Case Study: Python
Object Oriented Programming

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Class

- Class vs. Object
- Instance vs. static fields
- Instance, Class, Static methods
- Encapsulation
- Inheritance
- Polymorphism

Class vs. Object

- Class is a user-defined prototype for an object

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    'Optional class documentation string'
    <class_suite>
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- Object: an instance of the class

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class Employee:
    'Common base class for all employees'
    empCount = 0     => empCount: static field
    def __init__(self,n,s):
        self.name = n
        self.salary = s
        Employee.empCount += 1
obj = Employee("Nam",30)
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        Employee.empCount += 1
obj = Employee("Nam",30)  => create object
```

Instance Methods

- Instance Method: method belongs to the instance

```
class Employee:
   def displayEmployee(self):
      print( "Name : ", self.name,
                  ", Salary: ", self.salary)
obj = Employee("Nam",30)
obj.displayEmployee()
```

Instance Methods

- Instance Method: method belongs to the instance

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class Employee:
   def displayEmployee(self):
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=> first parameter for instance

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- able to access to instance fields through first parameter and '.' => self.name
- able to access to static field through class name and '.' => Employee.empCount

Class and Static Methods

```
class Employee:
   @classmethod
   def create(cls,n,s):
      print(cls.empCount)
      return cls(n,s)
   @staticmethod
   def isHighSal(s):
      if s > 8:
         print("High Salary")
obj = Employee.create("Nam",30)
Employee.isHighSal(30)
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    @classmethod                    =>to define class method
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    def isHighSal(s):               =>no parameter for class
        if s > 8:                   =>unable to access any fields
            print("High Salary")
obj = Employee.create("Nam",30)  =>Employee is passed to cls
Employee.isHighSal(30)  =>Employee is used to resolve
```

Encapsulation

- to hide fields and methods
- based on name of fields and methods
  - Protected: prefix by a single underscore (_example)
  - Private: prefix by a double underscores (__example)
  - Public: begin with a letter

Class Hierarchy

- Python 3: root is **object**
- Multiple Inheritance

  class <clsname>(<parent>(,<parent>)*)?:

- For example,

  class A: => superclass is **object**
  class Rectangle(Parallelogram):

  class Square(Rhombus, Rectangle):

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  class A: => superclass is **object**
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  => superclass is Parallelogram
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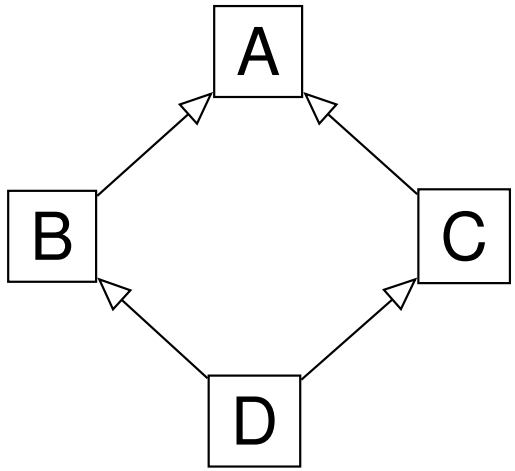
  => superclasses are Rhombus and Rectangle

Inheritance

- Subclass inherits non-private fields and methods from super-classes
- Diamond problem



- Method Resolution Order: determine search sequence of a class

