)
21)          e.empinfo()
```

Output:

Employee Name: Durga
Employee Number: 10000
Employee Car Info:
Car Name: Innova, Model: 2.5V and Color:Grey

In the above program Employee class Has-A Car reference and hence Employee class can access all members of Car class.

Demo Program-3:

```
1)  class X:
2)      a=10
3)      def __init__(self):
4)          self.b=20
5)      def m1(self):
6)              print("m1 method of X class")
7)
8)  class Y:
9)      c=30
10)     def __init__(self):
11)         self.d=40
12)     def m2(self):
13)         print("m2 method of Y class")
14)
15)     def m3(self):
16)         x1=X()
17)         print(x1.a)
18)         print(x1.b)
19)         x1.m1()
20)         print(Y.c)
21)         print(self.d)
22)         self.m2()
23)         print("m3 method of Y class")
24) y1=Y()
25)             y1.m3()
```

Output:

```
10
20
m1 method of X class
30
40
m2 method of Y class
m3 method of Y class
```

2) By Inheritance (IS-A Relationship):

What ever variables, methods and constructors available in the parent class by default available to the child classes and we are not required to rewrite. Hence the main advantage of inheritance is Code Reusability and we can extend existing functionality with some more extra functionality.

Syntax: class childclass(parentclass)

```
1)  class P:
2)      a=10
3)      def __init__(self):
4)          self.b=10
5)      def m1(self):
6)          print('Parent instance method')
7)      @classmethod
8)      def m2(cls):
9)          print('Parent class method')
10)     @staticmethod
11)     def m3():
12)         print('Parent static method')
13)
14) class C(P):
15)     pass
16)
17) c=C()
18) print(c.a)
19) print(c.b)
20) c.m1()
21) c.m2()
22) c.m3()
```

Output:

```
10
10
Parent instance method
Parent class method
Parent static method
```

```
1)  class P:
2)      10 methods
3)  class C(P):
4)      5 methods
```


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In the above example Parent class contains 10 methods and these methods automatically available to the child class and we are not required to rewrite those methods(Code Reusability)
Hence child class contains 15 methods.

Note: What ever members present in Parent class are by default available to the child class through inheritance.

```
1)  class P:
2)      def m1(self):
3)          print("Parent class method")
4)  class C(P):
5)      def m2(self):
6)          print("Child class method")
7)
8)  c=C();
9)  c.m1()
10) c.m2()
```

Output:

```
Parent class method
Child class method
```

What ever methods present in Parent class are automatically available to the child class and hence on the child class reference we can call both parent class methods and child class methods.

Similarly variables also

```
1)  class P:
2)      a=10
3)      def __init__(self):
4)          self.b=20
5)  class C(P):
6)      c=30
7)      def __init__(self):
8)          super().__init__()===>Line-1
9)          self.d=30
10)
11) c1=C()
12) print(c1.a,c1.b,c1.c,c1.d)
```

If we comment Line-1 then variable b is not available to the child class.

Demo program for Inheritance:

```
1)  class Person:
2)      def __init__(self,name,age):
3)          self.name=name
4)          self.age=age
5)      def  eatndrink(self):
6)          print('Eat Biryani and Drink Beer')
7)
8)  class Employee(Person):
9)      def __init__(self,name,age,eno,esal):
10)         super().__init__(name,age)
11)         self.eno=eno
12)         self.esal=esal
13)
14)     def work(self):
15)         print("Coding Python is very easy just like drinking Chilled Beer")
16)     def empinfo(self):
17)         print("Employee Name:",self.name)
18)         print("Employee Age:",self.age)
19)         print("Employee Number:",self.eno)
20)         print("Employee Salary:",self.esal)
21)
22) e=Employee('Durga', 48, 100, 10000)
23) e.eatndrink()
24) e.work()
25) e.empinfo()
```

Output:

```
Eat Biryani and Drink Beer
Coding Python is very easy just like drinking Chilled Beer
Employee Name: Durga
Employee Age: 48
Employee Number: 100
Employee Salary: 10000
```

IS-A vs HAS-A Relationship:

- If we want to extend existing functionality with some more extra functionality then we should go for IS-A Relationship.
- If we dont want to extend and just we have to use existing functionality then we should go for HAS-A Relationship.
- Eg: Employee class extends Person class Functionality But Employee class just uses Car functionality but not extending

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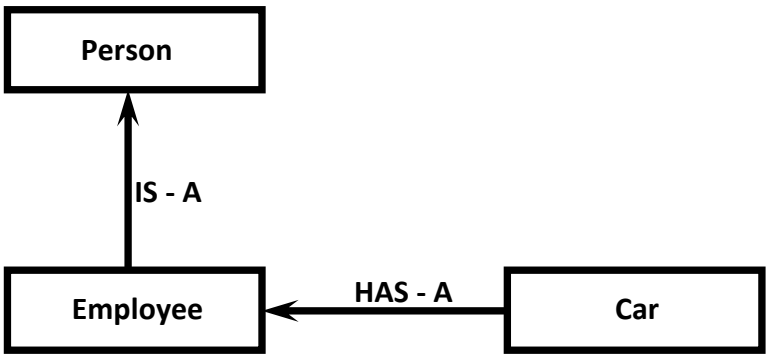



```
1)  class Car:
2)      def __init__(self,name,model,color):
3)          self.name=name
4)          self.model=model
5)          self.color=color
6)      def getinfo(self):
7)          print("\tCar Name:{} \n\t Model:{} \n\t Color:{}".format(self.name,self.model,
    self.color))
8)
9)  class Person:
10)     def __init__(self,name,age):
11)         self.name=name
12)         self.age=age
13)     def  eatndrink(self):
14)         print('Eat Biryani and Drink Beer')
15)
16) class Employee(Person):
17)     def __init__(self,name,age,eno,esal,car):
18)         super().__init__(name,age)
19)         self.eno=eno
20)         self.esal=esal
21)         self.car=car
22)     def work(self):
23)         print("Coding Python is very easy just like drinking Chilled Beer")
24)     def empinfo(self):
25)         print("Employee Name:",self.name)
26)         print("Employee Age:",self.age)
27)         print("Employee Number:",self.eno)
28)         print("Employee Salary:",self.esal)
29)         print("Employee Car Info:")
30)         self.car.getinfo()
31)
32) c=Car("Innova","2.5V","Grey")
33) e=Employee('Durga',48,100,10000,c)
34) e.eatndrink()
```

```
35) e.work()
36) e.empinfo()
```

Output:

```
Eat Biryani and Drink Beer
Coding Python is very easy just like drinking Chilled Beer
Employee Name: Durga
Employee Age: 48
Employee Number: 100
Employee Salary: 10000
Employee Car Info:
      Car Name:Innova
       Model:2.5V
       Color:Grey
```

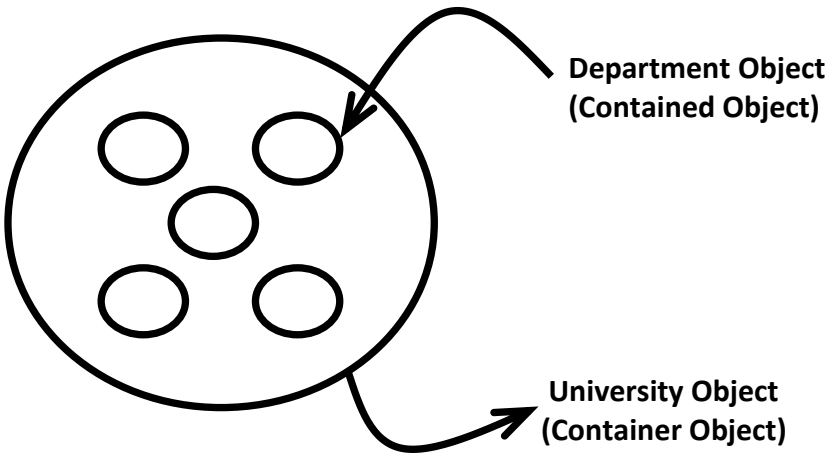
In the above example Employee class extends Person class functionality but just uses Car class functionality.

Composition vs Aggregation:

Composition:

Without existing container object if there is no chance of existing contained object then the container and contained objects are strongly associated and that strong association is nothing but Composition.

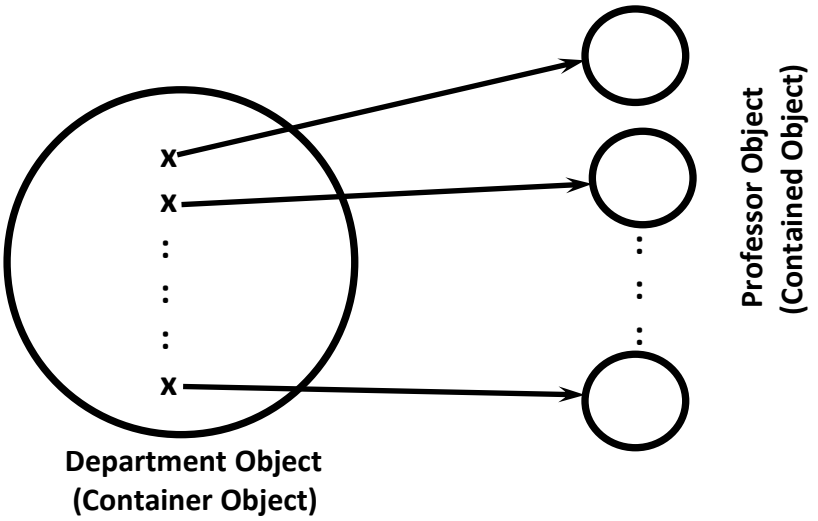
Eg: University contains several Departments and without existing university object there is no chance of existing Department object. Hence University and Department objects are strongly associated and this strong association is nothing but Composition.



Aggregation:

Without existing container object if there is a chance of existing contained object then the container and contained objects are weakly associated and that weak association is nothing but Aggregation.

Eg: Department contains several Professors. Without existing Department still there may be a chance of existing Professor. Hence Department and Professor Objects are weakly associated, which is nothing but Aggregation.



Coding Example:

```
1)  class Student:
2)      collegeName='DURGASOFT'
3)      def __init__(self,name):
4)          self.name=name
5)  print(Student.collegeName)
6)  s=Student('Durga')
7)  print(s.name)
```

Output:

```
DURGASOFT
Durga
```

In the above example without existing Student object there is no chance of existing his name. Hence Student Object and his name are strongly associated which is nothing but Composition.

But without existing Student object there may be a chance of existing collegeName. Hence Student object and collegeName are weakly associated which is nothing but Aggregation.

Conclusion:

The relation between object and its instance variables is always Composition where as the relation between object and static variables is Aggregation.

Note: Whenever we are creating child class object then child class constructor will be executed. If the child class does not contain constructor then parent class constructor will be executed, but parent object won't be created.

```
1)  class P:
2)      def __init__(self):
3)          print(id(self))
4)  class C(P):
5)      pass
6)  c=C()
7)  print(id(c))
```

Output:

```
6207088
6207088
```

```
1)  class Person:
2)      def __init__(self,name,age):
3)          self.name=name
4)          self.age=age
5)  class Student(Person):
6)      def __init__(self,name,age,rollno,marks):
7)          super().__init__(name,age)
8)          self.rollno=rollno
9)          self.marks=marks
10)     def __str__(self):
11)         return 'Name={}\nAge={}\nRollno={}\nMarks={}'.format(self.name,self.age,sel
    f.rollno,self.marks)
12) s1=Student('durga',48,101,90)
13) print(s1)
```

Output:

```
Name=durga
Age=48
Rollno=101
Marks=90
```

Note: In the above example when ever we are creating child class object both parent and child class constructors got executed to perform initialization of child object.

Types of Inheritance:

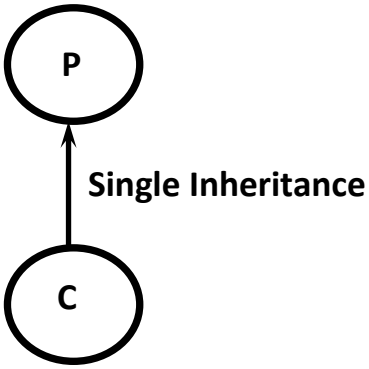
1) Single Inheritance:

The concept of inheriting the properties from one class to another class is known as single inheritance.

```
1)  class P:
2)      def m1(self):
3)          print("Parent Method")
4)  class C(P):
5)      def m2(self):
6)          print("Child Method")
7)  c=C()
8)  c.m1()
9)  c.m2()
```

Output:

```
Parent Method
Child Method
```



2) Multi Level Inheritance:

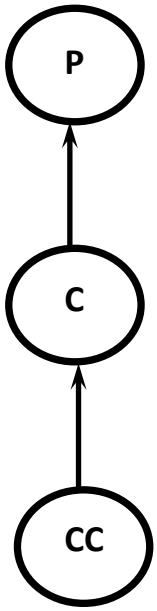
The concept of inheriting the properties from multiple classes to single class with the concept of one after another is known as multilevel inheritance.

```
1)  class P:
2)      def m1(self):
3)          print("Parent Method")
4)  class C(P):
5)      def m2(self):
6)          print("Child Method")
7)  class CC(C):
8)      def m3(self):
9)          print("Sub Child Method")
10) c=CC()
```

```
11) c.m1()
12) c.m2()
13) c.m3()
```

Output:

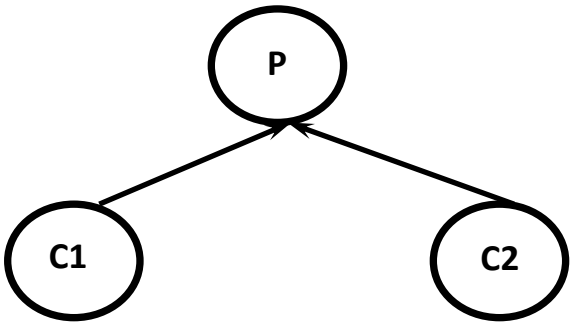
```
Parent Method
Child Method
Sub Child Method
```



Multi – Level Inheritance

3) Hierarchical Inheritance:

The concept of inheriting properties from one class into multiple classes which are present at same level is known as Hierarchical Inheritance



Hierarchical Inheritance

```
1)  class P:
2)      def m1(self):
3)          print("Parent Method")
4)  class C1(P):
```

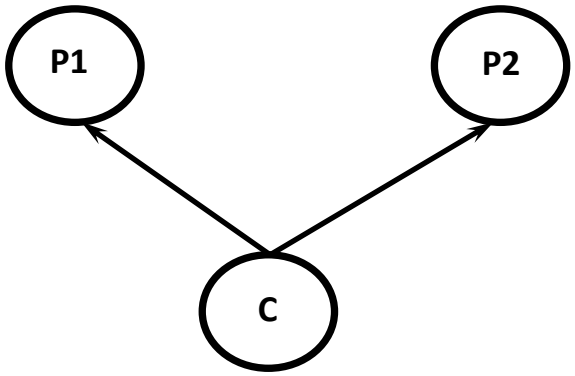
```
5)     def m2(self):
6)         print("Child1 Method")
7)  class C2(P):
8)     def m3(self):
9)         print("Child2 Method")
10) c1=C1()
11) c1.m1()
12) c1.m2()
13) c2=C2()
14) c2.m1()
15) c2.m3()
```

Output:

```
Parent Method
Child1 Method
Parent Method
Child2 Method
```

4) Multiple Inheritance:

The concept of inheriting the properties from multiple classes into a single class at a time, is known as multiple inheritance.



Multiple Inheritance

```
1)  class P1:
2)     def m1(self):
3)         print("Parent1 Method")
4)  class P2:
5)     def m2(self):
6)         print("Parent2 Method")
7)  class C(P1,P2):
8)     def m3(self):
9)         print("Child2 Method")
```

```
10) c=C()
11) c.m1()
12) c.m2()
13) c.m3()
```

Output:

```
Parent1 Method
Parent2 Method
Child2 Method
```

If the same method is inherited from both parent classes, then Python will always consider the order of Parent classes in the declaration of the child class.

class C(P1, P2): → P1 method will be considered
class C(P2, P1): → P2 method will be considered

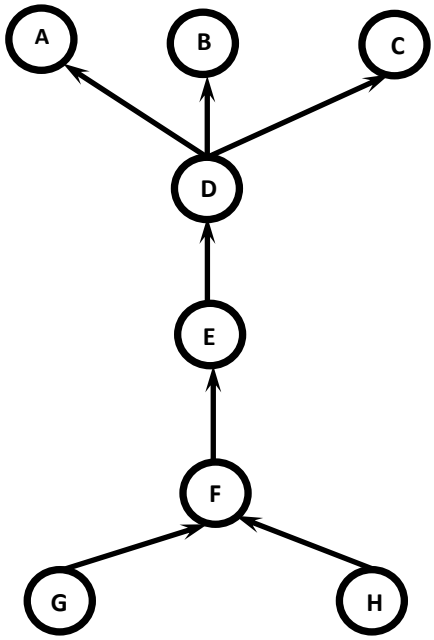
```
1)  class P1:
2)      def m1(self):
3)          print("Parent1 Method")
4)  class P2:
5)      def m1(self):
6)          print("Parent2 Method")
7)  class C(P1,P2):
8)      def m2(self):
9)          print("Child Method")
10) c=C()
11) c.m1()
12) c.m2()
```

Output:

```
Parent1 Method
Child Method
```

5) Hybrid Inheritance:

Combination of Single, Multi level, multiple and Hierarchical inheritance is known as Hybrid Inheritance.

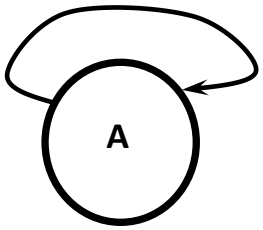


6) Cyclic Inheritance:

The concept of inheriting properties from one class to another class in cyclic way, is called Cyclic inheritance.Python won't support for Cyclic Inheritance of course it is really not required.

Eg - 1: class A(A):pass

NameError: name 'A' is not defined



Eg - 2:

```
1) class A(B):
2)     pass
3) class B(A):
4)     pass
```

NameError: name 'B' is not defined

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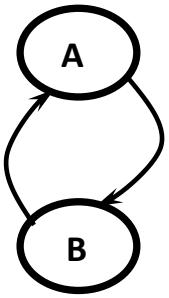

Method Resolution Order (MRO):

- In Hybrid Inheritance the method resolution order is decided based on MRO algorithm.
- This algorithm is also known as C3 algorithm.
- Samuele Pedroni proposed this algorithm.
- It follows DLR (Depth First Left to Right) i.e Child will get more priority than Parent.
- Left Parent will get more priority than Right Parent.
- MRO(X) = X+Merge(MRO(P1),MRO(P2),...,ParentList)

Head Element vs Tail Terminology:

- Assume C1,C2,C3,...are classes.
- In the list: C1C2C3C4C5....
- C1 is considered as Head Element and remaining is considered as Tail.

How to find Merge:

- Take the head of first list
- If the head is not in the tail part of any other list, then add this head to the result and remove it from the lists in the merge.
- If the head is present in the tail part of any other list, then consider the head element of the next list and continue the same process.

Note: We can find MRO of any class by using mro() function.

```
print(ClassName.mro())
```


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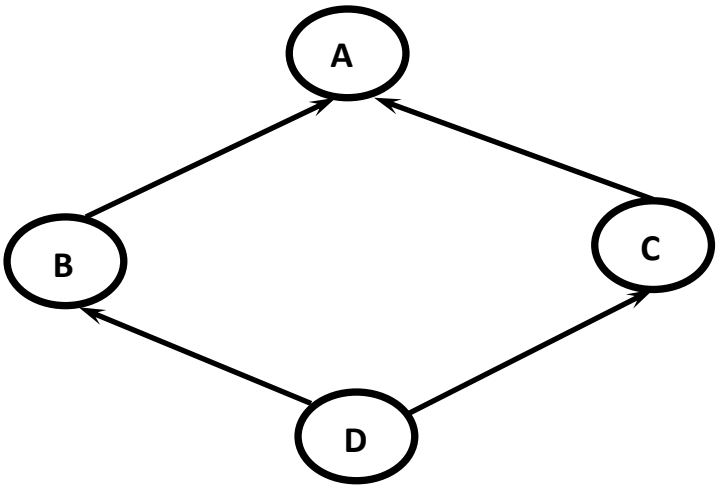
Demo Program-1 for Method Resolution Order:



mro(A) = A, object
mro(B) = B, A, object
mro(C) = C, A, object
mro(D) = D, B, C, A, object

test.py

```
1) class A:pass
2) class B(A):pass
3) class C(A):pass
4) class D(B,C):pass
5) print(A.mro())
6) print(B.mro())
7) print(C.mro())
8) print(D.mro())
```

Output:

```
[<class '__main__.A'>, <class 'object'>]
[<class '__main__.B'>, <class '__main__.A'>, <class 'object'>]
[<class '__main__.C'>, <class '__main__.A'>, <class 'object'>]
[<class '__main__.D'>, <class '__main__.B'>, <class '__main__.C'>, <class '__main__.A'>,
<class 'object'>]
```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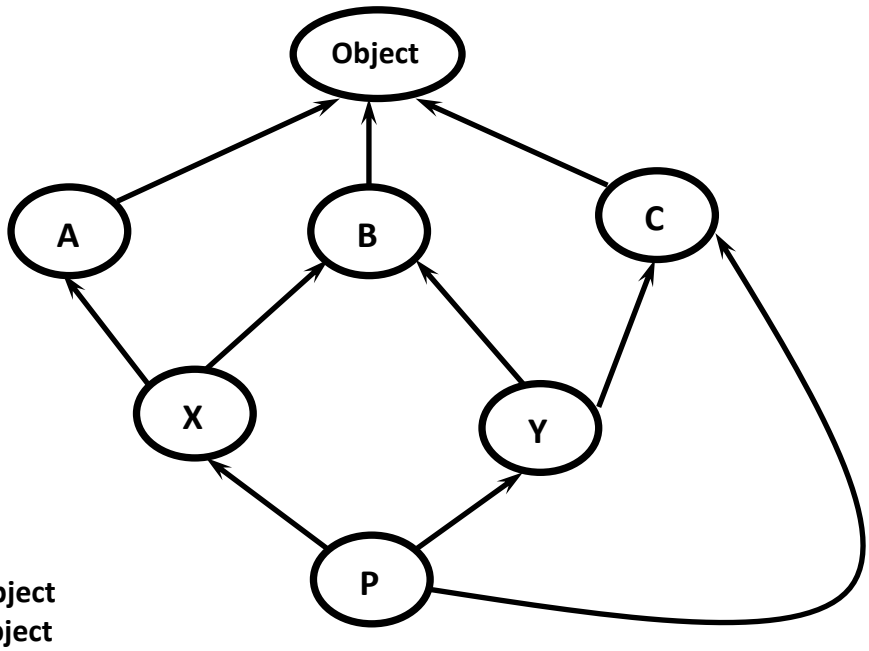
Demo Program-2 for Method Resolution Order:



mro(A)=A,object
mro(B)=B,object
mro(C)=C,object
mro(X)=X,A,B,object
mro(Y)=Y,B,C,object
mro(P)=P,X,A,Y,B,C,object

Finding mro(P) by using C3 Algorithm:

Formula: MRO(X) = X+Merge(MRO(P1),MRO(P2),...,ParentList)

mro(p) = P+Merge(mro(X),mro(Y),mro(C),XYC)
= P+Merge(XABO,YBCO,CO,XYC)
= P+X+Merge(ABO,YBCO,CO,YC)
= P+X+A+Merge(BO,YBCO,CO,YC)
= P+X+A+Y+Merge(BO,BCO,CO,C)
= P+X+A+Y+B+Merge(O,CO,CO,C)
= P+X+A+Y+B+C+Merge(O,O,O)
= P+X+A+Y+B+C+O

test.py

```
1) class A:pass
2) class B:pass
3) class C:pass
4) class X(A,B):pass
5) class Y(B,C):pass
6) class P(X,Y,C):pass
```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```
print(A.mro())#AO
print(X.mro())#XABO
print(Y.mro())#YBCO
print(P.mro())#PXAYBCO
```

Output:

```
[<class '__main__.A'>, <class 'object'>]
[<class '__main__.X'>, <class '__main__.A'>, <class '__main__.B'>, <class 'object'>]
[<class '__main__.Y'>, <class '__main__.B'>, <class '__main__.C'>, <class 'object'>]
[<class '__main__.P'>, <class '__main__.X'>, <class '__main__.A'>, <class '__main__.Y'>,
<class '__main__.B'>,
 <class '__main__.C'>, <class 'object'>]
```

test.py

```
class A:
    def m1(self):
        print('A class Method')
class B:
    def m1(self):
        print('B class Method')
class C:
    def m1(self):
        print('C class Method')
class X(A,B):
    def m1(self):
        print('X class Method')
class Y(B,C):
    def m1(self):
        print('Y class Method')
class P(X,Y,C):
    def m1(self):
        print('P class Method')
p=P()
p.m1()
```

Output: P class Method

In the above example P class m1() method will be considered.If P class does not contain m1() method then as per MRO, X class method will be considered. If X class does not contain then A class method will be considered and this process will be continued.

