Programming in Python

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COURSE 10

Classes (inheritance)

Python classes supports both simple and multiple inheritance.

Python 2.x/3.x (simple inheritance)

```
class <name>(Base):
      <statement1>
       …
      <statementn>
```

Where **statement$_i$** is usually a declaration of a method or data member.

Python 2.x/3.x (multiple inheritance)

```
class <name>(Base1,Base2,… Basem):
      <statement1>
       …
      <statementn>
```

Classes (inheritance)

Python has two keywords (**issubclass** and **isinstance**) that can be used to check if an object is a subclass of an instance of a specific type.

Python 2.x/3.x (simple inheritance)

```
class Base:
        x = 10
class Derived(Base):
        y = 20

d = Derived()
print ("d.X = ",d.x)
print ("d.Y = ",d.y)
print ("Instance of Derived:",isinstance(d,Derived))
print ("Instance of Base:",isinstance(d,Base))
print ("Derived is a subclass of Base:",issubclass(Derived,Base))
print ("Base is a subclass of Derived:",issubclass(Base,Derived))
```

Output

```
d.X =  10
d.Y =  20
Instance of Derived: True
Instance of Base: True
Derived is a subclass of Base: True
Base is a subclass of Derived: False
```

Classes (inheritance)

Inheritances does not assume that the __init__ function is automatically called for the base when the derived object is created.

Python 2.x/3.x (simple inheritance)

```
class Base:
        def __init__(self):
                self.x = 10

class Derived(Base):
        def __init__(self):
                self.y = 20

d = Derived()
print ("d.X = ",d.x)
print ("d.Y = ",d.y)
```

Execution error – d.X does not exists because base.__init__ was never called

Classes (inheritance)

Inheritances does not assume that the __init__ function is automatically called for the base when the derived object is created.

Python 2.x/3.x (simple inheritance)

```
class Base:
        def __init__(self):
                self.x = 10

class Derived(Base):
        def __init__(self):
                Base.__init__(self)
                self.y = 20

d = Derived()
print ("d.X = ",d.x)
print ("d.Y = ",d.y)
```

In Python 3 you can also write super().__init__()

Output

```
d.X =  10
d.Y =  20
```

Classes (inheritance)

Inheriting from a class will overwrite all base class members (methods or data members).

Python 2.x/3.x (simple inheritance)

```
class Base:
        def Print(self):
                print("Base class")

class Derived(Base):
        def Print(self):
                print("Derived class")

d = Derived()
d.Print()
```

Output

```
Derived class
```

Classes (inheritance)

Inheriting from a class will overwrite all base class members (methods or data members).

Python 2.x/3.x (simple inheritance)

```
class Base:
        def Print(self,value):
                print("Base class",value)

class Derived(Base):
        def Print(self):
                print("Deri

d = Derived()
d.Print()
d.Print(100)
```

Print function from Base class was completely overwritten by **Print** function from the derived class. The code will produce a runtime error.

Classes (inheritance)

Inheriting from a class will overwrite all base class members (methods or data members).

In this case member “x” from Base class will be overwritten by member “x” from the derived class.

Python 2.x/3.x (simple inheritance)

```
class Base:
        x = 10
class Derived(Base):
        x = 20

d = Derived()
print (d.x)
```

Output

```
20
```

Classes (inheritance)

Polymorphism works in a similar way. In reality the inheritance is not necessary to accomplish polymorphism in Python.

Python 2.x/3.x (simple inheritance)

```
class Forma:
        def PrintName(self): pass
class Square(Forma):
        def PrintName(self): print("Square")
class Circle(Forma):
        def PrintName(self): print("Circle")
class Rectangle(Forma):
        def PrintName(self): print("Rectangle")

for form in [Square(),Circle(),Rectangle()]:
        form.PrintName()
```

Output

```
Square
Circle
Rectangle
```

Classes (inheritance)

Polymorphism works in a similar way. In reality the inheritance is not necessary to accomplish polymorphism in Python.

Python 2.x/3.x (simple inheritance)

```
class Square:
        def PrintName(self): print("Square")
class Circle:
        def PrintName(self): print("Circle")
class Rectangle:
        def PrintName(self): print("Rectangle")

for form in [Square(),Circle(),Rectangle()]:
        form.PrintName()
```

Output

```
Square
Circle
Rectangle
```

Classes (inheritance)

In case of multiple inheritance, Python derives from the right most class to the left most class from the inheritance list.