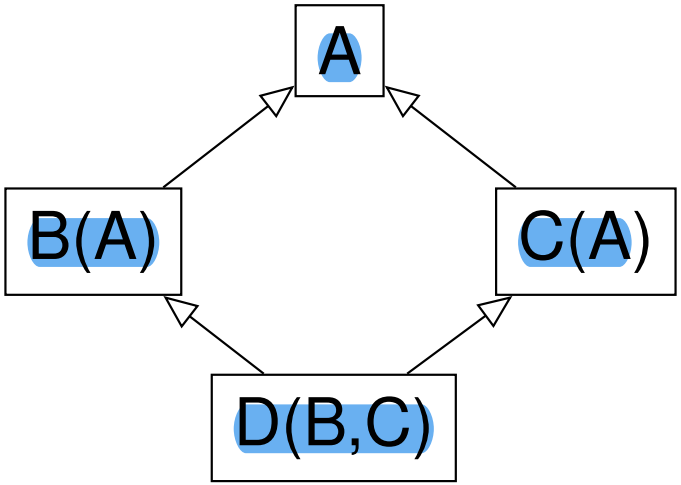
Method Resolution Order (MRO)

- MRO is used to determine search sequence L(M) of class M
  - L(object) = [object]
  - L(M(A,B,C)) = [M] + merge(L(A),L(B),L(C),[A,B,C])

Method Resolution Order (MRO)

- MRO is used to determine search sequence L(M) of class M
  - L(object) = [object]
  - L(M(A,B,C)) = [M] + merge(L(A),L(B),L(C),[A,B,C])
- merge([$H_1|T_1$],[$H_2|T_2$],[$H_3|T_3$])
  - Step 1: if H_1 is a **good** head which is NOT in the tail of other lists, take H_1 out as an output, remove H_1 out of all lists, back to Step 1.
  - Step 2: if H_1 is not a good head, check if H_2 is a good head. If it is, apply Step1 for H_2. If it is not, check for H_3 and so on. If there is no good head, give an error.

Example



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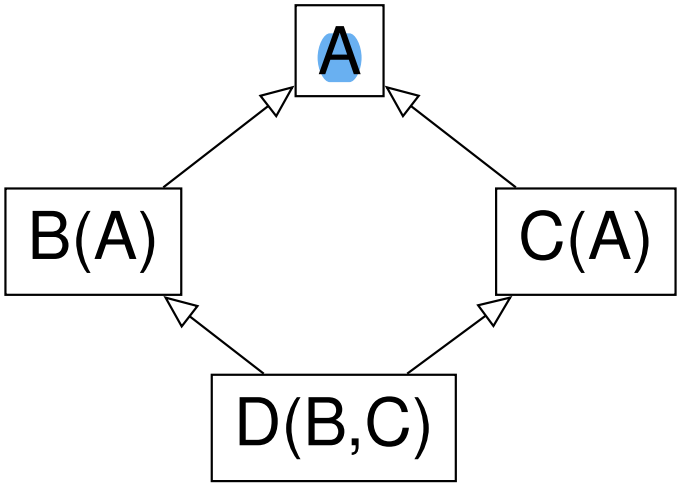

- L(A) = [A,object]

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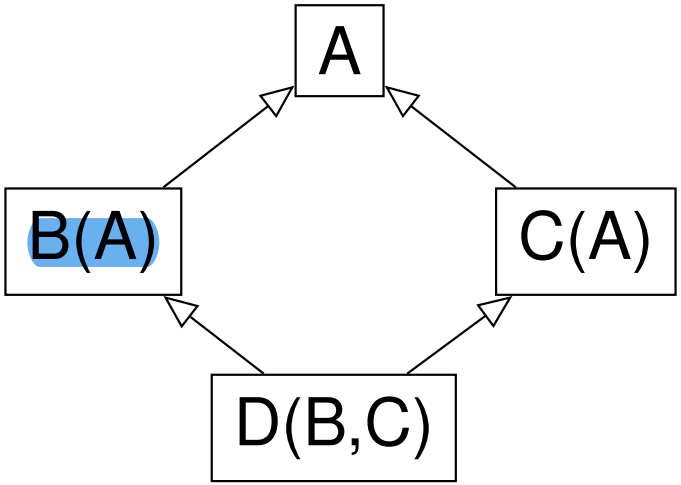

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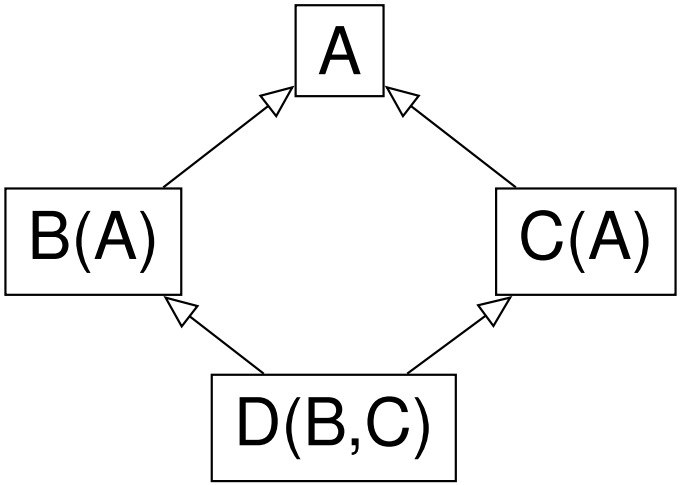

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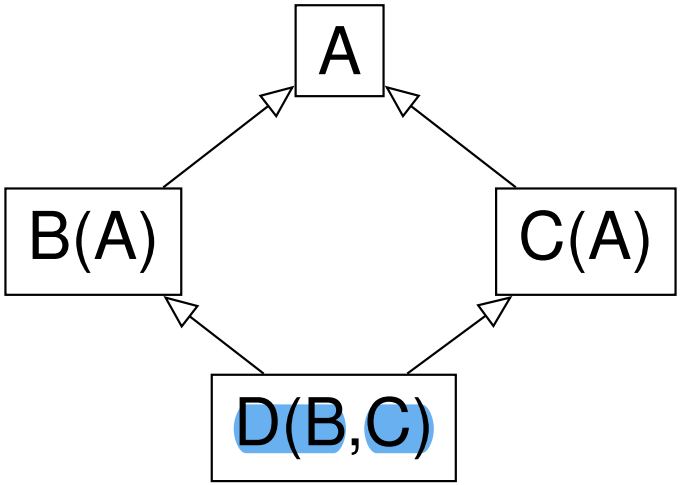

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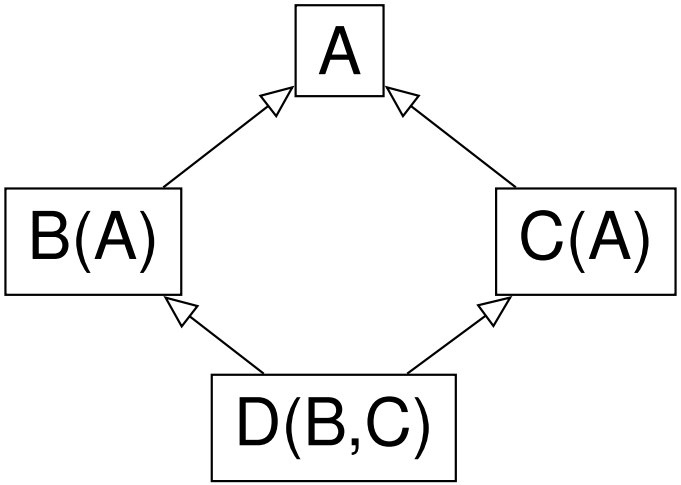

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- merge([B,A,o],[C,A,o],[B,C]) =>

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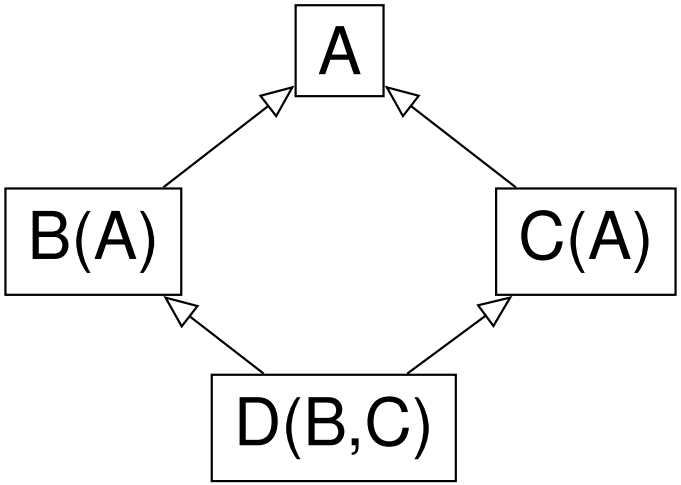

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  - B is a good head => [B]+merge([A,o],[C,A,o],[C])

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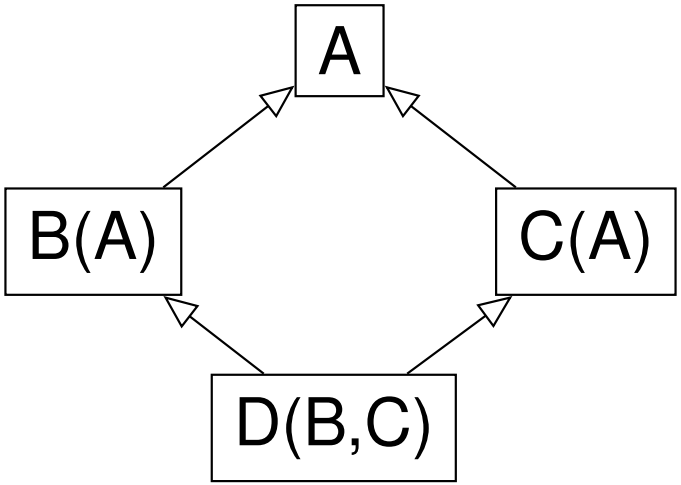