The method resolution in the following order: PXAYBCO

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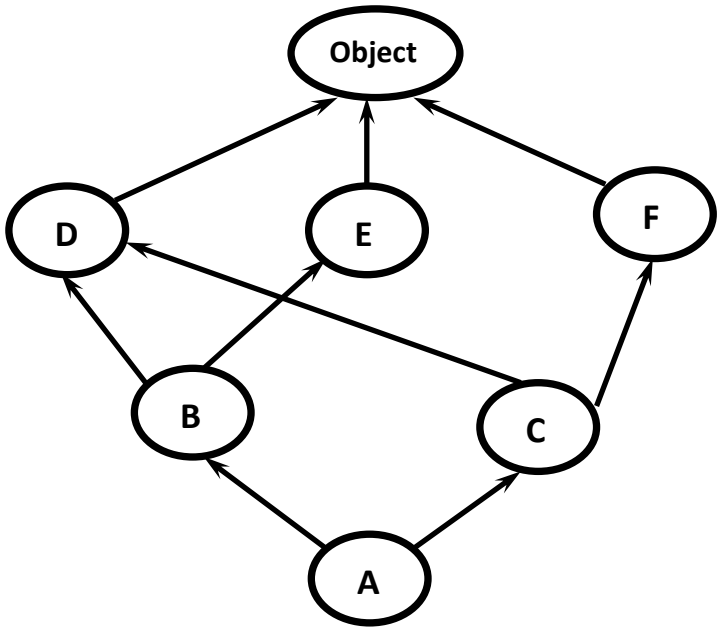
Demo Program-3 for Method Resolution Order:



mro(o) = object
mro(D) = D,object
mro(E) = E,object
mro(F) = F,object
mro(B) = B,D,E,object
mro(C) = C,D,F,object
mro(A) = A+Merge(mro(B),mro(C),BC)
= A+Merge(BDEO,CDFO,BC)
= A+B+Merge(DEO,CDFO,C)
= A+B+C+Merge(DEO,DFO)
= A+B+C+D+Merge(EO,FO)
= A+B+C+D+E+Merge(O,FO)
= A+B+C+D+E+F+Merge(O,O)
= A+B+C+D+E+F+O

test.py

```
1) class D:pass
2) class E:pass
3) class F:pass
4) class B(D,E):pass
5) class C(D,F):pass
6) class A(B,C):pass
7) print(D.mro())
8) print(B.mro())
```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```
print(C.mro())
print(A.mro())
```

Output:

```
[<class '__main__.D'>, <class 'object'>]
[<class '__main__.B'>, <class '__main__.D'>, <class '__main__.E'>, <class 'object'>]
[<class '__main__.C'>, <class '__main__.D'>, <class '__main__.F'>, <class 'object'>]
[<class '__main__.A'>, <class '__main__.B'>, <class '__main__.C'>, <class '__main__.D'>,
<class '__main__.E'>,
 <class '__main__.F'>, <class 'object'>]
```

super() Method:

super() is a built-in method which is useful to call the super class constructors,variables and methods from the child class.

Demo Program-1 for super():

```
class Person:
    def __init__(self,name,age):
        self.name=name
        self.age=age
    def display(self):
        print('Name:',self.name)
        print('Age:',self.age)

class Student(Person):
    def __init__(self,name,age,rollno,marks):
        super().__init__(name,age)
        self.rollno=rollno
        self.marks=marks

    def display(self):
        super().display()
        print('Roll No:',self.rollno)
        print('Marks:',self.marks)

s1=Student('Durga',22,101,90)
s1.display()
```

Output:

```
Name: Durga
Age: 22
Roll No: 101
Marks: 90
```


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In the above program we are using super() method to call parent class constructor and display() method

Demo Program-2 for super():

```
1)  class P:
2)      a=10
3)      def __init__(self):
4)          self.b=10
5)      def m1(self):
6)          print('Parent instance method')
7)      @classmethod
8)      def m2(cls):
9)          print('Parent class method')
10)     @staticmethod
11)     def m3():
12)         print('Parent static method')
13)
14) class C(P):
15)     a=888
16)     def __init__(self):
17)         self.b=999
18)         super().__init__()
19)         print(super().a)
20)         super().m1()
21)         super().m2()
22)         super().m3()
23)
24) c=C()
```

Output:

```
10
Parent instance method
Parent class method
Parent static method
```

In the above example we are using super() to call various members of Parent class.

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How to Call Method of a Particular Super Class:

We can use the following approaches

1) super(D, self).m1()

It will call m1() method of super class of D.

2) A.m1(self)

It will call A class m1() method

```
1)      class A:
2)      def m1(self):
3)          print('A class Method')
4)  class B(A):
5)      def m1(self):
6)          print('B class Method')
7)  class C(B):
8)      def m1(self):
9)          print('C class Method')
10) class D(C):
11)     def m1(self):
12)         print('D class Method')
13) class E(D):
14)     def m1(self):
15)         A.m1(self)
16)
17) e=E()
18) e.m1()
```

Output: A class Method

Various Important Points about super():

Case-1: From child class we are not allowed to access parent class instance variables by using super(), Compulsory we should use self only.
But we can access parent class static variables by using super().

```
1)  class P:
2)      a=10
3)      def __init__(self):
4)          self.b=20
5)
6)  class C(P):
7)      def m1(self):
```


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```
8)        print(super().a)#valid
9)        print(self.b)#valid
10)       print(super().b)#invalid
11) c=C()
12) c.m1()
```

Output:

```
10
20
AttributeError: 'super' object has no attribute 'b'
```

Case-2: From child class constructor and instance method, we can access parent class instance method, static method and class method by using super()

```
1)  class P:
2)     def __init__(self):
3)        print('Parent Constructor')
4)     def m1(self):
5)        print('Parent instance method')
6)     @classmethod
7)     def m2(cls):
8)        print('Parent class method')
9)     @staticmethod
10)    def m3():
11)       print('Parent static method')
12)
13) class C(P):
14)    def __init__(self):
15)       super().__init__()
16)       super().m1()
17)       super().m2()
18)       super().m3()
19)
20)    def m1(self):
21)       super().__init__()
22)       super().m1()
23)       super().m2()
24)       super().m3()
25)
26) c=C()
27) c.m1()
```


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Output:

```
Parent Constructor
Parent instance method
Parent class method
Parent static method
Parent Constructor
Parent instance method
Parent class method
Parent static method
```

Case-3: From child class, class method we cannot access parent class instance methods and constructors by using super() directly(but indirectly possible). But we can access parent class static and class methods.

```
1)  class P:
2)      def __init__(self):
3)          print('Parent Constructor')
4)      def m1(self):
5)          print('Parent instance method')
6)      @classmethod
7)      def m2(cls):
8)          print('Parent class method')
9)      @staticmethod
10)     def m3():
11)         print('Parent static method')
12)
13) class C(P):
14)     @classmethod
15)     def m1(cls):
16)         #super().__init__()--->invalid
17)         #super().m1()--->invalid
18)         super().m2()
19)         super().m3()
20)
21) C.m1()
```

Output:

```
Parent class method
Parent static method
```


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From Class Method of Child Class, how to call Parent Class Instance Methods and Constructors:

```
1)  class A:
2)      def __init__(self):
3)          print('Parent constructor')
4)
5)      def m1(self):
6)          print('Parent instance method')
7)
8)  class B(A):
9)      @classmethod
10)     def m2(cls):
11)         super(B,cls).__init__(cls)
12)         super(B,cls).m1(cls)
13)
14) B.m2()
```

Output:

```
Parent constructor
Parent instance method
```

Case-4: In child class static method we are not allowed to use super() generally (But in special way we can use)

```
1)  class P:
2)      def __init__(self):
3)          print('Parent Constructor')
4)      def m1(self):
5)          print('Parent instance method')
6)      @classmethod
7)      def m2(cls):
8)          print('Parent class method')
9)      @staticmethod
10)     def m3():
11)         print('Parent static method')
12)
13) class C(P):
14)     @staticmethod
15)     def m1():
16)         super().m1()-->invalid
17)         super().m2()--->invalid
18)         super().m3()--->invalid
19)
20) C.m1()
```

RuntimeError: super(): no arguments

How to Call Parent Class Static Method from Child Class Static Method by using super():

```
1)  class A:
2)
3)      @staticmethod
4)      def m1():
5)          print('Parent static method')
6)
7)  class B(A):
8)      @staticmethod
9)      def m2():
10)         super(B,B).m1()
11)
12) B.m2()
```

Output: Parent static method

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OOP's Part - 3

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POLYMORPHISM

poly means many. Morphs means forms.
Polymorphism means 'Many Forms'.

Eg1: Yourself is best example of polymorphism.In front of Your parents You will have one type of behaviour and with friends another type of behaviour.Same person but different behaviours at different places,which is nothing but polymorphism.

Eg2: + operator acts as concatenation and arithmetic addition

Eg3: * operator acts as multiplication and repetition operator

Eg4: The Same method with different implementations in Parent class and child classes.(overriding)

Related to Polymorphism the following 4 topics are important

1) **Duck Typing Philosophy of Python**

2) **Overloading**
   1) **Operator Overloading**
   2) **Method Overloading**
   3) **Constructor Overloading**

3) **Overriding**
   1) **Method Overriding**
   2) **Constructor Overriding**

1) Duck Typing Philosophy of Python:

In Python we cannot specify the type explicitly. Based on provided value at runtime the type will be considered automatically. Hence Python is considered as Dynamically Typed Programming Language.

```
def f1(obj):
obj.talk()
```

What is the Type of obj? We cannot decide at the Beginning. At Runtime we can Pass any Type. Then how we can decide the Type?

At runtime if 'it walks like a duck and talks like a duck,it must be duck'. Python follows this principle. This is called Duck Typing Philosophy of Python.

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```
1)  class Duck:
2)      def talk(self):
3)          print('Quack.. Quack..')
4)
5)  class Dog:
6)      def talk(self):
7)          print('Bow Bow..')
8)
9)  class Cat:
10)     def talk(self):
11)         print('Moew Moew ..')
12)
13) class Goat:
14)     def talk(self):
15)         print('Myaah Myaah ..')
16)
17) def  f1(obj):
18)     obj.talk()
19)
20) l=[Duck(),Cat(),Dog(),Goat()]
21) for obj in l:
22)     f1(obj)
```

Output:

```
Quack.. Quack..
Moew Moew ..
Bow Bow..
Myaah Myaah ..
```

The problem in this approach is if obj does not contain talk() method then we will get AttributeError.

```
1)  class Duck:
2)      def talk(self):
3)          print('Quack.. Quack..')
4)
5)  class Dog:
6)      def bark(self):
7)          print('Bow Bow..')
8)  def  f1(obj):
9)      obj.talk()
10)
11) d=Duck()
12) f1(d)
13)
```

```
14) d=Dog()
15) f1(d)
```

Output:

```
D:\durga_classes>py test.py
Quack.. Quack..
Traceback (most recent call last):
  File "test.py", line 22, in <module>
    f1(d)
  File "test.py", line 13, in f1
    obj.talk()
AttributeError: 'Dog' object has no attribute 'talk'
```

But we can solve this problem by using hasattr() function.

`hasattr(obj,'attributename')` ➔ **attributename can be Method Name OR Variable Name**

Demo Program with hasattr() Function:

```
1)   class Duck:
2)       def talk(self):
3)           print('Quack.. Quack..')
4)
5)   class Human:
6)       def talk(self):
7)           print('Hello Hi...')
8)
9)   class Dog:
10)      def bark(self):
11)          print('Bow Bow..')
12)
13) def  f1(obj):
14)      if hasattr(obj,'talk'):
15)          obj.talk()
16)      elif hasattr(obj,'bark'):
17)          obj.bark()
18)
19) d=Duck()
20) f1(d)
21)
22) h=Human()
23) f1(h)
24)
25) d=Dog()
26) f1(d)
```

27) Myaah Myaah Myaah...

2) Overloading

We can use same operator or methods for different purposes.

Eg 1: + operator can be used for Arithmetic addition and String concatenation

```
print(10+20)#30
print('durga'+'soft')#durgasoft
```

Eg 2: * operator can be used for multiplication and string repetition purposes.

```
print(10*20)#200
print('durga'*3)#durgadurgadurga
```

Eg 3: We can use deposit() method to deposit cash or cheque or dd

```
deposit(cash)
deposit(cheque)
deposit(dd)
```

There are 3 types of Overloading

1) Operator Overloading
2) Method Overloading
3) Constructor Overloading

1) Operator Overloading:

- We can use the same operator for multiple purposes, which is nothing but operator overloading.
- Python supports operator overloading.

Eg 1: + operator can be used for Arithmetic addition and String concatenation

```
print(10+20)#30
print('durga'+'soft')#durgasoft
```

Eg 2: * operator can be used for multiplication and string repetition purposes.

```
print(10*20)#200
print('durga'*3)#durgadurgadurga
```

Demo program to use + operator for our class objects:

```
1) class Book:
2)     def __init__(self,pages):
3)         self.pages=pages
4)
5) b1=Book(100)
```


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```
6) b2=Book(200)
7) print(b1+b2)
```

```
D:\durga_classes>py test.py
Traceback (most recent call last):
  File "test.py", line 7, in <module>
    print(b1+b2)
TypeError: unsupported operand type(s) for +: 'Book' and 'Book'
```

- We can overload + operator to work with Book objects also. i.e Python supports Operator Overloading.
- For every operator Magic Methods are available. To overload any operator we have to override that Method in our class.
- Internally + operator is implemented by using __add__() method.This method is called magic method for + operator. We have to override this method in our class.

Demo Program to Overload + Operator for Our Book Class Objects:

```
1) class Book:
2)     def __init__(self,pages):
3)         self.pages=pages
4)
5)     def __add__(self,other):
6)         return self.pages+other.pages
7)
8) b1=Book(100)
9) b2=Book(200)
10) print('The Total Number of Pages:',b1+b2)
```

Output: The Total Number of Pages: 300

The following is the list of operators and corresponding magic methods.

1)	+	→	object.__add__(self,other)
2)	-	→	object.__sub__(self,other)
3)	*	→	object.__mul__(self,other)
4)	/	→	object.__div__(self,other)
5)	//	→	object.__floordiv__(self,other)
6)	%	→	object.__mod__(self,other)
7)	**	→	object.__pow__(self,other)
8)	+=	→	object.__iadd__(self,other)
9)	-=	→	object.__isub__(self,other)
10)	*=	→	object.__imul__(self,other)
11)	/=	→	object.__idiv__(self,other)
12)	//=	→	object.__ifloordiv__(self,other)

13) %= → object.__imod__(self,other)
14) **= → object.__ipow__(self,other)
15) < → object.__lt__(self,other)
16) <= → object.__le__(self,other)
17) > → object.__gt__(self,other)
18) >= → object.__ge__(self,other)
19) == → object.__eq__(self,other)
20) != → object.__ne__(self,other)

Overloading > and <= Operators for Student Class Objects:

```
1)  class Student:
2)      def __init__(self,name,marks):
3)          self.name=name
4)          self.marks=marks
5)      def __gt__(self,other):
6)          return self.marks>other.marks
7)      def __le__(self,other):
8)          return self.marks<=other.marks
9)
10) print("10>20 =",10>20)
11) s1=Student("Durga",100)
12) s2=Student("Ravi",200)
13) print("s1>s2=",s1>s2)
14) print("s1<s2=",s1<s2)
15) print("s1<=s2=",s1<=s2)
16) print("s1>=s2=",s1>=s2)
```

Output

```
10>20 = False
s1>s2= False
s1<s2= True
s1<=s2= True
s1>=s2= False
```

Program to Overload Multiplication Operator to Work on Employee Objects:

```
1)  class Employee:
2)      def __init__(self,name,salary):
3)          self.name=name
4)          self.salary=salary
5)      def __mul__(self,other):
6)          return self.salary*other.days
7)
```

```
8)  class TimeSheet:
9)      def __init__(self,name,days):
10)         self.name=name
11)         self.days=days
12)
13) e=Employee('Durga',500)
14) t=TimeSheet('Durga',25)
15) print('This Month Salary:',e*t)
```

Output: This Month Salary: 12500

2) Method Overloading:

- If 2 methods having same name but different type of arguments then those methods are said to be overloaded methods.
  Eg: m1(int a)
  m1(double d)

- But in Python Method overloading is not possible.
- If we are trying to declare multiple methods with same name and different number of arguments then Python will always consider only last method.

Demo Program:

```
1)  class Test:
2)      def m1(self):
3)          print('no-arg method')
4)      def m1(self,a):
5)          print('one-arg method')
6)      def m1(self,a,b):
7)          print('two-arg method')
8)
9)  t=Test()
10) #t.m1()
11) #t.m1(10)
12) t.m1(10,20)
```

Output: two-arg method

In the above program python will consider only last method.

How we can handle Overloaded Method Requirements in Python:

Most of the times, if method with variable number of arguments required then we can handle with default arguments or with variable number of argument methods.

Demo Program with Default Arguments:

```
1)  class Test:
2)      def sum(self,a=None,b=None,c=None):
3)          if a!=None and b!= None and c!= None:
4)              print('The Sum of 3 Numbers:',a+b+c)
5)          elif a!=None and b!= None:
6)              print('The Sum of 2 Numbers:',a+b)
7)          else:
8)              print('Please provide 2 or 3 arguments')
9)  t=Test()
10) t.sum(10,20)
11) t.sum(10,20,30)
12) t.sum(10)
```

Output

```
The Sum of 2 Numbers: 30
The Sum of 3 Numbers: 60
Please provide 2 or 3 arguments
```

Demo Program with Variable Number of Arguments:

```
1)  class Test:
2)      def sum(self,*a):
3)          total=0
4)          for x in a:
5)              total=total+x
6)          print('The Sum:',total)
7)
8)  t=Test()
9)  t.sum(10,20)
10) t.sum(10,20,30)
11) t.sum(10)
12) t.sum()
```

3) Constructor Overloading:

- Constructor overloading is not possible in Python.
- If we define multiple constructors then the last constructor will be considered.

```
1)  class Test:
2)      def __init__(self):
3)          print('No-Arg Constructor')
4)
```


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```
5)     def __init__(self,a):
6)         print('One-Arg constructor')
7)
8)     def __init__(self,a,b):
9)         print('Two-Arg constructor')
10) #t1=Test()
11) #t1=Test(10)
12) t1=Test(10,20)
```

Output: Two-Arg constructor

- In the above program only Two-Arg Constructor is available.
- But based on our requirement we can declare constructor with default arguments and variable number of arguments.

Constructor with Default Arguments:

```
1)  class Test:
2)      def __init__(self,a=None,b=None,c=None):
3)          print('Constructor with 0|1|2|3 number of arguments')
4)
5)  t1=Test()
6)  t2=Test(10)
7)  t3=Test(10,20)
8)  t4=Test(10,20,30)
```

Output

```
Constructor with 0|1|2|3 number of arguments
Constructor with 0|1|2|3 number of arguments
Constructor with 0|1|2|3 number of arguments
Constructor with 0|1|2|3 number of arguments
```

Constructor with Variable Number of Arguments:

```
1)  class Test:
2)      def __init__(self,*a):
3)          print('Constructor with variable number of arguments')
4)
5)  t1=Test()
6)  t2=Test(10)
7)  t3=Test(10,20)
8)  t4=Test(10,20,30)
9)  t5=Test(10,20,30,40,50,60)
```

Output:

```
Constructor with variable number of arguments
Constructor with variable number of arguments
Constructor with variable number of arguments
Constructor with variable number of arguments
Constructor with variable number of arguments
```

3) Overriding

Method Overriding

- What ever members available in the parent class are bydefault available to the child class through inheritance. If the child class not satisfied with parent class implementation then child class is allowed to redefine that method in the child class based on its requirement. This concept is called overriding.
- Overriding concept applicable for both methods and constructors.

Demo Program for Method Overriding:

```
1)  class P:
2)      def property(self):
3)          print('Gold+Land+Cash+Power')
4)      def marry(self):
5)          print('Appalamma')
6)  class C(P):
7)      def marry(self):
8)          print('Katrina Kaif')
9)
10) c=C()
11) c.property()
12)         c.marry()
```

Output

```
Gold+Land+Cash+Power
Katrina Kaif
```

From Overriding method of child class,we can call parent class method also by using super() method.

```
1)  class P:
2)      def property(self):
3)          print('Gold+Land+Cash+Power')
```


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```
    def marry(self):
        print('Appalamma')
class C(P):
    def marry(self):
        super().marry()
        print('Katrina Kaif')

c=C()
c.property()
c.marry()
```

Output

```
Gold+Land+Cash+Power
Appalamma
Katrina Kaif
```

Demo Program for Constructor Overriding:

```
class P:
    def __init__(self):
        print('Parent Constructor')

class C(P):
    def __init__(self):
        print('Child Constructor')

c=C()
```

Output: Child Constructor

In the above example,if child class does not contain constructor then parent class constructor will be executed

From child class constuctor we can call parent class constructor by using super() method.

Demo Program to call Parent Class Constructor by using super():

```
class Person:
    def __init__(self,name,age):
        self.name=name
        self.age=age

class Employee(Person):
    def __init__(self,name,age,eno,esal):
        super().__init__(name,age)
```


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```
9)        self.eno=eno
10)       self.esal=esal
11)
12)   def display(self):
13)       print('Employee Name:',self.name)
14)       print('Employee Age:',self.age)
15)       print('Employee Number:',self.eno)
16)       print('Employee Salary:',self.esal)
17)
18) e1=Employee('Durga',48,872425,26000)
19) e1.display()
20) e2=Employee('Sunny',39,872426,36000)
21) e2.display()
```

Output

```
Employee Name: Durga
Employee Age: 48
Employee Number: 872425
Employee Salary: 26000

Employee Name: Sunny
Employee Age: 39
Employee Number: 872426
Employee Salary: 36000
```

OOP's Part - 4

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Agenda

1) Abstract Method
2) Abstract class
3) Interface
4) Public,Private and Protected Members
5) __str__() Method
6) Difference between str() and repr() functions
7) Small Banking Application

Abstract Method:

- Sometimes we don't know about implementation, still we can declare a method. Such types of methods are called abstract methods.i.e abstract method has only declaration but not implementation.
- In python we can declare abstract method by using @abstractmethod decorator as follows.

- @abstractmethod
- def m1(self): pass

- @abstractmethod decorator present in abc module. Hence compulsory we should import abc module,otherwise we will get error.
- abc → abstract base class module

```
1) class Test:
2)     @abstractmethod
3)     def m1(self):
4)         pass
```

NameError: name 'abstractmethod' is not defined

Eg:

```
1) from abc import *
2) class Test:
3)     @abstractmethod
4)     def m1(self):
5)         pass
```


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Eg:

```
1)  from abc import *
2)  class Fruit:
3)      @abstractmethod
4)      def taste(self):
5)          pass
```

Child classes are responsible to provide implemention for parent class abstract methods.

Abstract class:

Some times implementation of a class is not complete,such type of partially implementation classes are called abstract classes. Every abstract class in Python should be derived from ABC class which is present in abc module.

Case-1:

```
1)  from abc import *
2)  class Test:
3)      pass
4)
5)  t=Test()
```

In the above code we can create object for Test class b'z it is concrete class and it does not conatin any abstract method.

Case-2:

```
1)  from abc import *
2)  class Test(ABC):
3)      pass
4)
5)  t=Test()
```

In the above code we can create object, even it is derived from ABC class,b'z it does not contain any abstract method.

Case-3:

```
1)  from abc import *
2)  class Test(ABC):
3)      @abstractmethod
4)      def m1(self):
5)          pass
```


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```
6)
7)  t=Test()
```

TypeError: Can't instantiate abstract class Test with abstract methods m1

Case-4:

```
1)  from abc import *
2)  class Test:
3)      @abstractmethod
4)      def m1(self):
5)          pass
6)
7)  t=Test()
```

We can create object even class contains abstract method b'z we are not extending ABC class.

Case-5:

```
1)  from abc import *
2)  class Test:
3)      @abstractmethod
4)      def m1(self):
5)          print('Hello')
6)
7)  t=Test()
8)  t.m1()
```

Output: Hello

Conclusion: If a class contains atleast one abstract method and if we are extending ABC class then instantiation is not possible.

"abstract class with abstract method instantiation is not possible"

Parent class abstract methods should be implemented in the child classes. Otherwise we cannot instantiate child class.If we are not creating child class object then we won't get any error.

Case-1:

```
1)  from abc import *
2)  class Vehicle(ABC):
3)      @abstractmethod
```

```
4)     def noofwheels(self):
5)         pass
6)
7)  class Bus(Vehicle): pass
```

It is valid because we are not creating Child class object.

Case-2:

```
1)  from abc import *
2)  class Vehicle(ABC):
3)      @abstractmethod
4)      def noofwheels(self):
5)          pass
6)
7)  class Bus(Vehicle): pass
8)  b=Bus()
```

TypeError: Can't instantiate abstract class Bus with abstract methods noofwheels

Note: If we are extending abstract class and does not override its abstract method then child class is also abstract and instantiation is not possible.

```
1)  from abc import *
2)  class Vehicle(ABC):
3)      @abstractmethod
4)      def noofwheels(self):
5)          pass
6)
7)  class Bus(Vehicle):
8)      def noofwheels(self):
9)          return 7
10)
11) class Auto(Vehicle):
12)     def noofwheels(self):
13)         return 3
14) b=Bus()
15) print(b.noofwheels())#7
16)
17) a=Auto()
18) print(a.noofwheels())#3
```

Note: Abstract class can contain both abstract and non-abstract methods also.