Python 2.x/3.x (multiple inheritance)

```
class BaseA:
        def MyFunction(self):
                print ("Base A")
class BaseB:
        def MyFunction(self):
                print ("Base B")
class Derived(BaseA, BaseB):
        pass

d = Derived()
d.MyFunction()
```

Output

```
Base A
```

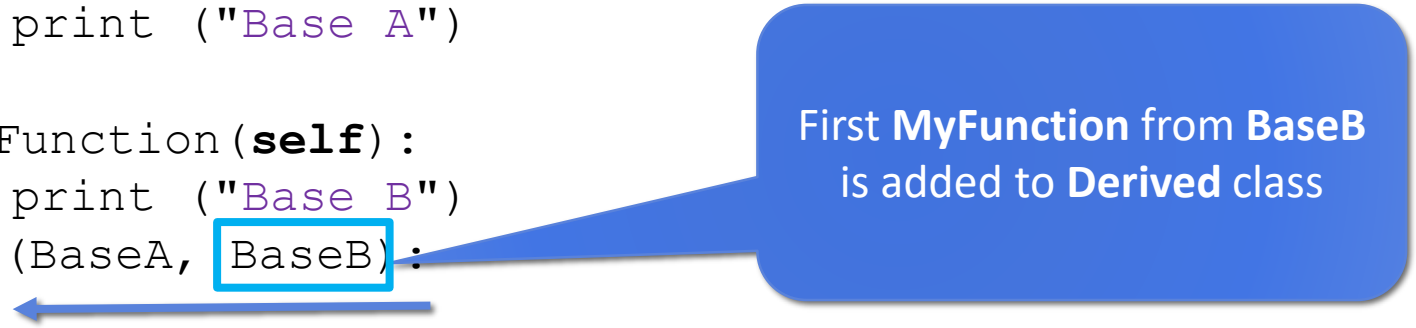
Classes (inheritance)

In case of multiple inheritance, Python derives from the right most class to the left most class from the inheritance list.

Python 2.x/3.x (multiple inheritance)

```
class BaseA:
        def MyFunction(self):
                print ("Base A")
class BaseB:
        def MyFunction(self):
                print ("Base B")
class Derived(BaseA, BaseB):
        pass

d = Derived()
d.MyFunction()
```



Classes (inheritance)

In case of multiple inheritance, Python derives from the right most class to the left most class from the inheritance list.

Python 2.x/3.x (multiple inheritance)

```
class BaseA:
        def MyFunction(self):
                print ("Base A")
class BaseB:
        def MyFunction(self):
                print ("Base B")
class Derived(BaseA, BaseB):
        pass

d = Derived()
d.MyFunction()
```

Classes (special methods)

If we reverse the order (BaseB will be first and BaseA wil be the last one), MyFunction will print “Base B” instead of “Base A”

Python 2.x/3.x (multiple inheritance)

```
class BaseA:
        def MyFunction(self):
                print ("Base A")
class BaseB:
        def MyFunction(self):
                print ("Base B")

class Derived(BaseB, BaseA):
        pass

d = Derived()
d.MyFunction()
```

Output

```
Base B
```

Classes (special methods)

Python defines a special set of functions that can be use do add additional properties to a class. Just like the initialization function (__init__) , these functions start and end with “__”.

Function	Purpose
__repr__, __str__	Called when the object needs to be converted into string
__lt__, __le__, __eq__, __ne__, __gt__, __ge__	Operators used to compare instances of the same class.
__bool__	To evaluate the truth value of an object (instance of a class)
__getattr__, __getattribute__	For attribute look-ups
__setattr__, __delattr__ __set__, __get__	For attribute operations
__len__, __del__,	For len / del operators
__setitem__, __getitem__, __contains__, __reversed__, __iter__, __next__	Iterator operators

Classes (special methods)

Python also defines a set of mathematical functions that can be used for the same purpose:

- __add__, __sub__, __mul__, __matmul__, __truediv__, __floordiv__, __mod__, __divmod__, __pow__, __lshift__, __rshift__, __and__, __xor__, __or__
- __radd__, __rsub__, __rmul__, __rmatmul__, __rtruediv__, __rfloordiv__, __rmod__, __rdivmod__, __rpow__, __rlshift__, __rrshift__, __rand__, __rxor__, __ror__,
- __iadd__, __isub__, __imul__, __imatmul__, __itruediv__, __ifloordiv__, __imod__, __ipow__, __ilshift__, __irshift__, __iand__, __ixor__, __ior__
- __neg__, __int__, __float__, __round__

Classes (special methods)

Converting a class to a string. It is recommended to overwrite both __str__ and __repr__

Python 2.x/3.x

```
class Test:
        x = 10

class Test2:
        x = 10
        def __str__(self): return "Test2 with X = "+str(self.x)

t = Test()
t2 = Test2()
print (t,":",str(t))
print (t2, ":", str(t2))
```

Output (Python 3)

```
<__main__.Test object at 0x..> : <__main__.Test object at 0x..>
Test2 with X = 10 : Test2 with X = 10
```

Classes (special methods)

Converting to an integer value.

Python 2.x/3.x

```
class Test:
        x = 10

class Test2:
        x = 10
        def __int__(self): return self.x

t = Test()
t2 = Test2()
Value = int(t)
```

This code will produce a runtime error because Python don't know how to translate an object of type Test to an integer

Classes (special methods)

Converting to an integer value.