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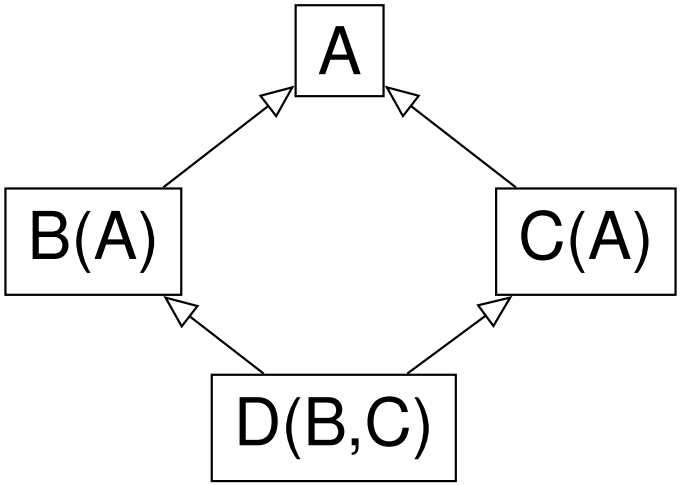

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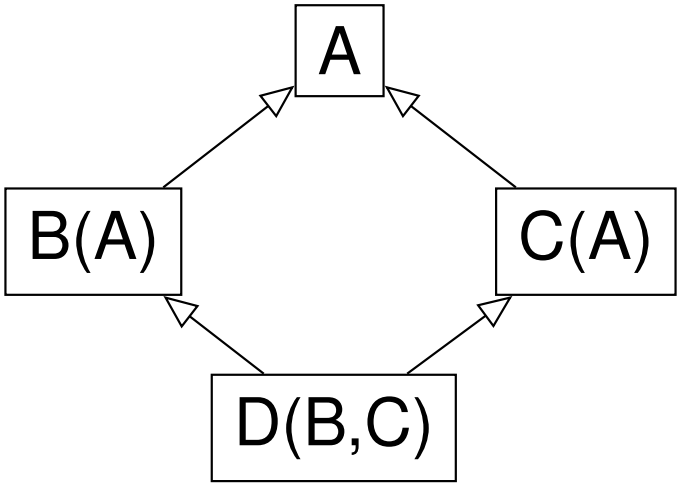

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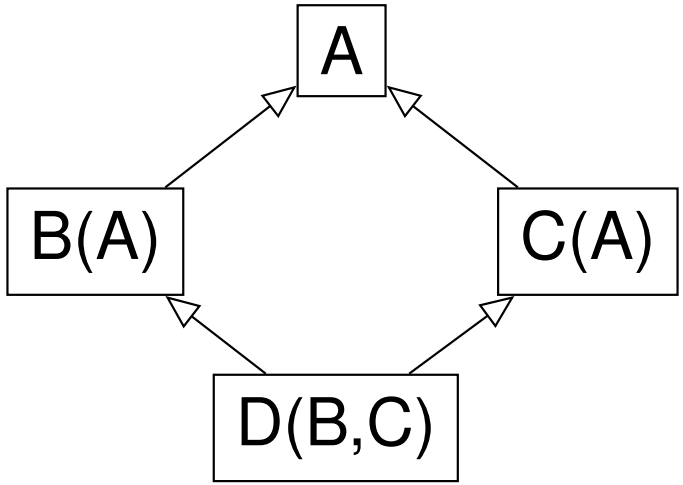

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super, isinstance, type

- **super()** => refer to the superclass

```
1 class A:
2     def foo(self,x):
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7 B().foo(3)
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x = B()
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class A: pass
class B(A): pass
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type(x) is B
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- **isinstance(o,T)** => check if object **o** is of type **T**

```
class A: pass
class B(A): pass
x = B()
```

type(x) is A => False

- **type(o)** => return the type of object **o**

Polymorphism

- **Overloading**:

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for x in [A(),B()]:
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Some other issues

- **id()**: address of the specified object

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x,y,z = 3,3,4
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References I

[1] Python Tutorial, http:w3schools.com/python, 10 08 2020.

[2] Python Programming Language, https://www.geeksforgeeks.org/python-programming-language/, 10 08 2020.

[3] Python Tutorial, https://www.tutorialspoint.com/python, 10 08 2020.

[4] Introduction to Python 3, https://realpython.com/python-introduction/, 10 08 2020.