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Interfaces In Python:

In general if an abstract class contains only abstract methods such type of abstract class is considered as interface.

```
1)  from abc import *
2)  class DBInterface(ABC):
3)      @abstractmethod
4)      def connect(self):pass
5)
6)      @abstractmethod
7)      def disconnect(self):pass
8)
9)  class Oracle(DBInterface):
10)     def connect(self):
11)         print('Connecting to Oracle Database...')
12)     def disconnect(self):
13)         print('Disconnecting to Oracle Database...')
14)
15) class Sybase(DBInterface):
16)     def connect(self):
17)         print('Connecting to Sybase Database...')
18)     def disconnect(self):
19)         print('Disconnecting to Sybase Database...')
20)
21) dbname=input('Enter Database Name:')
22) classname=globals()[dbname]
23) x=classname()
24) x.connect()
25) x.disconnect()
```

```
D:\durga_classes>py test.py
Enter Database Name:Oracle
Connecting to Oracle Database...
Disconnecting to Oracle Database...

D:\durga_classes>py test.py
Enter Database Name:Sybase
Connecting to Sybase Database...
Disconnecting to Sybase Database...
```

Note: **The inbuilt function globals()[str] converts the string 'str' into a class name and returns the classname.**

Demo Program-2: Reading class name from the file

config.txt

```
EPSON
```

test.py

```
1)  from abc import *
2)  class Printer(ABC):
3)      @abstractmethod
4)      def printit(self,text):pass
5)
6)      @abstractmethod
7)      def disconnect(self):pass
8)
9)  class EPSON(Printer):
10)     def printit(self,text):
11)         print('Printing from EPSON Printer...')
12)         print(text)
13)     def disconnect(self):
14)         print('Printing completed on EPSON Printer...')
15)
16) class HP(Printer):
17)     def printit(self,text):
18)         print('Printing from HP Printer...')
19)         print(text)
20)     def disconnect(self):
21)         print('Printing completed on HP Printer...')
22)
23) with open('config.txt','r') as f:
24)     pname=f.readline()
25)
26) classname=globals()[pname]
27) x=classname()
28) x.printit('This data has to print...')
29) x.disconnect()
```

Output:

```
Printing from EPSON Printer...
This data has to print...
Printing completed on EPSON Printer...
```


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Concreate class vs Abstract Class vs Inteface:

1) If we dont know anything about implementation just we have requirement specification then we should go for interface.
2) If we are talking about implementation but not completely then we should go for abstract class. (partially implemented class).
3) If we are talking about implementation completely and ready to provide service then we should go for concrete class.

```
1) from abc import *
2) class CollegeAutomation(ABC):
3)     @abstractmethod
4)     def m1(self): pass
5)     @abstractmethod
6)     def m2(self): pass
7)     @abstractmethod
8)     def m3(self): pass
9) class AbsCls(CollegeAutomation):
10)    def m1(self):
11)        print('m1 method implementation')
12)    def m2(self):
13)        print('m2 method implementation')
14)
15) class ConcreteCls(AbsCls):
16)    def m3(self):
17)        print('m3 method implemnentation')
18)
19) c=ConcreteCls()
20) c.m1()
21) c.m2()
22) c.m3()
```

Public, Protected and Private Attributes:

By default every attribute is public. We can access from anywhere either within the class or from outside of the class.

Eg: name = 'durga'

Protected attributes can be accessed within the class anywhere but from outside of the class only in child classes. We can specify an attribute as protected by prefexing with _ symbol.

Syntax: _variablename = value

Eg: _name='durga'

But is is just convention and in reality does not exists protected attributes.

private attributes can be accessed only within the class.i.e from outside of the class we cannot access. We can declare a variable as private explicitly by prefexing with 2 underscore symbols.

syntax: __variablename=value

Eg: __name='durga'

```
1)  class Test:
2)      x=10
3)      _y=20
4)      __z=30
5)      def m1(self):
6)          print(Test.x)
7)          print(Test._y)
8)          print(Test.__z)
9)
10) t=Test()
11) t.m1()
12) print(Test.x)
13) print(Test._y)
14) print(Test.__z)
```

Output:

```
10
20
30
10
20
Traceback (most recent call last):
  File "test.py", line 14, in <module>
    print(Test.__z)
AttributeError: type object 'Test' has no attribute '__z'
```

How to Access Private Variables from Outside of the Class:

We cannot access private variables directly from outside of the class.
But we can access indirectly as follows objectreference._classname__variablename

```
1)  class Test:
2)      def __init__(self):
3)          self.__x=10
4)
```


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```
5) t=Test()
6) print(t._Test__x)#10
```

__str__() method:

- Whenever we are printing any object reference internally __str__() method will be called which is returns string in the following format
  <__main__.classname object at 0x022144B0>

- To return meaningful string representation we have to override __str__() method.

```
1) class Student:
2)     def __init__(self,name,rollno):
3)         self.name=name
4)         self.rollno=rollno
5)
6)     def __str__(self):
7)       return 'This is Student with Name:{} and Rollno:{}'.format(self.name,self.rollno)
8)
9) s1=Student('Durga',101)
10) s2=Student('Ravi',102)
11) print(s1)
12) print(s2)
```

Output without Overriding str():

<__main__.Student object at 0x022144B0>
<__main__.Student object at 0x022144D0>

Output with Overriding str():

This is Student with Name: Durga and Rollno: 101
This is Student with Name: Ravi and Rollno: 102

Difference between str() and repr()
OR
Difference between __str__() and __repr__()

- str() internally calls __str__() function and hence functionality of both is same.
- Similarly,repr() internally calls __repr__() function and hence functionality of both is same.
- str() returns a string containing a nicely printable representation object.
- The main purpose of str() is for readability.It may not possible to convert result string to original object.

```
1) import datetime
2) today=datetime.datetime.now()
3) s=str(today)#converting datetime object to str
4) print(s)
5) d=eval(s)#converting str object to datetime
```

```
D:\durgaclasses>py test.py
2018-05-18 22:48:19.890888
Traceback (most recent call last):
  File "test.py", line 5, in <module>
    d=eval(s)#converting str object to datetime
  File "<string>", line 1
    2018-05-18 22:48:19.890888
         ^
SyntaxError: invalid token
```

But repr() returns a string containing a printable representation of object.
The main goal of repr() is unambigouous. We can convert result string to original object by using eval() function,which may not possible in str() function.

```
1) import datetime
2) today=datetime.datetime.now()
3) s=repr(today)#converting datetime object to str
4) print(s)
5) d=eval(s)#converting str object to datetime
6) print(d)
```

Output:

```
datetime.datetime(2018, 5, 18, 22, 51, 10, 875838)
2018-05-18 22:51:10.875838
```

Note: It is recommended to use repr() instead of str()

Mini Project: Banking Application

```
1)  class Account:
2)      def __init__(self,name,balance,min_balance):
3)          self.name=name
4)          self.balance=balance
5)          self.min_balance=min_balance
6)
7)      def deposit(self,amount):
8)          self.balance +=amount
9)
10)     def withdraw(self,amount):
```


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```
11)       if self.balance-amount >= self.min_balance:
12)          self.balance -=amount
13)       else:
14)          print("Sorry, Insufficient Funds")
15)
16)    def printStatement(self):
17)       print("Account Balance:",self.balance)
18)
19) class Current(Account):
20)    def __init__(self,name,balance):
21)       super().__init__(name,balance,min_balance=-1000)
22)    def __str__(self):
23)       return "{}'s Current Account with Balance :{}".format(self.name,self.balance)
24)
25) class Savings(Account):
26)    def __init__(self,name,balance):
27)       super().__init__(name,balance,min_balance=0)
28)    def __str__(self):
29)       return "{}'s Savings Account with Balance :{}".format(self.name,self.balance)
30)
31) c=Savings("Durga",10000)
32) print(c)
33) c.deposit(5000)
34) c.printStatement()
35) c.withdraw(16000)
36) c.withdraw(15000)
37) print(c)
38)
39) c2=Current('Ravi',20000)
40) c2.deposit(6000)
41) print(c2)
42) c2.withdraw(27000)
43) print(c2)
```

Output:

```
D:\durgaclasses>py test.py
Durga's Savings Account with Balance :10000
Account Balance: 15000
Sorry, Insufficient Funds
Durga's Savings Account with Balance :0
Ravi's Current Account with Balance :26000
Ravi's Current Account with Balance :-1000
```


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EXCEPTION HANDLING

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In any programming language there are 2 types of errors are possible.

1) Syntax Errors
2) Runtime Errors

1) Syntax Errors:

The errors which occur because of invalid syntax are called syntax errors.

Eg 1:

```
x = 10
if x == 10
  print("Hello")
```

SyntaxError: invalid syntax

Eg 2:

```
print "Hello"
```

SyntaxError: Missing parentheses in call to 'print'

Note: Programmer is responsible to correct these syntax errors. Once all syntax errors are corrected then only program execution will be started.

2) Runtime Errors:

- Also known as exceptions.
- While executing the program if something goes wrong because of end user input or programming logic or memory problems etc then we will get Runtime Errors.

Eg:

1) print(10/0) → ZeroDivisionError: division by zero
2) print(10/"ten") → TypeError: unsupported operand type(s) for /: 'int' and 'str'

3)
```
x = int(input("Enter Number:"))
print(x)
```

```
D:\Python_classes>py test.py
Enter Number:ten
ValueError: invalid literal for int() with base 10: 'ten'
```

Note: Exception Handling concept applicable for Runtime Errors but not for syntax errors

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What is Exception?

An unwanted and unexpected event that disturbs normal flow of program is called exception.

Eg:

- **ZeroDivisionError**
- **TypeError**
- **ValueError**
- **FileNotFoundError**
- **EOFError**
- **SleepingError**
- **TyrePuncturedError**

It is highly recommended to handle exceptions. The main objective of exception handling is Graceful Termination of the program (i.e we should not block our resources and we should not miss anything)

Exception handling does not mean repairing exception. We have to define alternative way to continue rest of the program normally.

Eg: For example our programming requirement is reading data from remote file locating at London. At runtime if London file is not available then the program should not be terminated abnormally. We have to provide local file to continue rest of the program normally. This way of defining alternative is nothing but exception handling.

try:

```
Read Data from Remote File locating at London.
except FileNotFoundError:
use local file and continue rest of the program  normally
```

Q. What is an Exception?
Q. What is the purpose of Exception Handling?
Q. What is the meaning of Exception Handling?

Default Exception Handing in Python:

- **Every exception in Python is an object. For every exception type the corresponding classes are available.**
- **Whevever an exception occurs PVM will create the corresponding exception object and will check for handling code. If handling code is not available then Python interpreter terminates the program abnormally and prints corresponding exception information to the console.**
- **The rest of the program won't be executed.**

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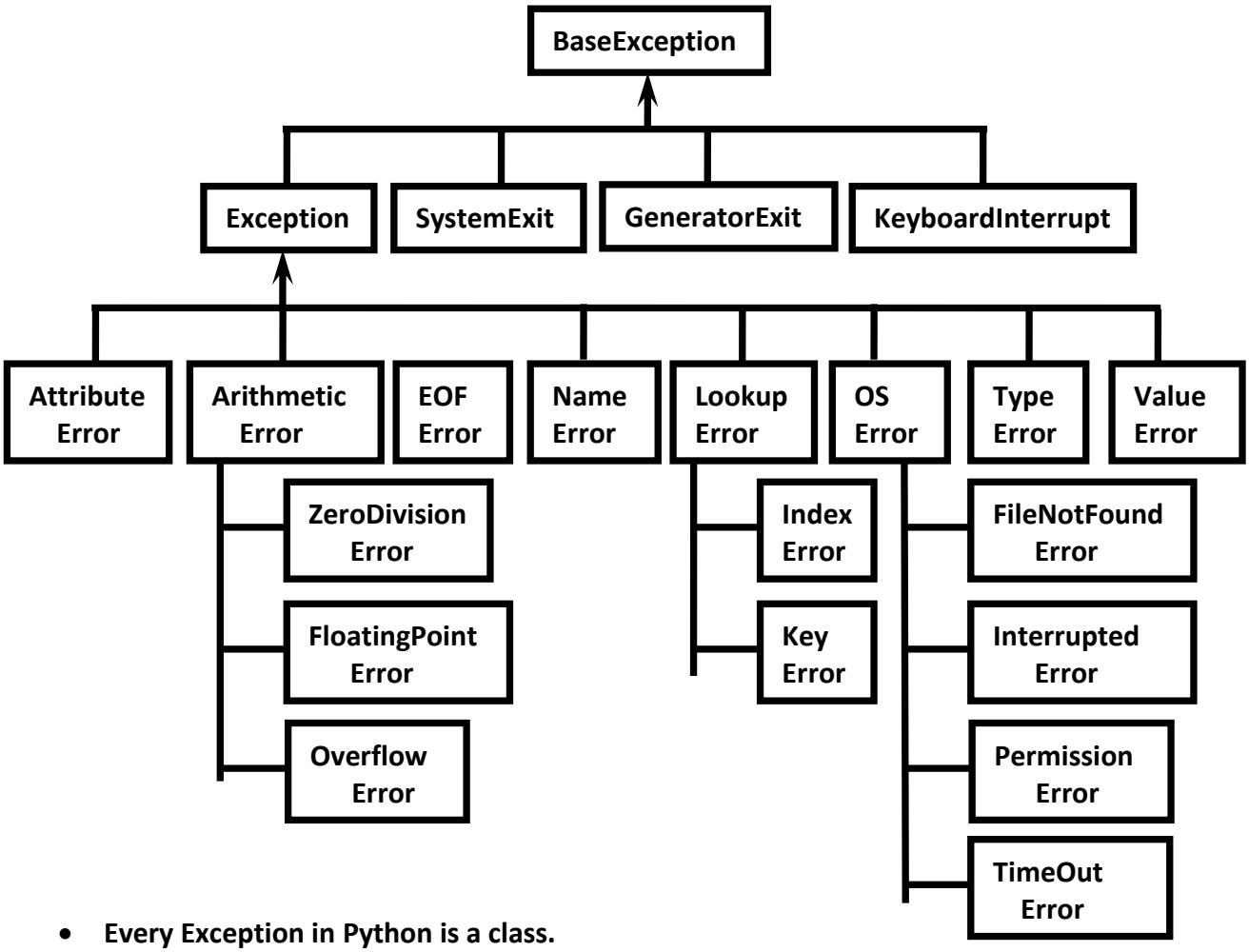
```
1) print("Hello")
2) print(10/0)
3) print("Hi")
```

```
D:\Python_classes>py test.py
Hello
Traceback (most recent call last):
  File "test.py", line 2, in <module>
    print(10/0)
ZeroDivisionError: division by zero
```

Python's Exception Hierarchy



- Every Exception in Python is a class.
- All exception classes are child classes of BaseException.i.e every exception class extends BaseException either directly or indirectly. Hence BaseException acts as root for Python Exception Hierarchy.
- Most of the times being a programmer we have to concentrate Exception and its child classes.

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Customized Exception Handling by using try-except:

- It is highly recommended to handle exceptions.
- The code which may raise exception is called risky code and we have to take risky code inside try block. The corresponding handling code we have to take inside except block.

```
try:
        Risky Code
except XXX:
        Handling code/Alternative Code
```

Without try-except:

```
1) print("stmt-1")
2) print(10/0)
3) print("stmt-3")
```

Output

```
stmt-1
ZeroDivisionError: division by zero
Abnormal termination/Non-Graceful Termination
```

With try-except:

```
1) print("stmt-1")
2) try:
3)     print(10/0)
4) except ZeroDivisionError:
5)     print(10/2)
6) print("stmt-3")
```

Output

```
stmt-1
5.0
stmt-3
Normal termination/Graceful Termination
```

Control Flow in try-except:

```
try:
        stmt-1
        stmt-2
        stmt-3
except XXX:
      stmt-4
stmt-5
```


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Case-1: If there is no exception
1,2,3,5 and Normal Termination

Case-2: If an exception raised at stmt-2 and corresponding except block matched
1,4,5 Normal Termination

Case-3: If an exception rose at stmt-2 and corresponding except block not matched
1, Abnormal Termination

Case-4: If an exception rose at stmt-4 or at stmt-5 then it is always abnormal termination.

Conclusions:

1) Within the try block if anywhere exception raised then rest of the try block won't be executed eventhough we handled that exception. Hence we have to take only risky code inside try block and length of the try block should be as less as possible.
2) In addition to try block, there may be a chance of raising exceptions inside except and finally blocks also.
3) If any statement which is not part of try block raises an exception then it is always abnormal termination.

How to Print Exception Information:

try:

```
1) print(10/0)
2) except ZeroDivisionError as msg:
3)     print("exception raised and its description is:",msg)
```

Output exception raised and its description is: division by zero

try with Multiple except Blocks:

The way of handling exception is varied from exception to exception.Hence for every exception type a seperate except block we have to provide. i.e try with multiple except blocks is possible and recommended to use.

Eg:

```
try:
    -------
    -------
    -------
except ZeroDivisionError:
        perform alternative arithmetic operations
```

except FileNotFoundError:
    use local file instead of remote file

If try with multiple except blocks available then based on raised exception the corresponding except block will be executed.

```
1)  try:
2)     x=int(input("Enter First Number: "))
3)     y=int(input("Enter Second Number: "))
4)     print(x/y)
5)  except ZeroDivisionError :
6)     print("Can't Divide with Zero")
7)  except ValueError:
8)     print("please provide int value only")
```

```
D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: 2
5.0

D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: 0
Can't Divide with Zero

D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: ten
please provide int value only
```

If try with multiple except blocks available then the order of these except blocks is important .Python interpreter will always consider from top to bottom until matched except block identified.

```
1)  try:
2)     x=int(input("Enter First Number: "))
3)     y=int(input("Enter Second Number: "))
4)     print(x/y)
5)  except ArithmeticError :
6)     print("ArithmeticError")
7)  except ZeroDivisionError:
8)     print("ZeroDivisionError")
```

```
D:\Python_classes>py test.py
Enter First Number: 10
```

```
Enter Second Number: 0
ArithmeticError
```

Single except Block that can handle Multiple Exceptions:

We can write a single except block that can handle multiple different types of exceptions.

except (Exception1,Exception2,exception3,..): OR
except (Exception1,Exception2,exception3,..) as msg :

Parentheses are mandatory and this group of exceptions internally considered as tuple.

```
1) try:
2)     x=int(input("Enter First Number: "))
3)     y=int(input("Enter Second Number: "))
4)     print(x/y)
5) except (ZeroDivisionError,ValueError) as msg:
6)     print("Plz Provide valid numbers only and problem is: ",msg)
```

```
D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: 0
Plz Provide valid numbers only and problem is:  division by zero

D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: ten
Plz Provide valid numbers only and problem is:  invalid literal for int() with b are 10: 'ten'
```

Default except Block:

We can use default except block to handle any type of exceptions.
In default except block generally we can print normal error messages.

Syntax:

```
except:
    statements
```

```
1) try:
2)     x=int(input("Enter First Number: "))
3)     y=int(input("Enter Second Number: "))
4)     print(x/y)
5) except ZeroDivisionError:
6)     print("ZeroDivisionError:Can't divide with zero")
7) except:
8)     print("Default Except:Plz provide valid input only")
```

```
D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: 0
ZeroDivisionError:Can't divide with zero

D:\Python_classes>py test.py
Enter First Number: 10
Enter Second Number: ten
Default Except:Plz provide valid input only
```

***Note: If try with multiple except blocks available then default except block should be last, otherwise we will get SyntaxError.

```
1) try:
2)     print(10/0)
3) except:
4)     print("Default Except")
5) except ZeroDivisionError:
6)     print("ZeroDivisionError")
```

SyntaxError: default 'except:' must be last

Note: The following are various possible combinations of except blocks

1) except ZeroDivisionError:
2) except ZeroDivisionError as msg:
3) except (ZeroDivisionError,ValueError) :
4) except (ZeroDivisionError,ValueError) as msg:
5) except :

finally Block:

- It is not recommended to maintain clean up code(Resource Deallocating Code or Resource Releasing code) inside try block because there is no guarentee for the execution of every statement inside try block always.
- It is not recommended to maintain clean up code inside except block, because if there is no exception then except block won't be executed.
- Hence we required some place to maintain clean up code which should be executed always irrespective of whether exception raised or not raised and whether exception handled or not handled. Such type of best place is nothing but finally block.
- Hence the main purpose of finally block is to maintain clean up code.

```
try:
    Risky Code
except:
    Handling Code
```

finally:
    Cleanup code

The speciality of finally block is it will be executed always whether exception raised or not raised and whether exception handled or not handled.

Case-1: If there is no exception

```
1) try:
2)     print("try")
3) except:
4)     print("except")
5) finally:
6)     print("finally")
```

Output

```
try
finally
```

Case-2: If there is an exception raised but handled

```
1) try:
2)     print("try")
3)     print(10/0)
4) except ZeroDivisionError:
5)     print("except")
6) finally:
7)     print("finally")
```

Output

```
try
except
finally
```

Case-3: If there is an exception raised but not handled

```
1) try:
2)     print("try")
3)     print(10/0)
4) except NameError:
5)     print("except")
6) finally:
7)     print("finally")
```


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Output

try
finally
ZeroDivisionError: division by zero(Abnormal Termination)

*** **Note:** There is only one situation where finally block won't be executed ie whenever we are using os._exit(0) function.

Whenever we are using os._exit(0) function then Python Virtual Machine itself will be shutdown.In this particular case finally won't be executed.

```
1) imports
2) try:
3)     print("try")
4)     os._exit(0)
5) except NameError:
6)     print("except")
7) finally:
8)     print("finally")
```

Output: try

Note:
os._exit(0)
Where 0 represents status code and it indicates normal termination
There are multiple status codes are possible.

Control Flow in try-except-finally:

```
try:
        stmt-1
        stmt-2
        stmt-3
except:
        stmt-4
finally:
        stmt-5
        stmt-6
```

Case-1: If there is no exception
1,2,3,5,6 Normal Termination

Case-2: If an exception raised at stmt2 and the corresponding except block matched
1,4,5,6 Normal Termination

Case-3: If an exception raised at stmt2 but the corresponding except block not matched 1,5 Abnormal Termination

Case-4: If an exception raised at stmt4 then it is always abnormal termination but before that finally block will be executed.

Case-5: If an exception raised at stmt-5 or at stmt-6 then it is always abnormal termination

Nested try-except-finally Blocks:

We can take try-except-finally blocks inside try or except or finally blocks.i.e nesting of try-except-finally is possible.

```
try:
    ----------
    ----------
    ----------
    try:
            -------------
            --------------
            --------------
    except:
            --------------
            --------------
            --------------
            ------------
except:
        ------------
        ------------
        ------------
```

General Risky code we have to take inside outer try block and too much risky code we have to take inside inner try block. Inside Inner try block if an exception raised then inner except block is responsible to handle. If it is unable to handle then outer except block is responsible to handle.

```
1)  try:
2)      print("outer try block")
3)      try:
4)          print("Inner try block")
5)          print(10/0)
6)      except ZeroDivisionError:
7)          print("Inner except block")
8)      finally:
9)          print("Inner finally block")
```


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```
10) except:
11)     print("outer except block")
12) finally:
13)     print("outer finally block")
```

Output

```
outer try block
Inner try block
Inner except block
Inner finally block
outer finally block
```

Control Flow in nested try-except-finally:

```
try:
        stmt-1
        stmt-2
        stmt-3
        try:
                stmt-4
                stmt-5
                stmt-6
        except X:
                stmt-7
        finally:
                stmt-8
                stmt-9
except Y:
        stmt-10
finally:
        stmt-11
        stmt-12
```

Case-1: If there is no exception
1,2,3,4,5,6,8,9,11,12 Normal Termination

Case-2: If an exception raised at stmt-2 and the corresponding except block matched
1,10,11,12 Normal Termination

Case-3: If an exceptiion raised at stmt-2 and the corresponding except block not matched
1,11,Abnormal Termination

Case-4: If an exception raised at stmt-5 and inner except block matched
1,2,3,4,7,8,9,11,12 Normal Termination

Case-5: If an exception raised at stmt-5 and inner except block not matched but outer except block matched 1,2,3,4,8,10,11,12,Normal Termination

Case-6: If an exception raised at stmt-5 and both inner and outer except blocks are not matched 1,2,3,4,8,11,Abnormal Termination

Case-7: If an exception raised at stmt-7 and corresponding except block matched
1,2,3,.,.,.,8,10,11,12,Normal Termination

Case-8: If an exception raised at stmt-7 and corresponding except block not matched
1,2,3,.,.,.,8,11,Abnormal Termination

Case-9: If an exception raised at stmt-8 and corresponding except block matched
1,2,3,.,.,.,.,10,11,12 Normal Termination

Case-10: If an exception raised at stmt-8 and corresponding except block not matched
1,2,3,.,.,.,.,11,Abnormal Termination

Case-11: If an exception raised at stmt-9 and corresponding except block matched
1,2,3,.,.,.,.,8,10,11,12,Normal Termination

Case-12: If an exception raised at stmt-9 and corresponding except block not matched
1,2,3,.,.,.,.,8,11,Abnormal Termination

Case-13: If an exception raised at stmt-10 then it is always abonormal termination but before abnormal termination finally block(stmt-11) will be executed.

Case-14: If an exception raised at stmt-11 or stmt-12 then it is always abnormal termination.

Note: If the control entered into try block then compulsary finally block will be executed. If the control not entered into try block then finally block won't be executed.

else Block with try-except-finally:

We can use else block with try-except-finally blocks.
else block will be executed if and only if there are no exceptions inside try block.