Python 2.x/3.x

```
class Test:
        x = 10

class Test2:
        x = 10
        def __int__(self): return self.x

t = Test()
t2 = Test2()
Value = int(t2)
```

This code works, **Value** will be 10

Classes (special methods)

Iterating through a class instance

Python 3.x

```
class CarList:
        cars = ["Dacia","BMW","Toyota"]
        def __iter__(self):
                self.pos = -1
                return self
        def __next__(self):
                self.pos += 1
                if self.pos==len(self.cars): raise StopIteration
                return self.cars[self.pos]

c = CarList()
for i in c:
        print (i)
```

Output (Python 3)

```
Dacia
BMW
Toyota
```

Classes (special methods)

Iterating through a class instance

Python 2.x

```
class CarList:
        cars = ["Dacia","BMW","Toyota"]
        def __iter__(self):
                self.pos = -1
                return self
        def next (self):
                self.pos += 1
                if self.pos==len(self.cars): raise StopIteration
                return self.cars[self.pos]

c = CarList()
for i in c:
        print (i)
```

Output (Python 2)

```
Dacia
BMW
Toyota
```

Classes (special methods)

Using class operators. In this case we overwrite __eq__ (==) operator.

Python 2.x/3.x

```
class Number:
        def __init__(self, value):
                self.x = value
        def __eq__(self, obj):
                return self.x+obj.x == 0

n1 = Number(-5)
n2 = Number(5)
n3 = Number(6)
print (n1==n2)
print (n1==n3)
```

Output

```
True
False
```

Classes (special methods)

Overwriting the "**in**" opertator (__contains__).

Python 2.x/3.x

```
class Number:
        def __init__(self, value):
                self.x = value
        def __contains__(self, value):
                return str(value) in str(self.x)

n = Number(123)
print (12 in n)
print (5 in n)
print (3 in n)
```

Output

```
True
False
True
```

Classes (special methods)

Overwriting the "**len**" opertator (__len__).

Python 2.x/3.x

```
class Number:
        def __init__(self, value):
                self.x = value
        def __len__(self, value):
                return len(str(self.x))

n1 = Number(123)
n2 = Number(99999)
n3 = Number(2)
print (len(n1),len(n2),len(n3))
```

Output

```
3 5 1
```

Classes (special methods)

Building your own dictionary (overwrite __setitem__ and __getitem__)

Python 2.x/3.x

```
class MyDict:
        def __init__(self): self.data = []
        def __setitem__(self,key,value): self.data += [(key,str(value))]
        def __getitem__(self,key):
                for i in self.data:
                        if i[0]==key:
                                return i[1]

d = MyDict()
d["test"] = "python"
d["numar"] = 123
print (d["test"],d["numar"])
```

Output

```
python 123
```

Classes (special methods)

Building a bit set (overloading operator [])

Python 2.x/3.x

```
class BitSet:
        def __init__(self): self.value = 0
        def __setitem__(self,index,value):
                if value: self.value |= (1 << (index & 31))
                else: self.value -= (self.value & (1 << (index & 31))
        def __getitem__(self,key):
                return (self.value & (1 << (index & 31)))!=0
b = BitSet()
b[0] = True
b[2] = True
b[4] = True
for i in range(0,8):
        print("Bit ",i," is ",b[i])
```

Output

```
Bit  0  is  True
Bit  1  is  False
Bit  2  is  True
Bit  3  is  False
Bit  4  is  True
Bit  5  is  False
Bit  6  is  False
Bit  7  is  False
```

Context manager

A context manager is a mechanism where an object is created an notification about the moment that object is being access and the moment that object is being terminated.

Context managers are used along with **with** keyword. The objects that available in a context manager should implement __enter__ and __exit__ methods.

with $item_1$ **as** $alias_1$, [$item_2$ **as** $alias_2$, … $item_n$ **as** $alias_n$]:
    <statement 1>
    <statement 2>
      ….
    <statement n>

with $item_1$, [$item_2$, … $item_n$]:
    <statement 1>
    <statement 2>
      ….
    <statement n>

Context manager

Whenever a **with** command is encounter, the following steps happen:

1. All items are evaluated
2. For all items __enter__ is called
3. If aliases are provided, the result of the __enter__ method is store into the alias
4. The block within the **with** is executed
5. If an exception appears, __exit__ is called and information related to the exception (type, value and traceback) are provided as parameters. If the __exit__ method returns false, the exception is re-raised. If the __exit__ method returns true, the exception is ignored.
6. If no exception appear, __exit__ is called with None parameters for (type, value and traceback). The result from the __exit__ method will be ignored.

Classes (special methods)

File context manager

Python 2.x/3.x

```
class CachedFile:
        def __init__(self,fileName):
                self.data = ""
                self.fileName = fileName
        def __enter__(self):
                print("__enter__ is called")
                return self
        def __exit__(self, exc_type, exc_value, traceback):
                print("__exit__ is called")
                open(self.fileName,"wt").write(self.data)
                return False
with CachedFile("Test.txt") as f:
        f.data = "Python course"
```

Output

```
__enter__ is called
__exit__ is called
```