```
try:
        Risky Code
except:
        will be executed if exception inside try
```

else:
will be executed if there is no exception inside try
finally:
will be executed whether exception raised or not raised and handled or not handled

Eg:

```
try:
        print("try")
        print(10/0) → 1
except:
        print("except")
else:
        print("else")
finally:
        print("finally")
```

If we comment line-1 then else block will be executed b'z there is no exception inside try. In this case the output is:
try
else
finally

If we are not commenting line-1 then else block won't be executed b'z there is exception inside try block. In this case output is:
try
except
finally

Various possible Combinations of try-except-else-finally:

1) **Whenever we are writing try block, compulsory we should write except or finally block.i.e without except or finally block we cannot write try block.**
2) **Wheneever we are writing except block, compulsory we should write try block. i.e except without try is always invalid.**
3) **Whenever we are writing finally block, compulsory we should write try block. i.e finally without try is always invalid.**
4) **We can write multiple except blocks for the same try,but we cannot write multiple finally blocks for the same try**
5) **Whenever we are writing else block compulsory except block should be there. i.e without except we cannot write else block.**
6) **In try-except-else-finally order is important.**
7) **We can define try-except-else-finally inside try, except, else and finally blocks. i.e nesting of try-except-else-finally is always possible.**

1	try: print("try")	✗
2	except: print("Hello")	✗
3	else: print("Hello")	✗
4	finally: print("Hello")	✗
5	try: print("try") except: print("except")	✓
6	try: print("try") finally: print("finally")	✓

7	try:
	print("try")
	except:
	print("except")
	else:
	print("else")
		✓

8	try:
	print("try")
	else:
	print("else")
		✗

9	try:
	print("try")
	else:
	print("else")
	finally:
	print("finally")
		✗

10	try: print("try") except XXX: print("except-1") except YYY: print("except-2")	✓
11	try: print("try") except : print("except-1")	✗

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	else: print("else") else: print("else")	
12	try: print("try") except : print("except-1") finally: print("finally") finally: print("finally")	✗
13	try: print("try") print("Hello") except: print("except")	✗
14	try: print("try") except: print("except") print("Hello") except: print("except")	✗
15	try: print("try") except: print("except") print("Hello") finally: print("finally")	✗

16	try:
	print("try")
	except:
	print("except")
	print("Hello")
	else:
	print("else")
		✗

17	try: print("try") except: print("except") try: print("try")	✓

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	except: print("except")	
18	try: print("try") except: print("except") try: print("try") finally: print("finally")	✓

19	try:
	print("try")
	except:
	print("except")
	if 10>20:
	print("if")
	else:
	print("else")
		✓

20	try: print("try") try: print("inner try") except: print("inner except block") finally: print("inner finally block") except: print("except")	✓
21	try: print("try") except: print("except") try: print("inner try") except: print("inner except block") finally: print("inner finally block")	✓
22	try: print("try") except: print("except") finally:	✓

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	try:
	  print("inner try")
	except:
	  print("inner except block")
	finally:
	  print("inner finally block")	

23	try:
	  print("try")
	except:
	  print("except")
	try:
	  print("try")
	else:
	  print("else")
		✗

24	try:
	  print("try")
	  try:
	  print("inner try")
	except:
	  print("except")
		✗

25	try:
	  print("try")
	else:
	  print("else")
	except:
	  print("except")
	finally:
	  print("finally")
		✗

Types of Exceptions:

In Python there are 2 types of exceptions are possible.

1) Predefined Exceptions
2) User Definded Exceptions

1) Predefined Exceptions:

- Also known as inbuilt exceptions.
- The exceptions which are raised automatically by Python virtual machine whenver a particular event occurs are called pre defined exceptions.

Eg 1: Whenever we are trying to perform Division by zero, automatically Python will raise ZeroDivisionError.

```
print(10/0)
```


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Eg 2: Whenever we are trying to convert input value to int type and if input value is not int value then Python will raise ValueError automatically
x=int("ten") → ValueError

2) User Defined Exceptions:

- Also known as Customized Exceptions or Programatic Exceptions
- Some time we have to define and raise exceptions explicitly to indicate that something goes wrong, such type of exceptions are called User Defined Exceptions or Customized Exceptions
- Programmer is responsible to define these exceptions and Python not having any idea about these. Hence we have to raise explicitly based on our requirement by using "raise" keyword.

  Eg:
  - InSufficientFundsException
  - InvalidInputException
  - TooYoungException
  - TooOldException

How to Define and Raise Customized Exceptions:

Every exception in Python is a class that extends Exception class either directly or indirectly.

Syntax:

```
class classname(predefined exception class name):
    def __init__(self,arg):
        self.msg=arg
```

```
1) class TooYoungException(Exception):
2)     def __init__(self,arg):
3)         self.msg=arg
```

TooYoungException is our class name which is the child class of Exception

We can raise exception by using raise keyword as follows
raise TooYoungException("message")

```
1) class TooYoungException(Exception):
2)     def __init__(self,arg):
3)         self.msg=arg
4)
5) class TooOldException(Exception):
6)     def __init__(self,arg):
7)         self.msg=arg
8)
```


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```
9)  age=int(input("Enter Age:"))
10) if age>60:
11)     raise TooYoungException("Plz wait some more time you will get best match soon!!!")
12) elif age<18:
13)     raise TooOldException("Your age already crossed marriage age...no chance of
        getting marriage")
14) else:
15)     print("You will get match details soon by email!!!")
```

```
D:\Python_classes>py test.py
Enter Age:90
__main__.TooYoungException: Plz wait some more time you will get best match soon!!!

D:\Python_classes>py test.py
Enter Age:12
__main__.TooOldException: Your age already crossed marriage age...no chance of g
etting marriage

D:\Python_classes>py test.py
Enter Age:27
You will get match details soon by email!!!
```

Note: raise keyword is best suitable for customized exceptions but not for pre defined exceptions

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FILE HANDLING

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- As the part of programming requirement, we have to store our data permanently for future purpose. For this requirement we should go for files.
- Files are very common permanent storage areas to store our data.

Types of Files:

There are 2 types of files

1) **Text Files:**
   Usually we can use text files to store character data
   Eg: abc.txt

2) **Binary Files:**
   Usually we can use binary files to store binary data like images,video files, audio files etc...

Opening a File:

- Before performing any operation (like read or write) on the file,first we have to open that file.For this we should use Python's inbuilt function open()
- But at the time of open, we have to specify mode,which represents the purpose of opening file.

```
f = open(filename, mode)
```

The allowed modes in Python are

1) r → open an existing file for read operation. The file pointer is positioned at the beginning of the file.If the specified file does not exist then we will get FileNotFoundError.This is default mode.

2) w → open an existing file for write operation. If the file already contains some data then it will be overridden. If the specified file is not already avaialble then this mode will create that file.

3) a → open an existing file for append operation. It won't override existing data.If the specified file is not already avaialble then this mode will create a new file.

4) r+ → To read and write data into the file. The previous data in the file will not be deleted.The file pointer is placed at the beginning of the file.
5) w+ → To write and read data. It will override existing data.

6) a+ → To append and read data from the file.It wont override existing data.

7) x → To open a file in exclusive creation mode for write operation. If the file already exists then we will get FileExistsError.

Note: All the above modes are applicable for text files. If the above modes suffixed with 'b' then these represents for binary files.

Eg: rb,wb,ab,r+b,w+b,a+b,xb

f = open("abc.txt","w")

We are opening abc.txt file for writing data.

Closing a File:

After completing our operations on the file, it is highly recommended to close the file. For this we have to use close() function.

f.close()

Various Properties of File Object:

Once we opend a file and we got file object, we can get various details related to that file by using its properties.

- name → Name of opened file
- mode → Mode in which the file is opened
- closed → Returns boolean value indicates that file is closed or not
- readable()→ Retruns boolean value indicates that whether file is readable or not
- writable()→ Returns boolean value indicates that whether file is writable or not.

```
1) f=open("abc.txt",'w')
2) print("File Name: ",f.name)
3) print("File Mode: ",f.mode)
4) print("Is File Readable:  ",f.readable())
5) print("Is File Writable:  ",f.writable())
6) print("Is File Closed : ",f.closed)
7) f.close()
8) print("Is File Closed : ",f.closed)
```

Output

```
D:\Python_classes>py test.py
File Name:  abc.txt
File Mode:  w
Is File Readable: False
Is File Writable: True
Is File Closed: False
Is File Closed: True
```


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Writing Data to Text Files:

We can write character data to the text files by using the following 2 methods.

1) write(str)
2) writelines(list of lines)

```
1) f=open("abcd.txt",'w')
2) f.write("Durga\n")
3) f.write("Software\n")
4) f.write("Solutions\n")
5) print("Data written to the file successfully")
6) f.close()
```

abcd.txt:

Durga
Software
Solutions

Note: In the above program, data present in the file will be overridden everytime if we run the program. Instead of overriding if we want append operation then we should open the file as follows.

```
f = open("abcd.txt","a")
```

Eg 2:

```
1) f=open("abcd.txt",'w')
2) list=["sunny\n","bunny\n","vinny\n","chinny"]
3) f.writelines(list)
4) print("List of lines written to the file successfully")
5) f.close()
```

abcd.txt:

sunny
bunny
vinny
chinny

Note: While writing data by using write() methods, compulsory we have to provide line seperator(\n), otherwise total data should be written to a single line.

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Reading Character Data from Text Files:

We can read character data from text file by using the following read methods.

- **read()→ To read total data from the file**
- **read(n) → To read 'n' characters from the file**
- **readline()→ To read only one line**
- **readlines()→ To read all lines into a list**

Eg 1: To read total data from the file

```
f=open("abc.txt",'r')
data=f.read()
print(data)
f.close()
```

Output

sunny
bunny
chinny
vinny

Eg 2: To read only first 10 characters:

```
f=open("abc.txt",'r')
data=f.read(10)
print(data)
f.close()
```

Output

sunny
bunn

Eg 3: To read data line by line:

```
f=open("abc.txt",'r')
line1=f.readline()
print(line1,end='')
line2=f.readline()
print(line2,end='')
line3=f.readline()
print(line3,end='')
f.close()
```

Output

```
sunny
bunny
chinny
```

Eg 4: To read all lines into list:

```
1) f=open("abc.txt",'r')
2) lines=f.readlines()
3) for line in lines:
4)     print(line,end='')
5) f.close()
```

Output

```
sunny
bunny
chinny
vinny
```

Eg 5:

```
1) f=open("abc.txt","r")
2) print(f.read(3))
3) print(f.readline())
4) print(f.read(4))
5) print("Remaining data")
6) print(f.read())
```

Output

```
sun
ny

bunn
Remaining data
y
chinny
vinny
```

The with Statement:

- The with statement can be used while opening a file.We can use this to group file operation statements within a block.
- The advantage of with statement is it will take care closing of file,after completing all operations automatically even in the case of exceptions also, and we are not required to close explicitly.

```
1)  with open("abc.txt","w") as f:
2)      f.write("Durga\n")
3)      f.write("Software\n")
4)      f.write("Solutions\n")
5)      print("Is File Closed: ",f.closed)
6)  print("Is File Closed: ",f.closed)
```

Output

```
Is File Closed:  False
Is File Closed:  True
```

The seek() and tell() Methods:

tell():

- We can use tell() method to return current position of the cursor(file pointer) from beginning of the file. [can you plese telll current cursor position]
- The position(index) of first character in files is zero just like string index.

```
1)  f=open("abc.txt","r")
2)  print(f.tell())
3)  print(f.read(2))
4)  print(f.tell())
5)  print(f.read(3))
6)  print(f.tell())
```

abc.txt:

```
sunny
bunny
chinny
vinny
```

Output:

```
0
su
2
nny
5
```

seek():

We can use seek() method to move cursor (file pointer) to specified location.
[Can you please seek the cursor to a particular location]
f.seek(offset, fromwhere) → offset represents the number of positions

The allowed Values for 2nd Attribute (from where) are
0 → From beginning of File (Default Value)
1 → From Current Position
2 → From end of the File

Note: Python 2 supports all 3 values but Python 3 supports only zero.

```
1)  data="All Students are STUPIDS"
2)  f=open("abc.txt","w")
3)  f.write(data)
4)  with open("abc.txt","r+") as f:
5)      text=f.read()
6)      print(text)
7)      print("The Current Cursor Position: ",f.tell())
8)      f.seek(17)
9)      print("The Current Cursor Position: ",f.tell())
10)     f.write("GEMS!!!")
11)     f.seek(0)
12)     text=f.read()
13)     print("Data After Modification:")
14)     print(text)
```

Output

```
All Students are STUPIDS
The Current Cursor Position:  24
The Current Cursor Position:  17
Data After Modification:
All Students are GEMS!!!
```

How to check a particular File exists OR not?

We can use os library to get information about files in our computer.
os module has path sub module,which contains isFile() function to check whether a particular file exists or not?

```
os.path.isfile(fname)
```

Q) Write a Program to check whether the given File exists OR not. If it is available then print its content?

```
1)  import os,sys
2)  fname=input("Enter File Name: ")
3)  if os.path.isfile(fname):
4)      print("File exists:",fname)
5)      f=open(fname,"r")
6)  else:
```

```
7)     print("File does not exist:",fname)
8)     sys.exit(0)
9)  print("The content of file is:")
10) data=f.read()
11) print(data)
```

Output

```
D:\Python_classes>py test.py
Enter File Name: durga.txt
File does not exist: durga.txt
D:\Python_classes>py test.py
Enter File Name: abc.txt
File exists: abc.txt
The content of file is:
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
```

Note:

sys.exit(0) → To exit system without executing rest of the program.
argument represents status code. 0 means normal termination and it is the default value.

Q) Program to print the Number of Lines, Words and Characters present in the given File?

```
1)  import os,sys
2)  fname=input("Enter File Name: ")
3)  if os.path.isfile(fname):
4)     print("File exists:",fname)
5)     f=open(fname,"r")
6)  else:
7)     print("File does not exist:",fname)
8)     sys.exit(0)
9)  lcount=wcount=ccount=0
10) for line in f:
11)    lcount=lcount+1
12)    ccount=ccount+len(line)
13)    words=line.split()
14)    wcount=wcount+len(words)
15) print("The number of Lines:",lcount)
16) print("The number of Words:",wcount)
```


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```
17) print("The number of Characters:",ccount)
```

Output

```
D:\Python_classes>py test.py
Enter File Name: durga.txt
File does not exist: durga.txt

D:\Python_classes>py test.py
Enter File Name: abc.txt
File exists: abc.txt
The number of Lines: 6
The number of Words: 24
The number of Characters: 149
```

abc.txt

```
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
All Students are GEMS!!!
```

Handling Binary Data:

It is very common requirement to read or write binary data like images,video files,audio files etc.

Q) Program to read Image File and write to a New Image File?

```
1) f1=open("rossum.jpg","rb")
2) f2=open("newpic.jpg","wb")
3) bytes=f1.read()
4) f2.write(bytes)
5) print("New Image is available with the name: newpic.jpg")
```

Handling CSV Files:

- CSV → Comma seperated values
- As the part of programming, it is very common requirement to write and read data wrt csv files. Python provides csv module to handle csv files.

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Writing Data to CSV File:

```
1)  import csv
2)  with open("emp.csv","w",newline='') as f:
3)      w=csv.writer(f)   # returns csv writer object
4)      w.writerow(["ENO","ENAME","ESAL","EADDR"])
5)      n=int(input("Enter Number of Employees:"))
6)      for i in range(n):
7)          eno=input("Enter Employee No:")
8)          ename=input("Enter Employee Name:")
9)          esal=input("Enter Employee Salary:")
10)         eaddr=input("Enter Employee Address:")
11)         w.writerow([eno,ename,esal,eaddr])
12) print("Total Employees data written to csv file successfully")
```

Note: Observe the difference with newline attribute and without

```
with open("emp.csv","w",newline='') as f:
with open("emp.csv","w") as f:
```

Note: If we are not using newline attribute then in the csv file blank lines will be included between data. To prevent these blank lines, newline attribute is required in Python-3,but in Python-2 just we can specify mode as 'wb' and we are not required to use newline attribute.

Reading Data from CSV File:

```
1)  import csv
2)  f=open("emp.csv",'r')
3)  r=csv.reader(f) #returns csv reader object
4)  data=list(r)
5)  #print(data)
6)  for line in data:
7)      for word in line:
8)          print(word,"\t",end='')
9)      print()
```

Output

```
D:\Python_classes>py test.py

ENO   ENAME   ESAL   EADDR
100    Durga   1000    Hyd
200    Sachin  2000    Mumbai
300    Dhoni   3000    Ranchi
```

Zipping and Unzipping Files:

It is very common requirement to zip and unzip files.

The main advantages are:

1) To improve memory utilization
2) We can reduce transport time
3) We can improve performance.

To perform zip and unzip operations, Python contains one in-bulit module zip file.
This module contains a class: ZipFile

To Create Zip File:

We have to create ZipFile class object with name of the zip file, mode and constant ZIP_DEFLATED. This constant represents we are creating zip file.

```
f = ZipFile("files.zip","w","ZIP_DEFLATED")
```

Once we create ZipFile object,we can add files by using write() method.

```
f.write(filename)
```

```
1) from zipfile import *
2) f=ZipFile("files.zip",'w',ZIP_DEFLATED)
3) f.write("file1.txt")
4) f.write("file2.txt")
5) f.write("file3.txt")
6) f.close()
7) print("files.zip file created successfully")
```

To perform unzip Operation:

We have to create ZipFile object as follows

```
f = ZipFile("files.zip","r",ZIP_STORED)
```

ZIP_STORED represents unzip operation. This is default value and hence we are not required to specify.
Once we created ZipFile object for unzip operation, we can get all file names present in that zip file by using namelist() method.

```
names  = f.namelist()
```

```
1) from zipfile import *
2) f=ZipFile("files.zip",'r',ZIP_STORED)
3) names=f.namelist()
4) for name in names:
5)     print(   "File Name: ",name)
```

```
6)  print("The Content of this  file is:")
7)  f1=open(name,'r')
8)  print(f1.read())
9)  print()
```

Working with Directories:

It is very common requirement to perform operations for directories like

1) **To know current working directory**
2) **To create a new directory**
3) **To remove an existing directory**
4) **To rename a directory**
5) **To list contents of the directory**

   etc...

To perform these operations, Python provides inbuilt module os,which contains several functions to perform directory related operations.

Q1) To Know Current Working Directory

```
import os
cwd = os.getcwd()
print("Current Working Directory:",cwd)
```

Q2) To Create a Sub Directory in the Current Working Directory

```
import os
os.mkdir("mysub")
print("mysub directory created in cwd")
```

Q3) To Create a Sub Directory in mysub Directory

```
cwd
   |-mysub
        |-mysub2
```

```
import os
os.mkdir("mysub/mysub2")
print("mysub2  created inside mysub")
```

Note: **Assume mysub already present in cwd.**

Q4) To Create Multiple Directories like sub1 in that sub2 in that sub3

```
import os
os.makedirs("sub1/sub2/sub3")
print("sub1 and in that sub2 and in that sub3 directories created")
```


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Q5) To Remove a Directory

```
import os
os.rmdir("mysub/mysub2")
print("mysub2 directory deleted")
```

Q6) To Remove Multiple Directories in the Path

```
import os
os.removedirs("sub1/sub2/sub3")
print("All 3 directories sub1,sub2 and sub3 removed")
```

Q7) To Rename a Directory

```
import os
os.rename("mysub","newdir")
print("mysub directory renamed to newdir")
```

Q8) To know Contents of Directory

OS Module provides listdir() to list out the contents of the specified directory. It won't display the contents of sub directory.

```
1) import os
2) print(os.listdir("."))
```

Output

```
D:\Python_classes>py test.py
['abc.py', 'abc.txt', 'abcd.txt', 'com', 'demo.py', 'durgamath.py', 'emp.csv', '
file1.txt', 'file2.txt', 'file3.txt', 'files.zip', 'log.txt', 'module1.py', 'myl
og.txt', 'newdir', 'newpic.jpg', 'pack1', 'rossum.jpg', 'test.py', '__pycache__']
```

- The above program display contents of current working directory but not contents of sub directories.
- If we want the contents of a directory including sub directories then we should go for walk() function.

Q9) To Know Contents of Directory including Sub Directories

- We have to use walk() function
- [Can you please walk in the directory so that we can aware all contents of that directory]
- os.walk(path, topdown = True, onerror = None, followlinks = False)
- It returns an Iterator object whose contents can be displayed by using for loop

- path → Directory Path. cwd means .
- topdown = True → Travel from top to bottom

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- onerror = None → On error detected which function has to execute.
- followlinks = True → To visit directories pointed by symbolic links

Eg: To display all contents of Current working directory including sub directories:

```
1) import os
2) for dirpath,dirnames,filenames  in os.walk('.'):
3)     print("Current Directory Path:",dirpath)
4)     print("Directories:",dirnames)
5)     print("Files:",filenames)
6)     print()
```

Output

```
Current Directory Path: .
Directories: ['com', 'newdir', 'pack1', '__pycache__']
Files: ['abc.txt', 'abcd.txt', 'demo.py', 'durgamath.py', 'emp.csv', 'file1.txt', 'file2.txt', 'file3.
txt', 'files.zip', 'log.txt', 'module1.py', 'mylog.txt', 'newpic.jpg', 'rossum.jpg', 'test.py']

Current Directory Path: .\com
Directories: ['durgasoft', '__pycache__']
Files: ['module1.py', '__init__.py']
...
```

Note: To display contents of particular directory, we have to provide that directory name as argument to walk() function.

```
os.walk("directoryname")
```

Q) What is the difference between listdir() and walk() Functions?

In the case of listdir(), we will get contents of specified directory but not sub directory contents. But in the case of walk() function we will get contents of specified directory and its sub directories also.

Running Other Programs from Python Program:

OS Module contains system() function to run programs and commands.
It is exactly same as system() function in C language.

```
os.system("commad string")
```

The argument is any command which is executing from DOS.

Eg:

```
import os
os.system("dir *.py")
os.system("py abc.py")
```


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How to get Information about a File:

We can get statistics of a file like size, last accessed time,last modified time etc by using stat() function of os module.

```
stats = os.stat("abc.txt")
```

The statistics of a file includes the following parameters:

1) **st_mode → Protection Bits**
2) **st_ino → Inode number**
3) **st_dev → Device**
4) **st_nlink → Number of Hard Links**
5) **st_uid → User id of Owner**
6) **st_gid → Group id of Owner**
7) **st_size → Size of File in Bytes**
8) **st_atime → Time of Most Recent Access**
9) **st_mtime → Time of Most Recent Modification**
10) **st_ctime → Time of Most Recent Meta Data Change**

Note: st_atime, st_mtime and st_ctime returns the time as number of milli seconds since Jan 1st 1970, 12:00 AM. By using datetime module from timestamp() function, we can get exact date and time.

Q) To Print all Statistics of File abc.txt

```
1) import os
2) stats=os.stat("abc.txt")
3) print(stats)
```

Output

```
os.stat_result(st_mode=33206, st_ino=844424930132788, st_dev=2657980798, st_nlin
k=1, st_uid=0, st_gid=0, st_size=22410, st_atime=1505451446, st_mtime=1505538999
, st_ctime=1505451446)
```

Q) To Print specified Properties

```
1) import os
2) from  datetime  import *
3) stats=os.stat("abc.txt")
4) print("File Size in Bytes:",stats.st_size)
5) print("File Last Accessed Time:",datetime.fromtimestamp(stats.st_atime))
6) print("File Last Modified Time:",datetime.fromtimestamp(stats.st_mtime))
```


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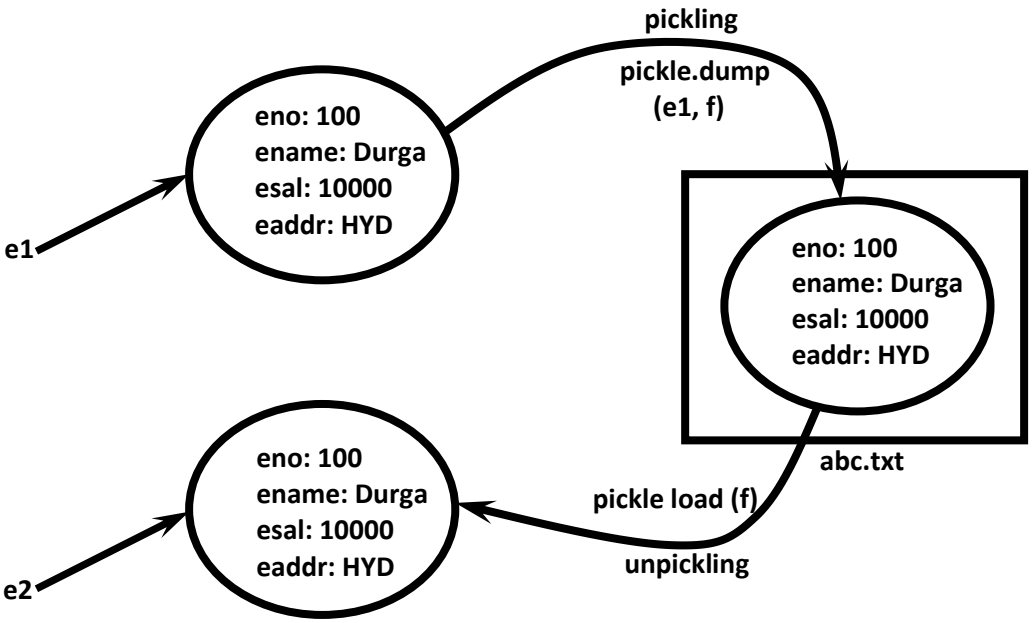
Output

```
File Size in Bytes: 22410
File Last Accessed Time: 2017-09-15 10:27:26.599490
File Last Modified Time: 2017-09-16 10:46:39.245394
```

Pickling and Unpickling of Objects:

- Sometimes we have to write total state of object to the file and we have to read total object from the file.
- The process of writing state of object to the file is called pickling and the process of reading state of an object from the file is called unpickling.
- We can implement pickling and unpickling by using pickle module of Python.
- pickle module contains dump() function to perform pickling. `pickle.dump(object,file)`
- pickle module contains load() function to perform unpickling `obj=pickle.load(file)`



Writing and Reading State of Object by using pickle Module:

```
1)  import pickle
2)  class Employee:
3)      def __init__(self,eno,ename,esal,eaddr):
4)          self.eno=eno;
5)          self.ename=ename;
6)          self.esal=esal;
7)          self.eaddr=eaddr;
8)      def display(self):
9)          print(self.eno,"\t",self.ename,"\t",self.esal,"\t",self.eaddr)
10) with open("emp.dat","wb") as f:
11)     e=Employee(100,"Durga",1000,"Hyd")
```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```
12)    pickle.dump(e,f)
13)    print("Pickling of Employee Object completed...")
14)
15) with open("emp.dat","rb") as f:
16)    obj=pickle.load(f)
17)    print("Printing Employee Information after unpickling")
18)    obj.display()
```

Writing Multiple Employee Objects to the File:

emp.py:

```
1)  class Employee:
2)     def __init__(self,eno,ename,esal,eaddr):
3)        self.eno=eno;
4)        self.ename=ename;
5)        self.esal=esal;
6)        self.eaddr=eaddr;
7)     def display(self):
8)
9)     print(self.eno,"\t",self.ename,"\t",self.esal,"\t",self.eaddr)
```

pick.py:

```
1)  import emp,pickle
2)  f=open("emp.dat","wb")
3)  n=int(input("Enter The number of Employees:"))
4)  for i in range(n):
5)     eno=int(input("Enter Employee Number:"))
6)     ename=input("Enter Employee Name:")
7)     esal=float(input("Enter Employee Salary:"))
8)     eaddr=input("Enter Employee Address:")
9)     e=emp.Employee(eno,ename,esal,eaddr)
10)    pickle.dump(e,f)
11) print("Employee Objects pickled successfully")
```

unpick.py:

```
1)  import emp,pickle
2)  f=open("emp.dat","rb")
3)  print("Employee Details:")
4)  while True:
5)     try:
6)        obj=pickle.load(f)
```


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```
7)          obj.display()
8)      except EOFError:
9)          print("All employees Completed")
10)         break
11) f.close()
```


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MULTI THREADING

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Multi Tasking:

Executing several tasks simultaneously is the concept of multitasking.

There are 2 types of Multi Tasking

1) **Process based Multi Tasking**
2) **Thread based Multi Tasking**

1) Process based Multi Tasking:

Executing several tasks simmultaneously where each task is a seperate independent process is called process based multi tasking.

Eg: while typing python program in the editor we can listen mp3 audio songs from the same system. At the same time we can download a file from the internet. All these taks are executing simultaneously and independent of each other. Hence it is process based multi tasking.

This type of multi tasking is best suitable at operating system level.

2) Thread based MultiTasking:

- **Executing several tasks simultaneously where each task is a seperate independent part of the same program, is called Thread based multi tasking, and each independent part is called a Thread.**
- **This type of multi tasking is best suitable at programmatic level.**

Note: Whether it is process based or thread based, the main advantage of multi tasking is to improve performance of the system by reducing response time.

The main important application areas of multi threading are:

1) **To implement Multimedia graphics**
2) **To develop animations**
3) **To develop video games**
4) **To develop web and application servers**

   etc...

Note: Where ever a group of independent jobs are available, then it is highly recommended to execute simultaneously instead of executing one by one.For such type of cases we should go for Multi Threading.

- **Python provides one inbuilt module "threading" to provide support for developing threads. Hence developing multi threaded Programs is very easy in python.**
- **Every Python Program by default contains one thread which is nothing but MainThread.**

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Q) Program to print Name of Current executing Thread

```
1) import threading
2) print("Current Executing Thread:",threading.current_thread().getName())
```

Output: Current Executing Thread: MainThread

Note: threading module contains function current_thread() which returns the current executing Thread object. On this object if we call getName() method then we will get current executing thread name.

The ways of Creating Thread in Python:

We can create a thread in Python by using 3 ways

1) Creating a Thread without using any class
2) Creating a Thread by extending Thread class
3) Creating a Thread without extending Thread class

1) Creating a Thread without using any Class

```
1) from threading import *
2) def display():
3)     for i in range(1,11):
4)         print("Child Thread")
5) t=Thread(target=display) #creating Thread object
6) t.start() #starting of Thread
7) for i in range(1,11):
8)     print("Main Thread")
```

If multiple threads present in our program, then we cannot expect execution order and hence we cannot expect exact output for the multi threaded programs. B'z of this we cannot provide exact output for the above program.It is varied from machine to machine and run to run.

Note: Thread is a pre defined class present in threading module which can be used to create our own Threads.

2) Creating a Thread by extending Thread Class

We have to create child class for Thread class. In that child class we have to override run() method with our required job. Whenever we call start() method then automatically run() method will be executed and performs our job.

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```
1)  from threading import *
2)  class MyThread(Thread):
3)      def run(self):
4)          for i in range(10):
5)              print("Child Thread-1")
6)  t=MyThread()
7)  t.start()
8)  for i in range(10):
9)      print("Main Thread-1")
```

3) Creating a Thread without extending Thread Class

```
1)  from threading import *
2)  class Test:
3)      def display(self):
4)          for i in range(10):
5)              print("Child Thread-2")
6)  obj=Test()
7)  t=Thread(target=obj.display)
8)  t.start()
9)  for i in range(10):
10)     print("Main Thread-2")
```

Without Multi Threading

```
1)  from threading import *
2)  import time
3)  def doubles(numbers):
4)      for n in numbers:
5)          time.sleep(1)
6)          print("Double:",2*n)
7)  def squares(numbers):
8)      for n in numbers:
9)          time.sleep(1)
10)         print("Square:",n*n)
11) numbers=[1,2,3,4,5,6]
12) begintime=time.time()
13) doubles(numbers)
14) squares(numbers)
15) print("The total time taken:",time.time()-begintime)
```


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With Multi Threading

```
1)  from threading import *
2)  import time
3)  def doubles(numbers):
4)      for n in numbers:
5)          time.sleep(1)
6)          print("Double:",2*n)
7)  def squares(numbers):
8)      for n in numbers:
9)          time.sleep(1)
10)         print("Square:",n*n)
11)
12) numbers=[1,2,3,4,5,6]
13) begintime=time.time()
14) t1=Thread(target=doubles,args=(numbers,))
15) t2=Thread(target=squares,args=(numbers,))
16) t1.start()
17) t2.start()
18) t1.join()
19) t2.join()
20) print("The total time taken:",time.time()-begintime)
```

Setting and Getting Name of a Thread:

Every thread in python has name. It may be default name generated by Python or Customized Name provided by programmer.

We can get and set name of thread by using the following Thread class methods.
t.getName() ➔ Returns Name of Thread
t.setName(newName) ➔ To set our own name

Note: Every Thread has implicit variable "name" to represent name of Thread.

```
1)  from threading import *
2)  print(current_thread().getName())
3)  current_thread().setName("Pawan Kalyan")
4)  print(current_thread().getName())
5)  print(current_thread().name)
```

Output

```
MainThread
Pawan Kalyan
Pawan Kalyan
```


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Thread Identification Number (ident):

For every thread internally a unique identification number is available. We can access this id by using implicit variable "ident"

```
1) from threading import *
2) def test():
3)     print("Child Thread")
4) t=Thread(target=test)
5) t.start()
6) print("Main Thread Identification Number:",current_thread().ident)
7) print("Child Thread Identification Number:",t.ident)
```

Output:

```
Child Thread
Main Thread Identification Number: 2492
Child Thread Identification Number: 2768
```

active_count():

This function returns the number of active threads currently running.

```
1) from threading import *
2) import time
3) def display():
4)     print(current_thread().getName(),"...started")
5)     time.sleep(3)
6)     print(current_thread().getName(),"...ended")
7) print("The Number of active Threads:",active_count())
8) t1=Thread(target=display,name="ChildThread1")
9) t2=Thread(target=display,name="ChildThread2")
10) t3=Thread(target=display,name="ChildThread3")
11) t1.start()
12) t2.start()
13) t3.start()
14) print("The Number of active Threads:",active_count())
15) time.sleep(5)
16) print("The Number of active Threads:",active_count())
```

Output:

```
D:\python_classes>py test.py
The Number of active Threads: 1
ChildThread1 ...started
ChildThread2 ...started
ChildThread3 ...started
The Number of active Threads: 4
```

```
ChildThread1 ...ended
ChildThread2 ...ended
ChildThread3 ...ended
The Number of active Threads: 1
```

enumerate() Function:

This function returns a list of all active threads currently running.

```
1)  from threading import *
2)  import time
3)  def display():
4)      print(current_thread().getName(),"...started")
5)      time.sleep(3)
6)      print(current_thread().getName(),"...ended")
7)  t1=Thread(target=display,name="ChildThread1")
8)  t2=Thread(target=display,name="ChildThread2")
9)  t3=Thread(target=display,name="ChildThread3")
10) t1.start()
11) t2.start()
12) t3.start()
13) l=enumerate()
14) for t in l:
15)     print("Thread Name:",t.name)
16) time.sleep(5)
17) l=enumerate()
18) for t in l:
19)     print("Thread Name:",t.name)
```

Output:

```
D:\python_classes>py test.py
ChildThread1 ...started
ChildThread2 ...started
ChildThread3 ...started
Thread Name: MainThread
Thread Name: ChildThread1
Thread Name: ChildThread2
Thread Name: ChildThread3
ChildThread1 ...ended
ChildThread2 ...ended
ChildThread3 ...ended
Thread Name: MainThread
```

isAlive() Method:

isAlive() method checks whether a thread is still executing or not.

```
1)  from threading import *
2)  import time
3)  def display():
4)      print(current_thread().getName(),"...started")
5)      time.sleep(3)
6)      print(current_thread().getName(),"...ended")
7)  t1=Thread(target=display,name="ChildThread1")
8)  t2=Thread(target=display,name="ChildThread2")
9)  t1.start()
10) t2.start()
11)
12) print(t1.name,"is Alive :",t1.isAlive())
13) print(t2.name,"is Alive :",t2.isAlive())
14) time.sleep(5)
15) print(t1.name,"is Alive :",t1.isAlive())
16) print(t2.name,"is Alive :",t2.isAlive())
```

Output:

```
D:\python_classes>py test.py
ChildThread1 ...started
ChildThread2 ...started
ChildThread1 is Alive : True
ChildThread2 is Alive : True
ChildThread1 ...ended
ChildThread2 ...ended
ChildThread1 is Alive : False
ChildThread2 is Alive : False
```

join() Method:

If a thread wants to wait until completing some other thread then we should go for join() method.

```
1)  from threading import *
2)  import time
3)  def display():
4)      for i in range(10):
5)          print("Seetha Thread")
6)          time.sleep(2)
7)
8)  t=Thread(target=display)
9)  t.start()
```


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```
10) t.join()#This Line executed by Main Thread
11) for i in range(10):
12)     print("Rama Thread")
```

In the above example Main Thread waited until completing child thread. In this case output is:

```
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
```

Note: We can call join() method with time period also.

t.join(seconds)

In this case thread will wait only specified amount of time.

```
1)  from threading import *
2)  import time
3)  def display():
4)      for i in range(10):
5)          print("Seetha Thread")
6)          time.sleep(2)
7)
8)  t=Thread(target=display)
9)  t.start()
10) t.join(5)#This Line executed by Main Thread
11) for i in range(10):
12)     print("Rama Thread")
```


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In this case Main Thread waited only 5 seconds.

Output

```
Seetha Thread
Seetha Thread
Seetha Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Rama Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
Seetha Thread
```

Summary of all methods related to threading module and Thread

Daemon Threads:

- The threads which are running in the background are called Daemon Threads.
- The main objective of Daemon Threads is to provide support for Non Daemon Threads(like main thread)
  Eg: Garbage Collector
- Whenever Main Thread runs with low memory, immediately PVM runs Garbage Collector to destroy useless objects and to provide free memory,so that Main Thread can continue its execution without having any memory problems.
- We can check whether thread is Daemon or not by using t.isDaemon() method of Thread class or by using daemon property.

```
1) from threading import *
2) print(current_thread().isDaemon()) #False
3) print(current_thread().daemon) #False
```

- We can change Daemon nature by using setDaemon() method of Thread class.
  t.setDaemon(True)

- But we can use this method before starting of Thread.i.e once thread started,we cannot change its Daemon nature,otherwise we will get
- RuntimeException:cannot set daemon status of active thread.

```
1) from threading import *
2) print(current_thread().isDaemon())
3) current_thread().setDaemon(True)
```

RuntimeError: cannot set daemon status of active thread

Default Nature:

By default Main Thread is always non-daemon.But for the remaining threads Daemon nature will be inherited from parent to child.i.e if the Parent Thread is Daemon then child thread is also Daemon and if the Parent Thread is Non Daemon then ChildThread is also Non Daemon.

```
1) from threading import *
2) def job():
3)     print("Child Thread")
4) t=Thread(target=job)
5) print(t.isDaemon())#False
6) t.setDaemon(True)
7) print(t.isDaemon()) #True
```

Note: Main Thread is always Non-Daemon and we cannot change its Daemon Nature b'z it is already started at the beginning only.

Whenever the last Non-Daemon Thread terminates automatically all Daemon Threads will be terminated.

```
1) from threading import *
2) import time
3) def job():
4)     for i in range(10):
5)         print("Lazy Thread")
6)         time.sleep(2)
7)
8) t=Thread(target=job)
9) #t.setDaemon(True)===>Line-1
10) t.start()
11) time.sleep(5)
12) print("End Of Main Thread")
```


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In the above program if we comment Line-1 then both Main Thread and Child Threads are Non Daemon and hence both will be executed until their completion.
In this case output is:

```
Lazy Thread
Lazy Thread
Lazy Thread
End Of Main Thread
Lazy Thread
Lazy Thread
Lazy Thread
Lazy Thread
Lazy Thread
Lazy Thread
Lazy Thread
```

If we are not commenting Line-1 then Main Thread is Non-Daemon and Child Thread is Daemon. Hence whenever MainThread terminates automatically child thread will be terminated. In this case output is

```
Lazy Thread
Lazy Thread
Lazy Thread
End of Main Thread
```

Synchronization:

If multiple threads are executing simultaneously then there may be a chance of data inconsistency problems.

```
1)  from threading import *
2)  import time
3)  def wish(name):
4)      for i in range(10):
5)          print("Good Evening:",end='')
6)          time.sleep(2)
7)          print(name)
8)  t1=Thread(target=wish,args=("Dhoni",))
9)  t2=Thread(target=wish,args=("Yuvraj",))
10) t1.start()
11) t2.start()
```

Output

```
Good Evening:Good Evening:Yuvraj
Dhoni
```

Good Evening:Good Evening:Yuvraj
Dhoni
....

- We are getting irregular output b'z both threads are executing simultaneously wish() function.
- To overcome this problem we should go for synchronization.
- In synchronization the threads will be executed one by one so that we can overcome data inconsistency problems.
- Synchronization means at a time only one Thread

The main application areas of synchronization are
1) Online Reservation system
2) Funds Transfer from joint accounts
etc

In Python, we can implement synchronization by using the following
1) Lock
2) RLock
3) Semaphore

Synchronization By using Lock Concept:

- Locks are the most fundamental synchronization mechanism provided by threading module.
- We can create Lock object as follows l = Lock()
- The Lock object can be hold by only one thread at a time.If any other thread required the same lock then it will wait until thread releases lock. (Similar to common wash rooms, public telephone booth etc)
- A Thread can acquire the lock by using acquire() Method l.acquire()
- A Thread can release the lock by using release() Method l.release()

Note: To call release() method compulsory thread should be owner of that lock.i.e thread should has the lock already,otherwise we will get Runtime Exception saying RuntimeError: release unlocked lock.

```
1) from threading import *
2) l=Lock()
3) #l.acquire() → 1
4) l.release()
```

If we are commenting line-1 then we will get RuntimeError: release unlocked lock

```
1) from threading import *
2) import time
```


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```
3)  l=Lock()
4)  def wish(name):
5)      l.acquire()
6)      for i in range(10):
7)          print("Good Evening:",end='')
8)          time.sleep(2)
9)          print(name)
10)     l.release()
11)
12) t1=Thread(target=wish,args=("Dhoni",))
13) t2=Thread(target=wish,args=("Yuvraj",))
14) t3=Thread(target=wish,args=("Kohli",))
15) t1.start()
16) t2.start()
17)         t3.start()
```

In the above program at a time only one thread is allowed to execute wish() method and hence we will get regular output.

Problem with Simple Lock:

The standard Lock object does not care which thread is currently holding that lock.If the lock is held and any thread attempts to acquire lock, then it will be blocked,even the same thread is already holding that lock.

```
1)  from threading import *
2)  l=Lock()
3)  print("Main Thread trying to acquire Lock")
4)  l.acquire()
5)  print("Main Thread trying to acquire Lock Again")
6)  l.acquire()
```

Output

```
D:\python_classes>py test.py
Main Thread trying to acquire Lock
Main Thread trying to acquire Lock Again
--
```

In the above Program main thread will be blocked b'z it is trying to acquire the lock second time.

Note: To kill the blocking thread from windows command prompt we have to use ctrl+break. Here ctrl+C won't work.

If the Thread calls recursive functions or nested access to resources,then the thread may trying to acquire the same lock again and again,which may block our thread.

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Hence Traditional Locking mechanism won't work for executing recursive functions.

To overcome this problem, we should go for RLock(Reentrant Lock). Reentrant means the thread can acquire the same lock again and again.If the lock is held by other threads then only the thread will be blocked.

Reentrant facility is available only for owner thread but not for other threads.

```
1) from threading import *
2) l=RLock()
3) print("Main Thread trying to acquire Lock")
4) l.acquire()
5) print("Main Thread trying to acquire Lock Again")
6) l.acquire()
```

In this case Main Thread won't be Locked b'z thread can acquire the lock any number of times.

This RLock keeps track of recursion level and hence for every acquire() call compulsory release() call should be available. i.e the number of acquire() calls and release() calls should be matched then only lock will be released.

Eg:

```
l=RLock()
l.acquire()
l.acquire()
l.release()
l.release()
```

After 2 release() calls only the Lock will be released.

Note:

1) Only owner thread can acquire the lock multiple times
2) The number of acquire() calls and release() calls should be matched.

Demo Program for Synchronization by using RLock:

```
1) from threading import *
2) import time
3) l=RLock()
4) def factorial(n):
5)     l.acquire()
6)     if n==0:
7)         result=1
```

```
8)      else:
9)          result=n*factorial(n-1)
10)     l.release()
11)     return result
12)
13) def results(n):
14)     print("The Factorial of",n,"is:",factorial(n))
15)
16) t1=Thread(target=results,args=(5,))
17) t2=Thread(target=results,args=(9,))
18) t1.start()
19) t2.start()
```

Output:

The Factorial of 5 is: 120
The Factorial of 9 is: 362880

In the above program instead of RLock if we use normal Lock then the thread will be blocked.

Difference between Lock and RLock

Lock	RLock
1) Lock object can be acquired by only one thread at a time.Even owner thread also cannot acquire multiple times.	1) RLock object can be acquired by only one thread at a time, but owner thread can acquire same lock object multiple times.
2) Not suitable to execute recursive functions and nested access calls.	2) Best suitable to execute recursive functions and nested access calls.
3) In this case Lock object will takes care only Locked or unlocked and it never takes care about owner thread and recursion level.	3) In this case RLock object will takes care whether Locked or unlocked and owner thread information, recursiion level.

Synchronization by using Semaphore:

- In the case of Lock and RLock, at a time only one thread is allowed to execute.
- Sometimes our requirement is at a time a particular number of threads are allowed to access(like at a time 10 memebers are allowed to access database server,4 members are allowed to access Network connection etc).To handle this requirement we cannot use Lock and RLock concepts and we should go for Semaphore concept.
- Semaphore can be used to limit the access to the shared resources with limited capacity.
- Semaphore is advanced Synchronization Mechanism.

- We can create Semaphore object as follows s = Semaphore(counter)
- Here counter represents the maximum number of threads are allowed to access simultaneously. The default value of counter is 1.
- Whenever thread executes acquire() method,then the counter value will be decremented by 1 and if thread executes release() method then the counter value will be incremented by 1.
- i.e for every acquire() call counter value will be decremented and for every release() call counter value will be incremented.

Case-1: s = Semaphore()

In this case counter value is 1 and at a time only one thread is allowed to access. It is exactly same as Lock concept.

Case-2: s = Semaphore(3)

In this case Semaphore object can be accessed by 3 threads at a time.The remaining threads have to wait until releasing the semaphore.

```
1)  from threading import *
2)  import time
3)  s=Semaphore(2)
4)  def wish(name):
5)      s.acquire()
6)      for i in range(10):
7)          print("Good Evening:",end='')
8)          time.sleep(2)
9)          print(name)
10)     s.release()
11)
12) t1=Thread(target=wish,args=("Dhoni",))
13) t2=Thread(target=wish,args=("Yuvraj",))
14) t3=Thread(target=wish,args=("Kohli",))
15) t4=Thread(target=wish,args=("Rohit",))
16) t5=Thread(target=wish,args=("Pandya",))
17) t1.start()
18) t2.start()
19) t3.start()
20) t4.start()
21) t5.start()
```

In the above program at a time 2 threads are allowed to access semaphore and hence 2 threads are allowed to execute wish() function.

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Bounded Semaphore:

Normal Semaphore is an unlimited semaphore which allows us to call release() method any number of times to increment counter.The number of release() calls can exceed the number of acquire() calls also.

```
1) from threading import *
2) s=Semaphore(2)
3) s.acquire()
4) s.acquire()
5) s.release()
6) s.release()
7) s.release()
8) s.release()
9) print("End")
```

- It is valid because in normal semaphore we can call release() any number of times.
- BounedSemaphore is exactly same as Semaphore except that the number of release() calls should not exceed the number of acquire() calls,otherwise we will get ValueError: Semaphore released too many times

```
1) from threading import *
2) s=BoundedSemaphore(2)
3) s.acquire()
4) s.acquire()
5) s.release()
6) s.release()
7) s.release()
8) s.release()
9) print("End")
```

ValueError: Semaphore released too many times
It is invalid b'z the number of release() calls should not exceed the number of acquire() calls in BoundedSemaphore.

Note: To prevent simple programming mistakes, it is recommended to use BoundedSemaphore over normal Semaphore.

Difference between Lock and Semaphore:

At a time Lock object can be acquired by only one thread, but Semaphore object can be acquired by fixed number of threads specified by counter value.

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Conclusion:

The main advantage of synchronization is we can overcome data inconsistency problems.But the main disadvantage of synchronization is it increases waiting time of threads and creates performance problems. Hence if there is no specific requirement then it is not recommended to use synchronization.

Inter Thread Communication:

- **Some times as the part of programming requirement, threads are required to communicate with each other. This concept is nothing but interthread communication.**
- **Eg: After producing items Producer thread has to communicate with Consumer thread to notify about new item.Then consumer thread can consume that new item.**
- **In Python, we can implement interthread communication by using the following ways**
  1) **Event**
  2) **Condition**
  3) **Queue**

  etc

Inter Thread Communication by using Event Objects:

- **Event object is the simplest communication mechanism between the threads. One thread signals an event and other thereds wait for it.**
- **We can create Event object as follows...**
- **event = threading.Event()**
- **Event manages an internal flag that can set() or clear()**
- **Threads can wait until event set.**

Methods of Event Class:

1) **set() ➔ internal flag value will become True and it represents GREEN signal for all waiting threads.**
2) **clear() ➔ inernal flag value will become False and it represents RED signal for all waiting threads.**
3) **isSet() ➔ This method can be used whether the event is set or not**
4) **wait()|wait(seconds) ➔ Thread can wait until event is set**

Pseudo Code:

```
event = threading.Event()
#consumer thread has to wait until event is set
event.wait()
#producer thread can set or clear event
event.set()
event.clear()
```


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Demo Program-1:

```
1)  from threading import *
2)  import time
3)  def producer():
4)      time.sleep(5)
5)      print("Producer thread producing items:")
6)      print("Producer thread giving notification by setting event")
7)      event.set()
8)  def consumer():
9)      print("Consumer thread is waiting for updation")
10)     event.wait()
11)     print("Consumer thread got notification and consuming items")
12)
13) event=Event()
14) t1=Thread(target=producer)
15) t2=Thread(target=consumer)
16) t1.start()
17) t2.start()
```

Output:

```
Consumer thread is waiting for updation
Producer thread producing items
Producer thread giving notification by setting event
Consumer thread got notification and consuming items
```

Demo Program-2:

```
1)   from threading import *
2)  import time
3)  def trafficpolice():
4)      while True:
5)          time.sleep(10)
6)          print("Traffic Police Giving GREEN Signal")
7)          event.set()
8)          time.sleep(20)
9)          print("Traffic Police Giving RED Signal")
10)         event.clear()
11) def driver():
12)     num=0
13)     while True:
14)         print("Drivers waiting for GREEN Signal")
15)         event.wait()
16)         print("Traffic Signal is GREEN...Vehicles can move")
17)         while event.isSet():
```


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```
18)          num=num+1
19)          print("Vehicle No:",num,"Crossing the Signal")
20)          time.sleep(2)
21)       print("Traffic Signal is  RED...Drivers have to wait")
22) event=Event()
23) t1=Thread(target=trafficpolice)
24) t2=Thread(target=driver)
25) t1.start()
26) t2.start()
```

In the above program driver thread has to wait until Trafficpolice thread sets event.ie until giving GREEN signal.Once Traffic police thread sets event(giving GREEN signal),vehicles can cross the signal. Once traffic police thread clears event (giving RED Signal)then the driver thread has to wait.

Inter Thread Communication by using Condition Object:

- Condition is the more advanced version of Event object for interthread communication.A condition represents some kind of state change in the application like producing item or consuming item. Threads can wait for that condition and threads can be notified once condition happend.i.e Condition object allows one or more threads to wait until notified by another thread.
- Condition is always associated with a lock (ReentrantLock).
- A condition has acquire() and release() methods that call the corresponding methods of the associated lock.
- We can create Condition object as follows `condition = threading.Condition()`

Methods of Condition:

1) acquire() ➔ To acquire Condition object before producing or consuming items.i.e thread acquiring internal lock.

2) release() ➔ To release Condition object after producing or consuming items. i.e thread releases internal lock

3) wait()|wait(time) ➔ To wait until getting Notification or time expired

4) notify() ➔ To give notification for one waiting thread

5) notifyAll() ➔ To give notification for all waiting threads

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Case Study:

The producing thread needs to acquire the Condition before producing item to the resource and notifying the consumers.

```
#Producer Thread
...generate item..
condition.acquire()
...add item to the resource...
condition.notify()#signal that a new item is available(notifyAll())
condition.release()
```

The Consumer must acquire the Condition and then it can consume items from the resource

```
#Consumer Thread
condition.acquire()
condition.wait()
consume item
condition.release()
```

Demo Program-1:

```
1)  from threading import *
2)  def consume(c):
3)      c.acquire()
4)      print("Consumer waiting for updation")
5)      c.wait()
6)      print("Consumer got notification & consuming the item")
7)      c.release()
8)
9)  def produce(c):
10)     c.acquire()
11)     print("Producer Producing Items")
12)     print("Producer giving Notification")
13)     c.notify()
14)     c.release()
15)
16) c=Condition()
17) t1=Thread(target=consume,args=(c,))
18) t2=Thread(target=produce,args=(c,))
19) t1.start()
20) t2.start()
```

Output

```
Consumer waiting for updation
Producer Producing Items
Producer giving Notification
Consumer got notification & consuming the item
```

Demo Program-2:

```
1)  from threading import *
2)  import time
3)  import random
4)  items=[]
5)  def produce(c):
6)      while True:
7)          c.acquire()
8)          item=random.randint(1,100)
9)          print("Producer Producing Item:",item)
10)         items.append(item)
11)         print("Producer giving Notification")
12)         c.notify()
13)         c.release()
14)         time.sleep(5)
15)
16) def consume(c):
17)     while True:
18)         c.acquire()
19)         print("Consumer waiting for updation")
20)         c.wait()
21)         print("Consumer consumed the item",items.pop())
22)         c.release()
23)         time.sleep(5)
24)
25) c=Condition()
26) t1=Thread(target=consume,args=(c,))
27) t2=Thread(target=produce,args=(c,))
28) t1.start()
29) t2.start()
```

Output

```
Consumer waiting for updation
Producer Producing Item: 49
Producer giving Notification
Consumer consumed the item 49
.....
```


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In the above program Consumer thread expecting updation and hence it is responsible to call wait() method on Condition object.
Producer thread performing updation and hence it is responsible to call notify() or notifyAll() on Condition object.

Inter Tread Communication by using Queue:

- Queues Concept is the most enhanced Mechanism for interthread communication and to share data between threads.
- Queue internally has Condition and that Condition has Lock.Hence whenever we are using Queue we are not required to worry about Synchronization.
- If we want to use Queues first we should import queue module import queue
- We can create Queue object as follows q = queue.Queue()

Important Methods of Queue:

1) put(): Put an item into the queue.
2) get(): Remove and return an item from the queue.

Producer Thread uses put() method to insert data in the queue. Internally this method has logic to acquire the lock before inserting data into queue. After inserting data lock will be released automatically.

put() method also checks whether the queue is full or not and if queue is full then the Producer thread will entered in to waiting state by calling wait() method internally.

Consumer Thread uses get() method to remove and get data from the queue. Internally this method has logic to acquire the lock before removing data from the queue.Once removal completed then the lock will be released automatically.

If the queue is empty then consumer thread will entered into waiting state by calling wait() method internally.Once queue updated with data then the thread will be notified automatically.

Note: The Queue Module takes care of locking for us which is a great Advantage.

```
1) from threading import *
2) import time
3) import random
4) import queue
5) def produce(q):
6)     while True:
7)         item=random.randint(1,100)
8)         print("Producer Producing Item:",item)
9)         q.put(item)
```


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```
10)       print("Producer giving Notification")
11)       time.sleep(5)
12) def consume(q):
13)     while True:
14)       print("Consumer waiting for updation")
15)       print("Consumer consumed the item:",q.get())
16)       time.sleep(5)
17)
18) q=queue.Queue()
19) t1=Thread(target=consume,args=(q,))
20) t2=Thread(target=produce,args=(q,))
21) t1.start()
22)           t2.start()
```

Output

```
Consumer waiting for updation
Producer Producing Item: 58
Producer giving Notification
Consumer consumed the item: 58
```

Types of Queues:

Python Supports 3 Types of Queues.

1) FIFO Queue:

q = queue.Queue()

This is Default Behaviour. In which order we put items in the queue, in the same order the items will come out (FIFO-First In First Out).

```
1)  import queue
2)  q=queue.Queue()
3)  q.put(10)
4)  q.put(5)
5)  q.put(20)
6)  q.put(15)
7)  while not q.empty():
8)      print(q.get(),end='   ')
```

Output: 10 5 20 15

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2) LIFO Queue:

The removal will be happend in the reverse order of Insertion (Last In First Out)

```
1) import queue
2) q=queue.LifoQueue()
3) q.put(10)
4) q.put(5)
5) q.put(20)
6) q.put(15)
7) while not q.empty():
8)     print(q.get(),end='  ')
```

Output: 15 20 5 10

3) Priority Queue:

The elements will be inserted based on some priority order.

```
1) import queue
2) q=queue.PriorityQueue()
3) q.put(10)
4) q.put(5)
5) q.put(20)
6) q.put(15)
7) while not q.empty():
8)     print(q.get(),end='  ')
```

Output: 5 10 15 20

Eg 2: If the data is non-numeric, then we have to provide our data in the form of tuple.
(x,y)
x is priority
y is our element

```
1) import queue
2) q=queue.PriorityQueue()
3) q.put((1,"AAA"))
4) q.put((3,"CCC"))
5) q.put((2,"BBB"))
6) q.put((4,"DDD"))
7) while not q.empty():
8)     print(q.get()[1],end='  ')
```

Output: AAA BBB CCC DDD

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Good Programming Practices with usage of Locks:

Case-1:

It is highly recommended to write code of releasing locks inside finally block.The advantage is lock will be released always whether exception raised or not raised and whether handled or not handled.

```
l = threading.Lock()
l.acquire()
try:
        perform required safe operations
finally:
        l.release()
```

Demo Program:

```
1)  from threading import *
2)  import time
3)  l=Lock()
4)  def wish(name):
5)      l.acquire()
6)      try:
7)          for i in range(10):
8)              print("Good Evening:",end='')
9)              time.sleep(2)
10)             print(name)
11)     finally:
12)         l.release()
13)
14) t1=Thread(target=wish,args=("Dhoni",))
15) t2=Thread(target=wish,args=("Yuvraj",))
16) t3=Thread(target=wish,args=("Kohli",))
17) t1.start()
18) t2.start()
19)         t3.start()
```

Case-2:

- **It is highly recommended to acquire lock by using with statement. The main advantage of with statement is the lock will be released automatically once control reaches end of with block and we are not required to release explicitly.**
- **This is exactly same as usage of with statement for files.**

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Example for File:

```
with open('demo.txt','w') as f:
    f.write("Hello...")
```

Example for Lock:

```
lock = threading.Lock()
with lock:
        perform required safe operations
        lock will be released automatically
```

Demo Program:

```
1)  from threading import *
2)  import time
3)  lock=Lock()
4)  def wish(name):
5)      with lock:
6)          for i in range(10):
7)              print("Good Evening:",end='')
8)              time.sleep(2)
9)              print(name)
10) t1=Thread(target=wish,args=("Dhoni",))
11) t2=Thread(target=wish,args=("Yuvraj",))
12) t3=Thread(target=wish,args=("Kohli",))
13) t1.start()
14) t2.start()
15) t3.start()
```

Q) What is the Advantage of using with Statement to acquire a Lock in Threading?

Lock will be released automatically once control reaches end of with block and we are not required to release explicitly.

Note: We can use with statement in multithreading for the following cases:

1) Lock
2) RLock
3) Semaphore
4) Condition

PYTHON DATABASE PROGRAMMING

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Storage Areas

As the Part of our Applications, we required to store our Data like Customers Information, Billing Information, Calls Information etc.

To store this Data, we required Storage Areas. There are 2 types of Storage Areas.

1) Temporary Storage Areas
2) Permanent Storage Areas

1) Temporary Storage Areas:

- These are the Memory Areas where Data will be stored temporarily.
  Eg: Python objects like List, Tuple, Dictionary.
- Once Python program completes its execution then these objects will be destroyed automatically and data will be lost.

2) Permanent Storage Areas:

- Also known as Persistent Storage Areas. Here we can store Data permanently.
  Eg: File Systems, Databases, Data warehouses, Big Data Technologies etc

File Systems:

File Systems can be provided by Local operating System. File Systems are best suitable to store very less Amount of Information.

Limitations:

1) We cannot store huge Amount of Information.
2) There is no Query Language support and hence operations will become very complex.
3) There is no Security for Data.
4) There is no Mechanism to prevent duplicate Data. Hence there may be a chance of Data Inconsistency Problems.

To overcome the above Problems of File Systems, we should go for Databases.

Databases:

1) We can store Huge Amount of Information in the Databases.
2) Query Language Support is available for every Database and hence we can perform Database Operations very easily.
3) To access Data present in the Database, compulsory username and pwd must be required. Hence Data is secured.
4) Inside Database Data will be stored in the form of Tables. While developing Database Table Schemas, Database Admin follow various Normalization Techniques and can implement various Constraints like Unique Key Constrains, Primary Key Constraints etc which prevent Data Duplication. Hence there is no chance of Data Inconsistency Problems.

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Limitations of Databases:

1) Database cannot hold very Huge Amount of Information like Terabytes of Data.
2) Database can provide support only for Structured Data (Tabular Data OR Relational Data) and cannot provide support for Semi Structured Data (like XML Files) and Unstructured Data (like Video Files, Audio Files, Images etc)

To overcome these Problems we should go for more Advanced Storage Areas like Big Data Technologies, Data warehouses etc.

Python Database Programming:

- Sometimes as the part of Programming requirement we have to connect to the database and we have to perform several operations like creating tables, inserting data, updating data, deleting data, selecting data etc.
- We can use SQL Language to talk to the database and we can use Python to send those SQL commands to the database.
- Python provides inbuilt support for several databases like Oracle, MySql, SqlServer, GadFly, sqlite, etc.
- Python has seperate module for each database.

  Eg: cx_Oralce module for communicating with Oracle database
  pymssql module for communicating with Microsoft Sql Server

Standard Steps for Python database Programming:

1) Import database specific module

   Eg: import cx_Oracle

2) Establish Connection between Python Program and database.
   We can create this Connection object by using connect() function of the module.
   con = cx_Oracle.connect(datbase information)

   Eg: con = cx_Oracle.connect('scott/tiger@localhost')

3) To execute our sql queries and to hold results some special object is required, which is nothing but Cursor object. We can create Cursor object by using cursor() method.

   cursor = con.cursor()

4) Execute SQL Queries By using Cursor object. For this we can use the following methods
   - execute(sqlquery) ➔ To execute a Single SQL Query
   - executescript(sqlqueries) ➔ To execute a String of SQL Queries seperated by semi-colon ';'
   - executemany() ➔ To execute a Parameterized Query.

   Eg: cursor.execute("select * from employees")

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5) Commit OR Rollback changes based on our requirement in the case of DML Queries (insert|update|delete)

commit() ➔ Saves the changes to the database
rollback() ➔ rolls all temporary changes back

6) Fetch the result from the Cursor object in the case of select queries
fetchone() ➔ To fetch only one row
fetchall() ➔ To fetch all rows and it returns a list of rows
fecthmany(n) ➔ To fetch first n rows

Eg 1:
```
data = cursor.fetchone()
print(data)
```

Eg 2:
```
data = cursor.fetchall()
for row in data:
  print(row)
```

7) Close the Resources
After completing our operations it is highly recommended to close the resources in the reverse order of their opening by using close() methods.

```
cursor.close()
con.close()
```

Note: The following is the list of all important methods which can be used for python database programming.

- connect()
- cursor()
- execute()
- executescript()
- executemany()
- commit()
- rollback()
- fetchone()
- fetchall()
- fetchmany(n)
- fetch
- close()

These methods won't be changed from database to database and same for all databases.

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Working with Oracle Database:

From Python Program if we want to communicate with any database, some translator must be required to translate Python calls into Database specific calls and Database specific calls into Python calls.This translator is nothing but Driver/Connector.

Diagram

For Oracle database the name of driver needed is cx_Oracle.
cx_Oracle is a Python extension module that enables access to Oracle Database.It can be used for both Python2 and Python3. It can work with any version of Oracle database like 9,10,11 and 12.

Installing cx_Oracle:

From Normal Command Prompt (But not from Python console) execute the following command

```
D:\python_classes>pip install cx_Oracle

 Collecting cx_Oracle
  Downloading cx_Oracle-6.0.2-cp36-cp36m-win32.whl (100kB)
    100% |----------| 102kB 256kB/s
Installing collected packages: cx-Oracle
Successfully installed cx-Oracle-6.0.2
```

How to Test Installation:

From python console execute the following command:

```
>>> help("modules")
```

In the output we can see cx_Oracle

```
....
_multiprocessing    crypt          ntpath          timeit
_opcode             csv            nturl2path      tkinter
_operator           csvr           numbers         token
_osx_support        csvw           opcode          tokenize
_overlapped         ctypes         operator        trace
_pickle             curses         optparse        traceback
_pydecimal          custexcept     os              tracemalloc
_pyio               cx_Oracle      parser          try
_random             data           pathlib         tty
_sha1               datetime       pdb             turtle
_sha256             dbm            pick            turtledemo
_sha3               decimal        pickle          types
_sha512             demo           pickletools     typing
```


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_signal	difflib	pip	unicodedata
_sitebuiltins	dis	pipes	unittest
_socket	distutils	pkg_resources	unpick
_sqlite3	doctest	pkgutil	update
_sre	dummy_threading	platform	urllib
_ssl	durgamath	plistlib	uu
_stat	easy_install	polymorph	uuid

.....

App 1) Program to Connect with Oracle Database and print its Version

```
1) import cx_Oracle
2) con=cx_Oracle.connect('scott/tiger@localhost')
3) print(con.version)
4) con.close()
```

Output

```
D:\python_classes>py db1.py
11.2.0.2.0
```

App 2) Write a Program to Create Employees Table in the Oracle Database

employees(eno,ename,esal,eaddr)

```
1) import cx_Oracle
2) try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     cursor.execute("create table employees(eno number,ename varchar2(10),esal n
   umber(10,2),eaddr varchar2(10))")
6)     print("Table created successfully")
7) except cx_Oracle.DatabaseError as e:
8)     if con:
9)         con.rollback()
10)        print("There is a problem with sql",e)
11) finally:
12)    if cursor:
13)        cursor.close()
14)    if con:
15)        con.close()
```


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App 3) Write a Program to Drop Employees Table from Oracle Database?

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     cursor.execute("drop table employees")
6)     print("Table dropped successfully")
7)  except cx_Oracle.DatabaseError as e:
8)     if con:
9)        con.rollback()
10)       print("There is a problem with sql",e)
11) finally:
12)    if cursor:
13)       cursor.close()
14)    if con:
15)       con.close()
```

App 3) Write a Program to Insert a Single Row in the Employees Table

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     cursor.execute("insert into employees values(100,'Durga',1000,'Hyd')")
6)     con.commit()
7)     print("Record Inserted Successfully")
8)  except cx_Oracle.DatabaseError as e:
9)     if con:
10)       con.rollback()
11)       print("There is a problem with sql",e)
12) finally:
13)    if cursor:
14)       cursor.close()
15)    if con:
16)       con.close()
```

Note: While performing DML Operations (insert|update|delte), compulsory we have to use commit() method,then only the results will be reflected in the database.

App 4) Write a Program to Insert Multiple Rows in the Employees Table by using executemany() Method

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     sql="insert into employees values(:eno,:ename,:esal,:eaddr)"
6)     records=[(200,'Sunny',2000,'Mumbai'),
7)              (300,'Chinny',3000,'Hyd'),
8)              (400,'Bunny',4000,'Hyd')]
9)     cursor.executemany(sql,records)
10)    con.commit()
11)    print("Records Inserted Successfully")
12) except cx_Oracle.DatabaseError as e:
13)    if con:
14)       con.rollback()
15)       print("There is a problem with sql",e)
16) finally:
17)    if cursor:
18)       cursor.close()
19)    if con:
20)       con.close()
```

App 5) Write a Program to Insert Multiple Rows in the Employees Table with Dynamic Input from the Keyboard?

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     while True:
6)        eno=int(input("Enter Employee Number:"))
7)        ename=input("Enter Employee Name:")
8)        esal=float(input("Enter Employee Salary:"))
9)        eaddr=input("Enter Employee Address:")
10)       sql="insert into employees values(%d,'%s',%f,'%s')"
11)       cursor.execute(sql %(eno,ename,esal,eaddr))
12)       print("Record Inserted Successfully")
13)       option=input("Do you want to insert one more record[Yes|No] :")
14)       if option=="No":
15)          con.commit()
16)          break
```


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```
except cx_Oracle.DatabaseError as e:
    if con:
        con.rollback()
        print("There is a problem with sql :",e)
finally:
    if cursor:
        cursor.close()
    if con:
        con.close()
```

App 6) Write a Program to Update Employee Salaries with Increment for the certain Range with Dynamic Input

Eg: Increment all employee salaries by 500 whose salary < 5000

```
import cx_Oracle
try:
    con=cx_Oracle.connect('scott/tiger@localhost')
    cursor=con.cursor()
    increment=float(input("Enter Increment Salary:"))
    salrange=float(input("Enter Salary Range:"))
    sql="update employees set esal=esal+%f where esal<%f"
    cursor.execute(sql %(increment,salrange))
    print("Records Updated Successfully")
    con.commit()
except cx_Oracle.DatabaseError as e:
    if con:
        con.rollback()
        print("There is a problem with sql :",e)
finally:
    if cursor:
        cursor.close()
    if con:
        con.close()
```

App 7) Write a Program to Delete Employees whose Salary Greater provided Salary as Dynamic Input?

Eg: delete all employees whose salary > 5000

```
import cx_Oracle
try:
    con=cx_Oracle.connect('scott/tiger@localhost')
    cursor=con.cursor()
    cutoffsalary=float(input("Enter CutOff Salary:"))
```

```
6)    sql="delete from employees where esal>%f"
7)    cursor.execute(sql %(cutoffsalary))
8)    print("Records Deleted Successfully")
9)    con.commit()
10) except cx_Oracle.DatabaseError as e:
11)   if con:
12)      con.rollback()
13)      print("There is a problem with sql :",e)
14) finally:
15)   if cursor:
16)      cursor.close()
17)   if con:
18)      con.close()
```

App 8) Write a Program to Select all Employees info by using fetchone() Method?

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     cursor.execute("select * from employees")
6)     row=cursor.fetchone()
7)     while row is not None:
8)        print(row)
9)        row=cursor.fetchone()
10) except cx_Oracle.DatabaseError as e:
11)    if con:
12)       con.rollback()
13)       print("There is a problem with sql :",e)
14) finally:
15)    if cursor:
16)       cursor.close()
17)    if con:
18)       con.close()
```

App 9) Write a Program to select all Employees info by using fetchall() Method?

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
```

```
5)     cursor.execute("select * from employees")
6)     data=cursor.fetchall()
7)     for row in data:
8)         print("Employee Number:",row[0])
9)         print("Employee Name:",row[1])
10)        print("Employee Salary:",row[2])
11)        print("Employee Address:",row[3])
12)        print()
13)        print()
14) except cx_Oracle.DatabaseError as e:
15)    if con:
16)        con.rollback()
17)        print("There is a problem with sql :",e)
18) finally:
19)    if cursor:
20)        cursor.close()
21)    if con:
22)        con.close()
```

App 10) Write a Program to select Employees info by using fetchmany() Method and the required Number of Rows will be provided as Dynamic Input?

```
1)  import cx_Oracle
2)  try:
3)     con=cx_Oracle.connect('scott/tiger@localhost')
4)     cursor=con.cursor()
5)     cursor.execute("select * from employees")
6)     n=int(input("Enter the number of required rows:"))
7)     data=cursor.fetchmany(n)
8)     for row in data:
9)         print(row)
10) except cx_Oracle.DatabaseError as e:
11)    if con:
12)        con.rollback()
13)        print("There is a problem with sql :",e)
14) finally:
15)    if cursor:
16)        cursor.close()
17)    if con:
18)        con.close()
```


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Output

```
D:\python_classes>py test.py
Enter the number of required rows:3
(100, 'Durga', 1500.0, 'Hyd')
(200, 'Sunny', 2500.0, 'Mumbai')
(300, 'Chinny', 3500.0, 'Hyd')

D:\python_classes>py test.py
Enter the number of required rows:4
(100, 'Durga', 1500.0, 'Hyd')
(200, 'Sunny', 2500.0, 'Mumbai')
(300, 'Chinny', 3500.0, 'Hyd')
(400, 'Bunny', 4500.0, 'Hyd')
```

Working with MySQL Database:

Current version: 5.7.19
Vendor: SUN Micro Systems/Oracle Corporation
Open Source and Freeware
Default Port: 3306
Default user: root

Note: In MySQL, everything we have to work with our own databases, which are also known as Logical Databases.

The following are 4 Default Databases available in MySQL.

- **information_schema**
- **mysql**
- **performance_schema**
- **test**

In the above diagram only one physical database is available and 4 logical databases are available.

Commonly used Commands in MySQL:

1) To Know Available Databases

```
mysql> show databases;
```

2) To Create Our Own Logical Database

```
mysql> create database durgadb;
```

3) To Drop Our Own Database

```
mysql> drop database durgadb;
```


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4) To Use a Particular Logical Database

mysql> use durgadb; OR mysql> connect durgadb;

5) To Create a Table

create table employees(eno int(5) primary key,ename varchar(10),esal double(10,2), eaddr varchar(10));

6) To Insert Data

insert into employees values(100,'Durga',1000,'Hyd');
insert into employees values(200,'Ravi',2000,'Mumbai');

In MySQL instead of single quotes we can use double quotes also.

Driver/Connector Information:

From Python program if we want to communicates with MySql database, compulsory some translator is required to convert python specific calls into mysql database specific calls and mysql database specific calls into python specific calls. This translator is nothing but Driver or Connector.

We have to download connector seperately from mysql database.
https://dev.mysql.com/downloads/connector/python/2.1.html

How to Check Installation:

From python console we have to use help("modules")
In the list of modules, compulsory MySQL should be there.

Note: In the case of Python3.4 we have to set PATH and PYTHONPATH explicitly

PATH=C:\Python34
PYTHONPATH=C:\Python34\Lib\site-packages

Q) Write a Program to Create Table, Insert Data and display Data by using MySQL Database

```
1) import mysql.connector
2) try:
3)     con=mysql.connector.connect(host='localhost',database='durgadb',user='root',password='root')
4)     cursor=con.cursor()
5)     cursor.execute("create table employees(eno int(5) primary key,ename varchar(10),esal double(10,2),eaddr varchar(10))")
```

```
print("Table Created...")

sql = "insert into employees(eno, ename, esal, eaddr) VALUES(%s, %s, %s, %s)"
records=[(100,'Sachin',1000,'Mumbai'),
         (200,'Dhoni',2000,'Ranchi'),
         (300,'Kohli',3000,'Delhi')]
cursor.executemany(sql,records)
con.commit()
print("Records Inserted Successfully...")
cursor.execute("select * from employees")
data=cursor.fetchall()
for row in data:
    print("Employee Number:",row[0])
    print("Employee Name:",row[1])
    print("Employee Salary:",row[2])
    print("Employee Address:",row[3])
    print()
    print()
except mysql.connector.DatabaseError as e:
if con:
    con.rollback()
    print("There is a problem with sql :",e)
finally:
if cursor:
    cursor.close()
if con:
    con.close()
```

Q) Write a Program to Copy Data present in Employees Table of MySQL Database into Oracle Database

```
import mysql.connector
import cx_Oracle
try:
    con=mysql.connector.connect(host='localhost',database='durgadb',user='root',password='root')
    cursor=con.cursor()
    cursor.execute("select * from employees")
    data=cursor.fetchall()
    list=[]
    for row in data:
        t=(row[0],row[1],row[2],row[3])
        list.append(t)
except mysql.connector.DatabaseError as e:
```

```
    if con:
        con.rollback()
        print("There is a problem with MySql :",e)
finally:
    if cursor:
        cursor.close()
    if con:
        con.close()

try:
    con=cx_Oracle.connect('scott/tiger@localhost')
    cursor=con.cursor()
    sql="insert into employees values(:eno,:ename,:esal,:eaddr)"
    cursor.executemany(sql,list)
    con.commit()
    print("Records Copied from MySQL Database to  Oracle Database  Successfully")

except cx_Oracle.DatabaseError as e:
    if con:
        con.rollback()
        print("There is a problem with sql",e)
finally:
    if cursor:
        cursor.close()
    if con:
        con.close()
```

https://dev.mysql.com/downloads/connector/python/2.1.html

```
create table employees(eno int(5) primary key,ename varchar(10),esal double(10,2
),eaddr varchar(10));
 insert into employees values(100,'Durga',1000,'Hyd');
 insert into employees values(200,'Ravi',2000,'Mumbai');
 insert into employees values(300,'Shiva',3000,'Hyd');
```

REGULAR EXPRESSIONS & WEB SCRAPING

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- If we want to represent a group of Strings according to a particular format/pattern then we should go for Regular Expressions.
- i.e Regualr Expressions is a declarative mechanism to represent a group of Strings accroding to particular format/pattern.
- **Eg 1:** We can write a regular expression to represent all mobile numbers
- **Eg 2:** We can write a regular expression to represent all mail ids.

- The main important application areas of Regular Expressions are
  1) To develop validation frameworks/validation logic
  2) To develop Pattern matching applications (ctrl-f in windows, grep in UNIX etc)
  3) To develop Translators like compilers, interpreters etc
  4) To develop digital circuits
  5) To develop communication protocols like TCP/IP, UDP etc.

- We can develop Regular Expression Based applications by using python module: re
- This module contains several inbuilt functions to use Regular Expressions very easily in our applications.

1) compile()

Returns Module contains compile() Function to compile a Pattern into RegexObject.

```
pattern = re.compile("ab")
```

2) finditer():

Returns an Iterator object which yields Match object for every Match

```
matcher = pattern.finditer("abaababa")
```

On Match object we can call the following methods.

1) start() ➔ Returns start index of the match
2) end() ➔ Returns end+1 index of the match
3) group() ➔ Returns the matched string

```
1) import re  count=0
2) pattern=re.compile("ab")
3) matcher=pattern.finditer("abaababa")
4) for match in matcher:
5)     count+=1
6)     print(match.start(),"...",match.end(),"...",match.group())
7) print("The number of occurrences: ",count)
```

Output:

```
0 ... 2 ... ab
3 ... 5 ... ab
5 ... 7 ... ab
```


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The number of occurrences: 3

Note: We can pass pattern directly as argument to finditer() function.

```
1) import re
2) count=0
3) matcher=re.finditer("ab","abaababa")
4) for match in matcher:
5)     count+=1
6)     print(match.start(),"...",match.end(),"...",match.group())
7) print("The number of occurrences: ",count)
```

Output:

```
0 ... 2 ... ab
3 ... 5 ... ab
5 ... 7 ... ab
The number of occurrences: 3
```

Character Classes:

We can use character classes to search a group of characters

1) [abc] → Either a OR b OR c
2) [^abc] → Except a and b and c
3) [a-z] → Any Lower case alphabet symbol
4) [A-Z] → Any upper case alphabet symbol
5) [a-zA-Z] → Any alphabet symbol
6) [0-9] → Any digit from 0 to 9
7) [a-zA-Z0-9] → Any alphanumeric character
8) [^a-zA-Z0-9]→ Except alphanumeric characters(Special Characters)

```
1) import re
2) matcher=re.finditer("x","a7b@k9z")
3) for match in matcher:
4)     print(match.start(),".....",match.group())
```

x = [abc]	x = [^abc]	x = [a-z]	x = [0-9]	x = [a-zA-Z0-9]	x = [^a-zA-Z0-9]
0 ..... a	1 7	0 ..... a	1 7	0 ..... a	3 ..... @
2 ..... b	3 ..... @	2 ..... b	5 9	1 7	
	4 ..... k	4 ..... k		2 ..... b	
	5 9	6 ..... z		4 ..... k	
	6 ..... z			5 9	
				6 ..... z	

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Pre defined Character Classes:

1) \s ➔ Space character
2) \S ➔ Any character except space character
3) \d ➔ Any digit from 0 to 9
4) \D ➔ Any character except digit
5) \w ➔ Any word character [a-zA-Z0-9]
6) \W ➔ Any character except word character (Special Characters)
7) . ➔ Any character including special characters

```
1) import re
2) matcher=re.finditer("x","a7b k@9z")
3) for match in matcher:
4)     print(match.start(),".....",match.group())
```

x = \s:	x = \S:	x = \d:	x = \D:	x = \w:	x = \W:	x = .
3	0 ..... a	1 7	0 ..... a	0 ..... a	3	0 ..... a
	1 7	6 9	2 ..... b	1 7	5 ..... @	1 7
	2 ..... b		3	2 ..... b		2 ..... b
	4 ..... k		4 ..... k	4 ..... k		3 .....
	5 ..... @		5 ..... @	6 9		4 ..... k
	6 9		7 ..... z	7 ..... z		5 ..... @
	7 ..... z					6 9
						7 ..... z

Qunatifiers:

We can use quantifiers to specify the number of occurrences to match.

1) a ➔ Exactly one 'a'
2) a+ ➔ Atleast one 'a'
3) a* ➔ Any number of a's including zero number
4) a? ➔ Atmost one 'a' ie either zero number or one number
5) a{m} ➔ Exactly m number of a's
6) a{m,n} ➔ Minimum m number of a's and Maximum n number of a's.

```
1) import re
2) matcher=re.finditer("x","abaabaaab")
3) for match in matcher:
4)     print(match.start(),".....",match.group())
```

x = a:	x = a+:	x = a*:	x = a?:	x = a{3}:	x = a{2,4}:
0 ..... a	0 ..... a	0 ..... a	0 ..... a	5 ..... aaa	2 ..... aa
2 ..... a	2 ..... aa	1	1		5 ..... aaa
3 ..... a	5 ..... aaa	2 ..... aa	2 ..... a		
5 ..... a		4	3 ..... a		
6 ..... a		5 ..... aaa	4		
7 ..... a		8	5 ..... a		
		9	6 ..... a		
			7 ..... a		
			8		
			9		

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Note:

1) ^x ➔ It will check whether target string starts with x OR not.
2) x$ ➔ It will check whether target string ends with x OR not.

Important Functions of Remodule:

1) match()
2) fullmatch()
3) search()
4) findall()
5) finditer()
6) sub()
7) subn()
8) split()
9) compile()

1) match():

- We can use match function to check the given pattern at beginning of target string.
- If the match is available then we will get Match object, otherwise we will get None.

```
1) import re
2) s=input("Enter pattern to check: ")
3) m=re.match(s,"abcabdefg")
4) if m!= None:
5)     print("Match is available at the beginning of the String")
6)     print("Start Index:",m.start(), "and End Index:",m.end())
7) else:
8)     print("Match is not available at the beginning of the String")
```

Output:

```
D:\python_classes>py test.py
Enter pattern to check: abc
Match is available at the beginning of the String
Start Index: 0 and End Index: 3

D:\python_classes>py test.py
Enter pattern to check: bde
Match is not available at the beginning of the String
```

2) fullmatch():

- We can use fullmatch() function to match a pattern to all of target string. i.e complete string should be matched according to given pattern.
- If complete string matched then this function returns Match object otherwise it returns None.

```
1) import re
2) s=input("Enter pattern to check: ")
3) m=re.fullmatch(s,"ababab")
4) if m!= None:
5)     print("Full String Matched")
6) else:
7)     print("Full String not Matched")
```

Output:

```
D:\python_classes>py test.py
Enter pattern to check: ab
Full String not Matched

D:\python_classes>py test.py
Enter pattern to check: ababab
Full String Matched
```

3) search():

- We can use search() function to search the given pattern in the target string.
- If the match is available then it returns the Match object which represents first occurrence of the match.
- If the match is not available then it returns None

```
1) import re
2) s=input("Enter pattern to check: ")
3) m=re.search(s,"abaaaba")
4) if m!= None:
5)     print("Match is available")
6)     print("First Occurrence of match with start index:",m.start(),"and end index:",m.
   end())
7) else:
8)     print("Match is not available")
```

Output:

```
D:\python_classes>py test.py
Enter pattern to check: aaa
Match is available
First Occurrence of match with start index: 2 and end index: 5

D:\python_classes>py test.py
Enter pattern to check: bbb
Match is not available
```


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4) findall():

- To find all occurrences of the match.
- This function returns a list object which contains all occurrences.

```
1) import re
2) l=re.findall("[0-9]","a7b9c5kz")
3) print(l)
```

Output: ['7', '9', '5']

5) finditer():

- Returns the iterator yielding a match object for each match.
- On each match object we can call start(), end() and group() functions.

```
1) import re
2) itr=re.finditer("[a-z]","a7b9c5k8z")
3) for m in itr:
4)     print(m.start(),"...",m.end(),"...",m.group())
```

Output:
```
D:\python_classes>py test.py
0 ... 1 ... a
2 ... 3 ... b
4 ... 5 ... c
6 ... 7 ... k
8 ... 9 ... z
```

6) sub():

- sub means substitution or replacement.
- re.sub(regex,replacement,targetstring)
- In the target string every matched pattern will be replaced with provided replacement.

```
1) import re
2) s=re.sub("[a-z]","#","a7b9c5k8z")
3) print(s)
```

Output: #7#9#5#8#
Every alphabet symbol is replaced with # symbol

7) subn():

- It is exactly same as sub except it can also returns the number of replacements.
- This function returns a tuple where first element is result string and second element is number of replacements.
  (resultstring, number of replacements)

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```
1) import re
2) t=re.subn("[a-z]","#","a7b9c5k8z")
3) print(t)
4) print("The Result String:",t[0])
5) print("The number of replacements:",t[1])
```

Output:

```
D:\python_classes>py test.py
('#7#9#5#8#', 5)
The Result String: #7#9#5#8#
The number of replacements: 5
```

8) split():

- If we want to split the given target string according to a particular pattern then we should go for split() function.
- This function returns list of all tokens.

```
1) import re
2) l=re.split(",","sunny,bunny,chinny,vinny,pinny")
3) print(l)
4) for t in l:
5)     print(t)
```

Output:

```
D:\python_classes>py test.py
['sunny', 'bunny', 'chinny', 'vinny', 'pinny']
sunny
bunny
chinny
vinny
pinny
```

```
1) import re
2) l=re.split("\.","www.durgasoft.com")
3) for t in l:
4)     print(t)
```

Output:

```
D:\python_classes>py test.py
www
durgasoft
com
```


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9) ^ symbol:

- We can use ^ symbol to check whether the given target string starts with our provided pattern or not.
- Eg: res = re.search("^Learn",s)
- If the target string starts with learn then it will return Match object,otherwise returns None.

test.py

```
1) import re
2) s="Learning Python is Very Easy"
3) res=re.search("^Learn",s)
4) if res != None:
5)     print("Target String starts with Learn")
6) else:
7)     print("Target String Not starts with Learn")
```

Output: Target String starts with Learn

10) $ symbol:

- We can use $ symbol to check whether the given target string ends with our provided pattern or not.
- Eg: res = re.search("Easy$",s)
- If the target string ends with Easy then it will return Match object,otherwise returns None.

test.py

```
1) import re
2) s="Learning Python is Very Easy"
3) res=re.search("Easy$",s)
4) if res != None:
5)     print("Target String ends with Easy")
6) else:
7)     print("Target String Not ends with Easy")
```

Output: Target String ends with Easy

Note: If we want to ignore case then we have to pass 3rd argument re.IGNORECASE for search() function.

Eg: res = re.search("easy$",s,re.IGNORECASE)

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test.py

```
1) import re
2) s="Learning Python is Very Easy"
3) res=re.search("easy$",s,re.IGNORECASE)
4) if res != None:
5)     print("Target String ends with Easy by ignoring case")
6) else:
7)     print("Target String Not ends with Easy by ignoring case")
```

Output: Target String ends with Easy by ignoring case

App 1) Write a Regular Expression to represent all Yava Language Identifiers

Rules:

1) The allowed characters are a-z,A-Z,0-9,#
2) The first character should be a lower case alphabet symbol from a to k
3) The second character should be a digit divisible by 3
4) The length of identifier should be atleast 2.

[a-k][0369][a-zA-Z0-9#]*

App 2) Write a Python Program to check whether the given String is Yava Language Identifier OR not?

```
1) import re
2) s=input("Enter Identifier:")
3) m=re.fullmatch("[a-k][0369][a-zA-Z0-9#]*",s)
4) if m!= None:
5)     print(s,"is valid Yava Identifier")
6) else:
7)     print(s,"is invalid Yava Identifier")
```

Output

```
D:\python_classes>py test.py
Enter Identifier:a6kk9z##
a6kk9z## is valid Yava Identifier

D:\python_classes>py test.py
Enter Identifier:k9b876
k9b876 is valid Yava Identifier

D:\python_classes>py test.py
Enter Identifier:k7b9
k7b9 is invalid Yava Identifier
```

App 3) Write a Regular Expression to represent all 10 Digit Mobile Numbers

Rules:

1) Every Number should contains exactly 10 Digits
2) The 1st Digit should be 7 OR 8 OR 9

```
[7-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9]
  OR
[7-9][0-9]{9}
  OR
[7-9]\d{9}
```

App 4) Write a Python Program to check whether the given Number is valid Mobile Number OR not?

```
1)  import re
2)  n=input("Enter number:")
3)  m=re.fullmatch("[7-9]\d{9}",n)
4)  if m!= None:
5)      print("Valid Mobile Number")
6)  else:
7)      print("Invalid Mobile Number")
```

Output

```
D:\python_classes>py test.py
Enter number:9898989898
Valid Mobile Number

D:\python_classes>py test.py
Enter number:6786786787
Invalid Mobile Number

D:\python_classes>py test.py
Enter number:898989
Invalid Mobile Number
```

App 5) Write a Python Program to extract all Mobile Numbers present in input.txt where Numbers are mixed with Normal Text Data

```
1)  import re
2)  f1=open("input.txt","r")
3)  f2=open("output.txt","w")
```


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```
4)  for line in f1:
5)      list=re.findall("[7-9]\d{9}",line)
6)      for n in list:
7)          f2.write(n+"\n")
8)  print("Extracted all Mobile Numbers into output.txt")
9)  f1.close()
10) f2.close()
```

Web Scraping by using Regular Expressions

The process of collecting information from web pages is called web scraping. In web scraping to match our required patterns like mail ids, mobile numbers we can use regular expressions.

```
1)  import re,urllib
2)  import urllib.request
3)  sites="google rediff".split()
4)  print(sites)
5)  for s in sites:
6)      print("Searching...",s)
7)      u=urllib.request.urlopen("http://"+s+".com")
8)      text=u.read()
9)      title=re.findall("<title>.*</title>",str(text),re.I)
10)             print(title[0])
```

Program to get all Phone Numbers of redbus.in by using Web Scraping and Regular Expressions

```
1)  import re,urllib
2)  import urllib.request
3)  u=urllib.request.urlopen("https://www.redbus.in/info/contactus")
4)  text=u.read()
5)  numbers=re.findall("[0-9-]{7}[0-9-]+",str(text),re.I)
6)  for n in numbers:
7)      print(n)
```

Write a Python Program to check whether the given mail id is valid gmail id OR not?

```
1)  import re
2)  s=input("Enter Mail id:")
3)  m=re.fullmatch("\w[a-zA-Z0-9_.]*@gmail[.]com",s)
4)  if m!=None:
5)      print("Valid Mail Id");
```


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```
6)  else:
7)      print("Invalid Mail id")
```

Output:

```
D:\python_classes>py test.py
Enter Mail id:durgatoc@gmail.com
Valid Mail Id

D:\python_classes>py test.py
Enter Mail id:durgatoc
Invalid Mail id

D:\python_classes>py test.py
Enter Mail id:durgatoc@yahoo.co.in
Invalid Mail id
```

Write a Python Program to check whether given Car Registration Number is valid Telangana State Registration Number OR not?

```
1)  import re
2)  s=input("Enter Vehicle Registration Number:")
3)  m=re.fullmatch("TS[012][0-9][A-Z]{2}\d{4}",s)
4)  if m!=None:
5)      print("Valid Vehicle Registration Number");
6)  else:
7)      print("Invalid Vehicle Registration Number")
```

Output:

```
D:\python_classes>py test.py
Enter Vehicle Registration Number:TS07EA7777
Valid Vehicle Registration Number

D:\python_classes>py test.py
Enter Vehicle Registration Number:TS07KF0786
Valid Vehicle Registration Number

D:\python_classes>py test.py
Enter Vehicle Registration Number:AP07EA7898
Invalid Vehicle Registration Number
```

Python Program to check whether the given Mobile Number is valid OR not (10 Digit OR 11 Digit OR 12 Digit)

```
1) import re
2) s=input("Enter Mobile Number:")
3) m=re.fullmatch("(0|91)?[7-9][0-9]{9}",s)
4) if m!=None:
5)     print("Valid Mobile Number");
6) else:
7)     print("Invalid Mobile Number")
```

Summary Table and some more Examples.

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DECORATOR FUNCTIONS

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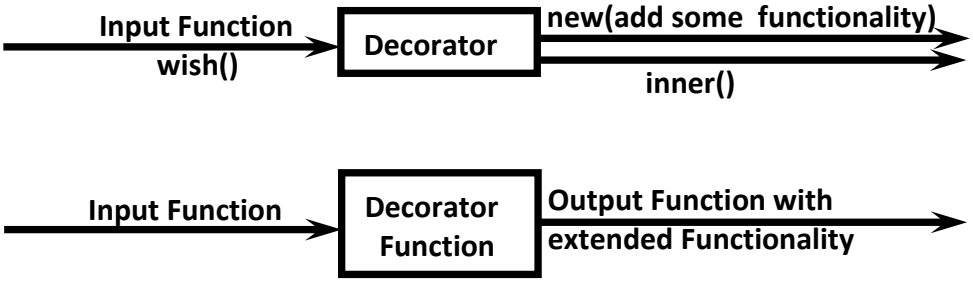
Decorator is a function which can take a function as argument and extend its functionality and returns modified function with extended functionality.



The main objective of decorator functions is we can extend the functionality of existing functions without modifies that function.

```
1)  def wish(name):
2)      print("Hello",name,"Good Morning")
```

This function can always print same output for any name

Hello Durga Good Morning
Hello Ravi Good Morning
Hello Sunny Good Morning

But we want to modify this function to provide different message if name is Sunny.
We can do this without touching wish() function by using decorator.

```
1)  def decor(func):
2)      def inner(name):
3)          if name=="Sunny":
4)              print("Hello Sunny Bad Morning")
5)          else:
6)              func(name)
7)      return inner
8)
9)  @decor
10) def wish(name):
11)     print("Hello",name,"Good Morning")
12)
13) wish("Durga")
14) wish("Ravi")
15) wish("Sunny")
```

Output

Hello Durga Good Morning
Hello Ravi Good Morning

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Hello Sunny Bad Morning

In the above program whenever we call wish() function automatically decor function will be executed.

How to call Same Function with Decorator and without Decorator:

We should not use @decor

```
1)  def decor(func):
2)      def inner(name):
3)          if name=="Sunny":
4)              print("Hello Sunny Bad Morning")
5)          else:
6)              func(name)
7)      return inner
8)
9)  def wish(name):
10)     print("Hello",name,"Good Morning")
11)
12) decorfunction=decor(wish)
13)
14) wish("Durga") #decorator wont be executed
15) wish("Sunny") #decorator wont be executed
16)
17) decorfunction("Durga")#decorator will be executed
18) decorfunction("Sunny")#decorator will be executed
```

Output

Hello Durga Good Morning
Hello Sunny Good Morning
Hello Durga Good Morning
Hello Sunny Bad Morning

```
1)  def  smart_division(func):
2)      def inner(a,b):
3)          print("We are dividing",a,"with",b)
4)          if b==0:
5)              print("OOPS...cannot divide")
6)              return
7)          else:
8)              return func(a,b)
9)      return inner
10)
11) @smart_division
12) def  division(a,b):
13)     return a/b
```


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```
14) print(division(20,2))
15) print(division(20,0))
```

Without Decorator we will get Error. In this Case Output is:

```
10.0
Traceback (most recent call last):
File "test.py", line 16, in <module>
  print(division(20,0))
File "test.py", line 13, in division
  return a/b
ZeroDivisionError: division by zero
```

With Decorator we won't get any Error. In this Case Output is:

```
We are dividing 20 with 2
10.0
We are dividing 20 with 0
OOPS...cannot divide
None
```

```
1)  def marriagedecor(func):
2)      def inner():
3)          print('Hair decoration...')
4)          print('Face decoration with Platinum package')
5)          print('Fair and Lovely etc..')
6)          func()
7)      return inner
8)
9)  def getready():
10)     print('Ready for the marriage')
11)
12) decorated_getready=marriagedecor(getready)
13)
14) decorated_getready()
```

Decorator Chaining

We can define multiple decorators for the same function and all these decorators will form Decorator Chaining.

Eg:

```
@decor1
@decor
def num():
```

For num() function we are applying 2 decorator functions. First inner decorator will work and then outer decorator.

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```
1)  def decor1(func):
2)      def inner():
3)          x=func()
4)          return x*x
5)      return inner
6)
7)  def decor(func):
8)      def inner():
9)          x=func()
10)         return 2*x
11)     return inner
12)
13) @decor1
14) @decor
15) def num():
16)     return 10
17)
18) print(num())
```


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GENERATOR FUNCTIONS

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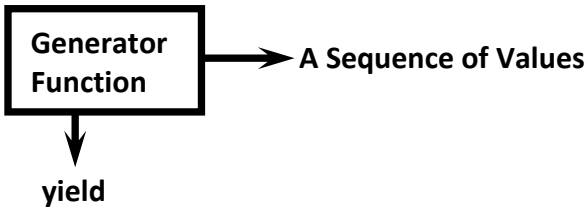
Generator is a function which is responsible to generate a sequence of values.
We can write generator functions just like ordinary functions, but it uses yield keyword to return values.




```
1)  def mygen():
2)      yield 'A'
3)      yield 'B'
4)      yield 'C'
5)
6)  g=mygen()
7)  print(type(g))
8)
9)  print(next(g))
10) print(next(g))
11) print(next(g))
12) print(next(g))
```

Output

```
<class 'generator'>
A
B
C
Traceback (most recent call last):
  File "test.py", line 12, in <module>
    print(next(g))
StopIteration
```

```
1)  def countdown(num):
2)      print("Start Countdown")
3)      while(num>0):
4)          yield num
5)          num=num-1
6)  values=countdown(5)
7)  for x in values:
8)      print(x)
```

Output

```
Start Countdown
5
```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4
3
2
1

Eg 3: To generate first n numbers

```
1) def firstn(num):
2)     n=1
3)     while n<=num:
4)         yield n
5)         n=n+1
6)
7) values=firstn(5)
8) for x in values:
9)     print(x)
```

Output

1
2
3
4
5

We can convert generator into list as follows:

```
values = firstn(10)
l1 = list(values)
print(l1)    #[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
```

Eg 4: To generate Fibonacci Numbers...
The next is the sum of previous 2 numbers

Eg: 0,1,1,2,3,5,8,13,21,...

```
1) def fib():
2)     a,b=0,1
3)     while True:
4)         yield a
5)         a,b=b,a+b
6) for f in fib():
7)     if f>100:
8)         break
9)     print(f)
```


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Output

```
0
1
1
2
3
5
8
13
21
34
55
89
```

Advantages of Generator Functions:

1) When compared with Class Level Iterators, Generators are very easy to use.
2) Improves Memory Utilization and Performance.
3) Generators are best suitable for reading Data from Large Number of Large Files.
4) Generators work great for web scraping and crawling.

Generators vs Normal Collections wrt Performance:

```
1)  import random
2)  import time
3)
4)  names = ['Sunny','Bunny','Chinny','Vinny']
5)  subjects = ['Python','Java','Blockchain']
6)
7)  def people_list(num_people):
8)      results = []
9)      for i in range(num_people):
10)         person = {
11)                 'id':i,
12)                 'name': random.choice(names),
13)                 'subject':random.choice(subjects)
14)                }
15)     results.append(person)
16)   return results
17)
18) def people_generator(num_people):
19)   for i in range(num_people):
20)      person = {
21)                 'id':i,
22)                 'name': random.choice(names),
```


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```
23)                 'major':random.choice(subjects)
24)                 }
25)         yield person
26)
27) """t1 = time.clock()
28) people = people_list(10000000)
29) t2 = time.clock()"""
30)
31) t1 = time.clock()
32) people = people_generator(10000000)
33) t2 = time.clock()
34)
35) print('Took {}'.format(t2-t1))
```

Note: In the above program observe the differnce wrt execution time by using list and generators

Generators vs Normal Collections wrt Memory Utilization:

Normal Collection:

```
l=[x*x for x in range(10000000000000000)]
print(l[0])
```

We will get MemoryError in this case because all these values are required to store in the memory.

Generators:

```
g=(x*x for x in range(10000000000000000))
print(next(g))
```

Output: 0

We won't get any MemoryError because the values won't be stored at the beginning

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ASSERTIONS

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Debugging Python Program by using assert Keyword:

- The process of identifying and fixing the bug is called debugging.
- Very common way of debugging is to use print() statement. But the problem with the print() statement is after fixing the bug,compulsory we have to delete the extra added print() statments,otherwise these will be executed at runtime which creates performance problems and disturbs console output.
- To overcome this problem we should go for assert statement. The main advantage of assert statement over print() statement is after fixing bug we are not required to delete assert statements. Based on our requirement we can enable or disable assert statements.
- Hence the main purpose of assertions is to perform debugging. Usully we can perform debugging either in development or in test environments but not in production environment. Hence assertions concept is applicable only for dev and test environments but not for production environment.

Types of assert Statements:

There are 2 types of assert statements

1) Simple Version
2) Augmented Version

1) Simple Version:

assert conditional_expression

2) Augmented Version:

- assert conditional_expression, message
- conditional_expression will be evaluated and if it is true then the program will be continued.
- If it is false then the program will be terminated by raising AssertionError.
- By seeing AssertionError, programmer can analyze the code and can fix the problem.

```
1)  def squareIt(x):
2)      return x**x
3)  assert squareIt(2)==4,"The square of 2 should be 4"
4)  assert squareIt(3)==9,"The square of 3 should be 9"
5)  assert squareIt(4)==16,"The square of 4 should be 16"
6)  print(squareIt(2))
7)  print(squareIt(3))
8)  print(squareIt(4))
9)
10) D:\Python_classes>py test.py
11) Traceback (most recent call last):
12)   File "test.py", line 4, in <module>
13)     assert squareIt(3)==9,"The square of 3 should be 9"
```

```
14) AssertionError: The square of 3 should be 9
15)
16) def squareIt(x):
17)     return x*x
18) assert squareIt(2)==4,"The square of 2 should be 4"
19) assert squareIt(3)==9,"The square of 3 should be 9"
20) assert squareIt(4)==16,"The square of 4 should be 16"
21) print(squareIt(2))
22) print(squareIt(3))
23) print(squareIt(4))
```

Output

```
4
9
16
```

Exception Handling vs Assertions:

Assertions concept can be used to alert programmer to resolve development time errors.
Exception Handling can be used to handle runtime errors.

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PYTHON LOGGING

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It is highly recommended to store complete application flow and exceptions information to a file. This process is called logging.

The main advanatages of logging are:
1) We can use log files while performing debugging
2) We can provide statistics like number of requests per day etc

To implement logging, Python provides inbuilt module logging.

Logging Levels:

Depending on type of information, logging data is divided according to the following 6 levels in python

1) CRITICAL → 50
   Represents a very serious problem that needs high attention

2) ERROR → 40
   Represents a serious error

3) WARNING → 30
   Represents a warning message, some caution needed. It is alert to the programmer.

4) INFO → 20
   Represents a message with some important information

5) DEBUG → 10
   Represents a message with debugging information

6) NOTSET → 0
   Represents that level is not set

By default while executing Python program only WARNING and higher level messages will be displayed.

How to implement Logging:

To perform logging, first we required to create a file to store messages and we have to specify which level messages required to store.

We can do this by using basicConfig() function of logging module.

```
logging.basicConfig(filename='log.txt',level=logging.WARNING)
```

The above line will create a file log.txt and we can store either WARNING level or higher level messages to that file.

After creating log file, we can write messages to that file by using the following methods

- logging.debug(message)
- logging.info(message)
- logging.warning(message)
- logging.error(message)
- logging.critical(message)

Q) Write a Python Program to create a Log File and write WARNING and Higher Level Messages?

```
1) import logging
2) logging.basicConfig(filename='log.txt',level=logging.WARNING)
3) print('Logging Demo')
4) logging.debug('Debug Information')
5) logging.info('info Information')
6) logging.warning('warning Information')
7) logging.error('error Information')
8) logging.critical('critical Information')
```

log.txt:

```
WARNING:root:warning Information
ERROR:root:error Information
CRITICAL:root:critical Information
```

Note: In the above program only WARNING and higher level messages will be written to the log file. If we set level as DEBUG then all messages will be written to the log file.

test.py

```
1) import logging
2) logging.basicConfig(filename='log.txt',level=logging.DEBUG)
3) print('Logging Demo')
4) logging.debug('Debug Information')
5) logging.info('info Information')
6) logging.warning('warning Information')
7) logging.error('error Information')
8) logging.critical('critical Information')
```

log.txt

```
DEBUG:root:Debug Information
INFO:root:info Information
WARNING:root:warning Information
ERROR:root:error Information
CRITICAL:root:critical Information
```


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How to configure Log File in over writing Mode:

In the above program by default data will be appended to the log file.i.e append is the default mode. Instead of appending if we want to over write data then we have to use filemode property.

logging.basicConfig(filename='log786.txt',level=logging.WARNING)
Meant for appending

logging.basicConfig(filename='log786.txt',level=logging.WARNING,filemode='a')
Explicitly we are specifying appending.

logging.basicConfig(filename='log786.txt',level=logging.WARNING,filemode='w')
Meant for over writing of previous data.

Note:

logging.basicConfig(filename='log.txt',level=logging.DEBUG)
If we are not specifying level then the default level is WARNING(30)
If we are not specifying file name then the messages will be printed to the console.

test.py

```
1) import logging
2) logging.basicConfig()
3) print('Logging Demo')
4) logging.debug('Debug Information')
5) logging.info('info Information')
6) logging.warning('warning Information')
7) logging.error('error Information')
8) logging.critical('critical Information')
```

```
D:\durgaclasses>py test.py
Logging Demo
WARNING:root:warning Information
ERROR:root:error Information
CRITICAL:root:critical Information
```

How to Format Log Messages:

By using format keyword argument, we can format messages.

1) To display only level name: **logging.basicConfig(format='%(levelname)s')**

Output

```
WARNING
ERROR
CRITICAL
```


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2) To display levelname and message:

```
logging.basicConfig(format='%(levelname)s:%(message)s')
```

Output

```
WARNING:warning Information
ERROR:error Information
CRITICAL:critical Information
```

How to add Timestamp in the Log Messages:

```
logging.basicConfig(format='%(asctime)s:%(levelname)s:%(message)s')
```

Output

```
2018-06-15 11:50:08,325:WARNING:warning Information
2018-06-15 11:50:08,372:ERROR:error Information
2018-06-15 11:50:08,372:CRITICAL:critical Information
```

How to Change Date and Time Format:

We have to use special keyword argument: datefmt

```
logging.basicConfig(format='%(asctime)s:%(levelname)s:%(message)s',
datefmt='%d/%m/%Y  %I:%M:%S %p')
```

datefmt='%d/%m/%Y %I:%M:%S %p' → Case is important

Output

```
15/06/2018  12:04:31 PM:WARNING:warning Information
15/06/2018  12:04:31 PM:ERROR:error Information
15/06/2018  12:04:31 PM:CRITICAL:critical Information
```

Note:

%I → means 12 Hours time scale
%H → means 24 Hours time scale

Eg:

```
logging.basicConfig(format='%(asctime)s:%(levelname)s:%(message)s',
datefmt='%d/%m/%Y  %H:%M:%S')
```

Output:

```
15/06/2018  12:06:28:WARNING:warning Information
15/06/2018  12:06:28:ERROR:error Information
15/06/2018  12:06:28:CRITICAL:critical Information
```

https://docs.python.org/3/library/logging.html#logrecord-attributes
https://docs.python.org/3/library/time.html#time.strftime

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How to write Python Program Exceptions to the Log File:

By using the following function we can write exception information to the log file.

logging.exception(msg)

Q) Python Program to write Exception Information to the Log File

```
1)  import logging
2)  logging.basicConfig(filename='mylog.txt',level=logging.INFO,format='%(asctime)s:
    %(levelname)s:%(message)s',datefmt='%d/%m/%Y  %I:%M:%S %p')
3)  logging.info('A new Request Came')
4)  try:
5)      x=int(input('Enter First Number:'))
6)      y=int(input('Enter Second Number:'))
7)      print('The Result:',x/y)
8)
9)  except ZeroDivisionError as msg:
10)     print('cannot divide with zero')
11)     logging.exception(msg)
12)
13) except ValueError as msg:
14)     print('Please provide int values only')
15)     logging.exception(msg)
16)
17) logging.info('Request Processing Completed')
```

```
D:\durgaclasses>py test.py
Enter First Number:10
Enter Second Number:2
The Result: 5.0

D:\durgaclasses>py test.py
Enter First Number:20
Enter Second Number:2
The Result: 10.0

D:\durgaclasses>py test.py
Enter First Number:10
Enter Second Number:0
cannot divide with zero

D:\durgaclasses>py test.py
Enter First Number:ten
Please provide int values only
```

mylog.txt

```
15/06/2018  12:30:51 PM:INFO:A new Request Came
15/06/2018  12:30:53 PM:INFO:Request Processing Completed
15/06/2018  12:30:55 PM:INFO:A new Request Came
15/06/2018  12:31:00 PM:INFO:Request Processing Completed
15/06/2018  12:31:02 PM:INFO:A new Request Came
15/06/2018  12:31:05 PM:ERROR:division by zero
Traceback (most recent call last):
  File "test.py", line 7, in <module>
    print('The Result:',x/y)
ZeroDivisionError: division by zero
15/06/2018  12:31:05 PM:INFO:Request Processing Completed
15/06/2018  12:31:06 PM:INFO:A new Request Came
15/06/2018  12:31:10 PM:ERROR:invalid literal for int() with base 10: 'ten'
Traceback (most recent call last):
  File "test.py", line 5, in <module>
    x=int(input('Enter First Number:'))
ValueError: invalid literal for int() with base 10: 'ten'
15/06/2018  12:31:10 PM:INFO:Request Processing Completed
```

Problems with Root Logger:

If we are not defining our own logger,then bydefault root logger will be considered.
Once we perform basic configuration to root logger then the configurations are fixed and we cannot change.

Demo Application:

student.py:

```
1) import logging
2) logging.basicConfig(filename='student.log',level=logging.INFO)
3) logging.info('info message from student module')
```

test.py:

```
1) import logging
2) import student
3) logging.basicConfig(filename='test.log',level=logging.DEBUG)
4) logging.debug('debug message from test module')
```

student.log:

```
INFO: root:info message from student module
```

In the above application the configurations performed in test module won't be reflected, because root logger is already configured in student module.

Need of Our Own Customized Logger:

The problems with root logger are:

1) Once we set basic configuration then that configuration is final and we cannot change.
2) It will always work for only one handler at a time, either console or file, but not both simultaneously.
3) It is not possible to configure logger with different configurations at different levels.
4) We cannot specify multiple log files for multiple modules/classes/methods.

To overcome these problems we should go for our own customized loggers

Advanced logging Module Features: Logger:

Logger is more advanced than basic logging.
It is highly recommended to use and it provides several extra features.

Steps for Advanced Logging:

1) Creation of Logger object and set log level.
```
logger = logging.getLogger('demologger')
logger.setLevel(logging.INFO)
```

2) Creation of Handler object and set log level.

3) There are several types of Handlers like StreamHandler, FileHandler etc.
```
consoleHandler = logging.StreamHandler()
consoleHandler.setLevel(logging.INFO)
```

Note: If we use StreamHandler then log messages will be printed to console.

4) Creation of Formatter Object.
```
formatter = logging.Formatter('%(asctime)s - %(name)s - %(levelname)s: %(message)s',
datefmt = '%d/%m/%Y %I:%M:%S %p')
```

5) Add Formatter to Handler → `consoleHandler.setFormatter(formatter)`

6) Add Handler to Logger → `logger.addHandler(consoleHandler)`

7) Write messages by using logger object and the following methods
```
logger.debug('debug message')
logger.info('info message')
```

```
logger.warn('warn message')
logger.error('error message')
logger.critical('critical message')
```

Note: Bydefault logger will set to WARNING level. But we can set our own level based on our requirement.

```
logger = logging.getLogger('demologger')
logger.setLevel(logging.INFO)
```

logger log level by default available to console and file handlers. If we are not satisfied with logger level, then we can set log level explicitly at console level and file levels.

```
consoleHandler  = logging.StreamHandler()
consoleHandler.setLevel(logging.WARNING)

fileHandler = logging.FileHandler('abc.log',mode='a')
fileHandler.setLevel(logging.ERROR)
```

Note: console and file log levels should be supported by logger. i.e logger log level should be lower than console and file levels. Otherwise only logger log level will be considered.

Eg:

logger → DEBUG console → INFO → Valid and INFO will be considered
logger → INFO console → DEBUG → Invalid and only INFO will be considered to the console.

Demo Program for Console Handler:

```
1)  import logging
2)  class LoggerDemoConsole:
3)
4)      def testLog(self):
5)          logger = logging.getLogger('demologger')
6)          logger.setLevel(logging.INFO)
7)
8)          consoleHandler = logging.StreamHandler()
9)          consoleHandler.setLevel(logging.INFO)
10)
11)         formatter = logging.Formatter('%(asctime)s - %(name)s -
        %(levelname)s: %(message)s',
12)                 datefmt='%m/%d/%Y %I:%M:%S %p')
13)
14)         consoleHandler.setFormatter(formatter)
15)         logger.addHandler(consoleHandler)
```


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```
16)       logger.debug('debug message')
17)       logger.info('info message')
18)       logger.warn('warn message')
19)       logger.error('error message')
20)       logger.critical('critical message')
21)
22) demo = LoggerDemoConsole()
23) demo.testLog()
```

```
D:\durgaclasses>py loggingdemo3.py
06/18/2018 12:14:15 PM - demologger - INFO: info message
06/18/2018 12:14:15 PM - demologger - WARNING: warn message
06/18/2018 12:14:15 PM - demologger - ERROR: error message
06/18/2018 12:14:15 PM - demologger - CRITICAL: critical message
```

Note: If we want to use class name as logger name then we have to create logger object as follows `logger = logging.getLogger(LoggerDemoConsole.__name__)`

In this case output is:

```
D:\durgaclasses>py loggingdemo3.py
06/18/2018 12:21:00 PM - LoggerDemoConsole - INFO: info message
06/18/2018 12:21:00 PM - LoggerDemoConsole - WARNING: warn message
06/18/2018 12:21:00 PM - LoggerDemoConsole - ERROR: error message
06/18/2018 12:21:00 PM - LoggerDemoConsole - CRITICAL: critical message
```

Demo Program for File Handler:

```
1)  import logging
2)  class LoggerDemoConsole:
3)
4)     def testLog(self):
5)        logger = logging.getLogger('demologger')
6)        logger.setLevel(logging.INFO)
7)
8)        fileHandler = logging.FileHandler('abc.log',mode='a')
9)        fileHandler.setLevel(logging.INFO)
10)
11)       formatter = logging.Formatter('%(asctime)s - %(name)s -
      %(levelname)s: %(message)s',
12)                datefmt='%m/%d/%Y %I:%M:%S %p')
13)
14)       fileHandler.setFormatter(formatter)
15)       logger.addHandler(fileHandler)
16)
```


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```
17)     logger.debug('debug message')
18)     logger.info('info message')
19)     logger.warn('warn message')
20)     logger.error('error message')
21)     logger.critical('critical message')
22)
23) demo = LoggerDemoConsole()
24) demo.testLog()
```

abc.log:

```
07/05/2018 08:58:04 AM - demologger - INFO: info message
07/05/2018 08:58:04 AM - demologger - WARNING: warn message
07/05/2018 08:58:04 AM - demologger - ERROR: error message
07/05/2018 08:58:04 AM - demologger - CRITICAL: critical message
```

Logger with Configuration File:

In the above program, everything we hard coded in the python script. It is not a good programming practice. We will configure all the required things inside a configuration file and we can use this file directly in our program.

```
logging.config.fileConfig('logging.conf')
logger = logging.getLogger(LoggerDemoConf.__name__)
```

Note: The extension of the file need not be conf. We can use any extension like txt or durga etc.

logging.conf

```
[loggers]
keys=root,LoggerDemoConf

[handlers]
keys=fileHandler

[formatters]
keys=simpleFormatter

[logger_root]
level=DEBUG
handlers=fileHandler

[logger_LoggerDemoConf]
level=DEBUG
handlers=fileHandler
qualname=demoLogger
```

```
[handler_fileHandler]
class=FileHandler
level=DEBUG
formatter=simpleFormatter
args=('test.log', 'w')

[formatter_simpleFormatter]
format=%(asctime)s - %(name)s - %(levelname)s - %(message)s
datefmt=%m/%d/%Y %I:%M:%S %p
```

test.py

```
1)  import logging
2)  import logging.config
3)  class LoggerDemoConf():
4)      def testLog(self):
5)          logging.config.fileConfig('logging.conf')
6)          logger = logging.getLogger(LoggerDemoConf.__name__)
7)
8)          logger.debug('debug message')
9)          logger.info('info message')
10)         logger.warn('warn message')
11)         logger.error('error message')
12)         logger.critical('critical message')
13)
14) demo = LoggerDemoConf()
15) demo.testLog()
```

test.log

```
06/18/2018 12:40:05 PM - LoggerDemoConf - DEBUG - debug message
06/18/2018 12:40:05 PM - LoggerDemoConf - INFO - info message
06/18/2018 12:40:05 PM - LoggerDemoConf - WARNING - warn message
06/18/2018 12:40:05 PM - LoggerDemoConf - ERROR - error message
06/18/2018 12:40:05 PM - LoggerDemoConf - CRITICAL - critical message
```

Case-1: To set log level as INFO

```
[handler_fileHandler]
class=FileHandler
level=INFO
formatter=simpleFormatter
args=('test.log', 'w')
```

Case-2: To set Append Mode

```
[handler_fileHandler]
class=FileHandler
level=INFO
formatter=simpleFormatter
args=('test.log', 'a')
```

Creation of Custom Logger:

customlogger.py

```
1)  import logging
2)  import inspect
3)  def getCustomLogger(level):
4)          # Get Name of class/method from where this method called
5)      loggername=inspect.stack()[1][3]
6)      logger=logging.getLogger(loggername)
7)      logger.setLevel(level)
8)
9)      fileHandler=logging.FileHandler('abc.log',mode='a')
10)     fileHandler.setLevel(level)
11)
12)     formatter = logging.Formatter('%(asctime)s - %(name)s -
    %(levelname)s: %(message)s',datefmt='%m/%d/%Y %I:%M:%S %p')
13)     fileHandler.setFormatter(formatter)
14)     logger.addHandler(fileHandler)
15)
16)     return logger
```

test.py

```
1)  import logging
2)  from customlogger import getCustomLogger
3)  class LoggingDemo:
4)      def m1(self):
5)          logger=getCustomLogger(logging.DEBUG)
6)          logger.debug('m1:debug message')
7)          logger.info('m1:info message')
8)          logger.warn('m1:warn message')
9)          logger.error('m1:error message')
10)         logger.critical('m1:critical message')
11)     def m2(self):
12)         logger=getCustomLogger(logging.WARNING)
```

```
13)       logger.debug('m2:debug message')
14)       logger.info('m2:info message')
15)       logger.warn('m2:warn message')
16)       logger.error('m2:error message')
17)       logger.critical('m2:critical message')
18)    def m3(self):
19)       logger=getCustomLogger(logging.ERROR)
20)       logger.debug('m3:debug message')
21)       logger.info('m3:info message')
22)       logger.warn('m3:warn message')
23)       logger.error('m3:error message')
24)       logger.critical('m3:critical message')
25)
26) l=LoggingDemo()
27) print('Custom Logger Demo')
28) l.m1()
29) l.m2()
30) l.m3()
```

abc.log:

```
06/19/2018 12:17:19 PM - m1 - DEBUG: m1:debug message
06/19/2018 12:17:19 PM - m1 - INFO: m1:info message
06/19/2018 12:17:19 PM - m1 - WARNING: m1:warn message
06/19/2018 12:17:19 PM - m1 - ERROR: m1:error message
06/19/2018 12:17:19 PM - m1 - CRITICAL: m1:critical message
06/19/2018 12:17:19 PM - m2 - WARNING: m2:warn message
06/19/2018 12:17:19 PM - m2 - ERROR: m2:error message
06/19/2018 12:17:19 PM - m2 - CRITICAL: m2:critical message
06/19/2018 12:17:19 PM - m3 - ERROR: m3:error message
06/19/2018 12:17:19 PM - m3 - CRITICAL: m3:critical message
```

How to Create seperate Log File based on Caller:

```
1)  import logging
2)  import inspect
3)  def getCustomLogger(level):
4)     loggername=inspect.stack()[1][3]
5)     logger=logging.getLogger(loggername)
6)     logger.setLevel(level)
7)
8)     fileHandler=logging.FileHandler('{}.log'.format(loggername),mode='a')
9)     fileHandler.setLevel(level)
10)
```

```
11)   formatter = logging.Formatter('%(asctime)s - %(name)s -
      %(levelname)s: %(message)s',datefmt='%m/%d/%Y %I:%M:%S %p')
12)   fileHandler.setFormatter(formatter)
13)   logger.addHandler(fileHandler)
14)
15)   return logger
```

test.py:

#Same as previous

```
1)  import logging
2)  from customlogger import getCustomLogger
3)  class LoggingDemo:
4)     def m1(self):
5)        logger=getCustomLogger(logging.DEBUG)
6)        logger.debug('m1:debug message')
7)        logger.info('m1:info message')
8)        logger.warn('m1:warn message')
9)        logger.error('m1:error message')
10)       logger.critical('m1:critical message')
11)    def m2(self):
12)       logger=getCustomLogger(logging.WARNING)
13)       logger.debug('m2:debug message')
14)       logger.info('m2:info message')
15)       logger.warn('m2:warn message')
16)       logger.error('m2:error message')
17)       logger.critical('m2:critical message')
18)    def m3(self):
19)       logger=getCustomLogger(logging.ERROR)
20)       logger.debug('m3:debug message')
21)       logger.info('m3:info message')
22)       logger.warn('m3:warn message')
23)       logger.error('m3:error message')
24)       logger.critical('m3:critical message')
25)
26) l=LoggingDemo()
27) print('Logging Demo with Seperate Log File')
28) l.m1()
29) l.m2()
30) l.m3()
```

m1.log

```
06/19/2018 12:26:04 PM - m1 - DEBUG: m1:debug message
06/19/2018 12:26:04 PM - m1 - INFO: m1:info message
06/19/2018 12:26:04 PM - m1 - WARNING: m1:warn message
```

06/19/2018 12:26:04 PM - m1 - ERROR: m1:error message
06/19/2018 12:26:04 PM - m1 - CRITICAL: m1:critical message

m2.log

06/19/2018 12:26:04 PM - m2 - WARNING: m2:warn message
06/19/2018 12:26:04 PM - m2 - ERROR: m2:error message
06/19/2018 12:26:04 PM - m2 - CRITICAL: m2:critical message

m3.log

06/19/2018 12:26:04 PM - m3 - ERROR: m3:error message
06/19/2018 12:26:04 PM - m3 - CRITICAL: m3:critical message

Advantages of Customized Logger:

1) We can reuse same customlogger code where ever logger required.
2) For every caller we can able to create a seperate log file
3) For different handlers we can set different log levels.

Another Example for Custom Handler:

customlogger.py:

```
1)  import logging
2)  import inspect
3)  def getCustomLogger(level):
4)      loggername=inspect.stack()[1][3]
5)
6)      logger=logging.getLogger(loggername)
7)      logger.setLevel(level)
8)      fileHandler=logging.FileHandler('test.log',mode='a')
9)      fileHandler.setLevel(level)
10)     formatter=logging.Formatter('%(asctime)s - %(name)s -
        %(levelname)s: %(message)s',datefmt='%m/%d/%Y %I:%M:%S %p')
11)     fileHandler.setFormatter(formatter)
12)     logger.addHandler(fileHandler)
13)     return logger
```

test.py

```
1)  import logging
2)  from customlogger import getCustomLogger
3)  class Test:
4)      def logtest(self):
5)          logger=getCustomLogger(logging.DEBUG)
```


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```
6)        logger.debug('debug  message')
7)        logger.info('info  message')
8)        logger.warning('warning  message')
9)        logger.error('error  message')
10)       logger.critical('critical message')
11) t=Test()
12) t.logtest()
```

student.py:

```
1)  import logging
2)  from customlogger import getCustomLogger
3)  def studentfunction():
4)      logger=getCustomLogger(logging.ERROR)
5)      logger.debug('debug  message')
6)      logger.info('info  message')
7)      logger.warning('warning  message')
8)      logger.error('error  message')
9)      logger.critical('critical message')
10) studentfunction()
```

Note: we can disable a partcular level of logging as follows:

```
logging.disable(logging.CRITICAL)
```