Lecture 19

Subclasses & Inheritance

Announcements for Today

Prelim 2

- **Prelim, Nov 11th at 7:30**
  - Once again in two rooms
  - Review session on Sunday
- **Material up to Nov. 4**
  - Study guide this week
  - Recursion + Loops + Classes
- **Conflict with Prelim?**
  - Prelim 2 Conflict on CMS
  - SDS students must submit!

Assignments

- A4 graded by end of week
  - Survey is still open
- A5 was posted **Thursday**
  - Shorter written assignment
  - Due Thursday at Midnight
- A6 was posted **Monday**
  - Due a **week after** prelim
  - Designed to take two weeks
  - Follow **micro-deadlines!**

Announcements for Today

Prelim 2

- **Prelim, Nov 11th at 7:30**
  - Once again
  - Review ses
- **Material u**
  - Study guide
  - Recursion -
- **Conflict wi**
  - Prelim 2 Conflict on CMS
  - SDS students must submit!

Assignments

- A4 graded by end of week
  - till open
  - d **Thursday**
  - tten assignment
  - day at Midnight
  - ed **Monday**
  - **after** prelim
    - Designed to take two weeks
    - Follow **micro-deadlines!**

Video Lessons

- **Lesson 22** for today
- **Videos 23.1-23.7** next time
- **Video 23.8** is *very* optional

An Application

- **Goal**: Presentation program (e.g. PowerPoint)
- **Problem**: There are many types of content
  - **Examples**: text box, rectangle, image, etc.
  - Have to write code to display each one
- **Solution**: Use object oriented features
  - Define class for every type of content
  - Make sure each has a `draw` method:

```
for x in slide[i].contents:
    x.draw(window)
```

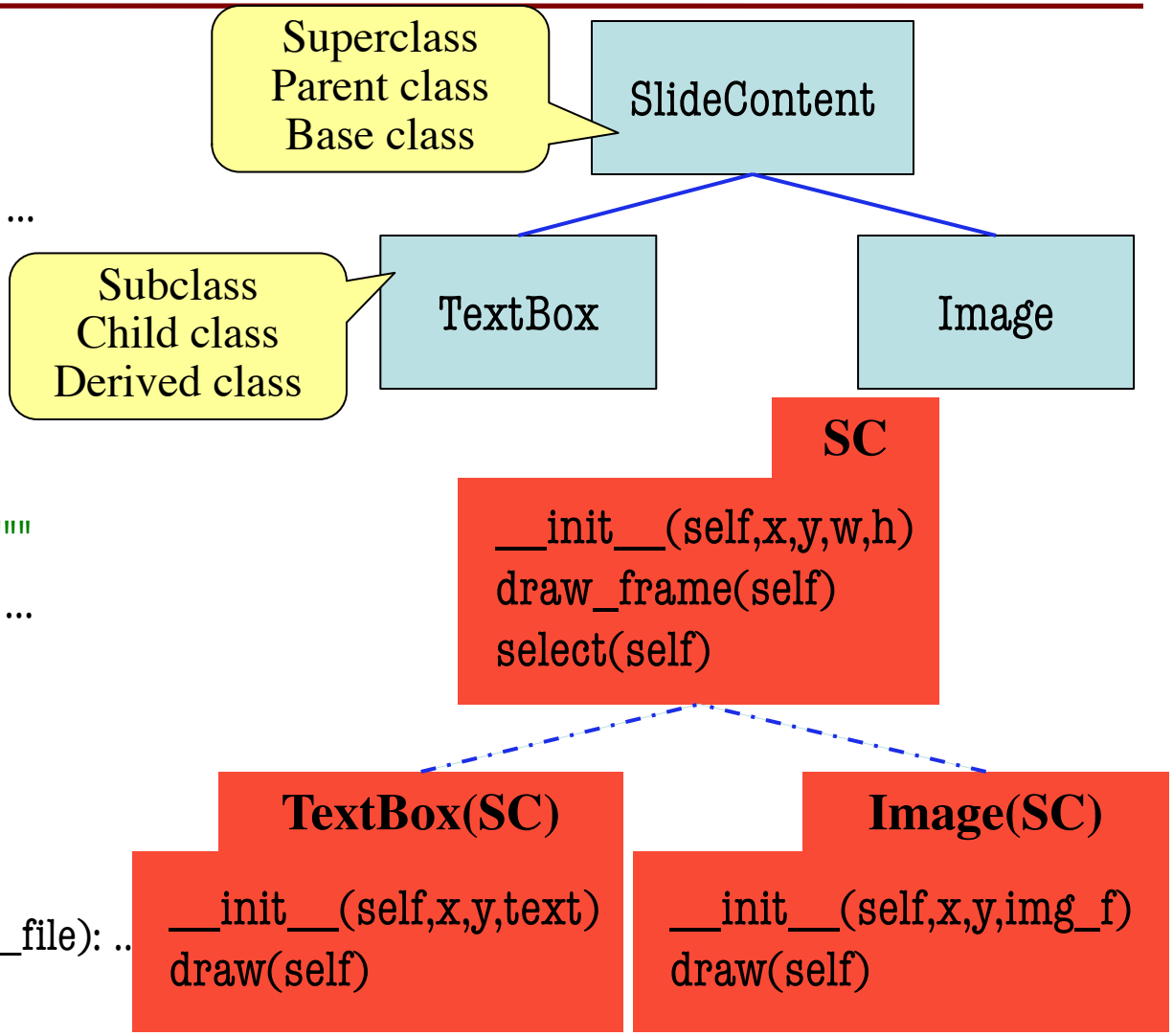
Sharing Work

- These classes will have a lot in common
  - Drawing handles for selection
  - Background and foreground color
  - Current size and position
  - And more (see the formatting bar in PowerPoint)
- **Result**: A lot of repetitive code
- **Solution**: Create one class with shared code
  - All content are *subclasses* of the *parent* class

Defining a Subclass

Abbreviate as SC to right

```
class SlideContent(object):
    """Any object on a slide."""
    def __init__(self, x, y, w, h): ...
    def draw_frame(self): ...
    def select(self): ...

class TextBox(SlideContent):
    """An object containing text."""
    def __init__(self, x, y, text): ...
    def draw(self): ...

class Image(SlideContent):
    """An image."""
    def __init__(self, x, y, image_file): ..
    def draw(self): ...
```



Class Definition: Revisited

class <*name*>(<superclass>):

    """Class specification"""

    getters and setters

    initializer (__init__)

    definition of operators

    definition of methods

    anything else

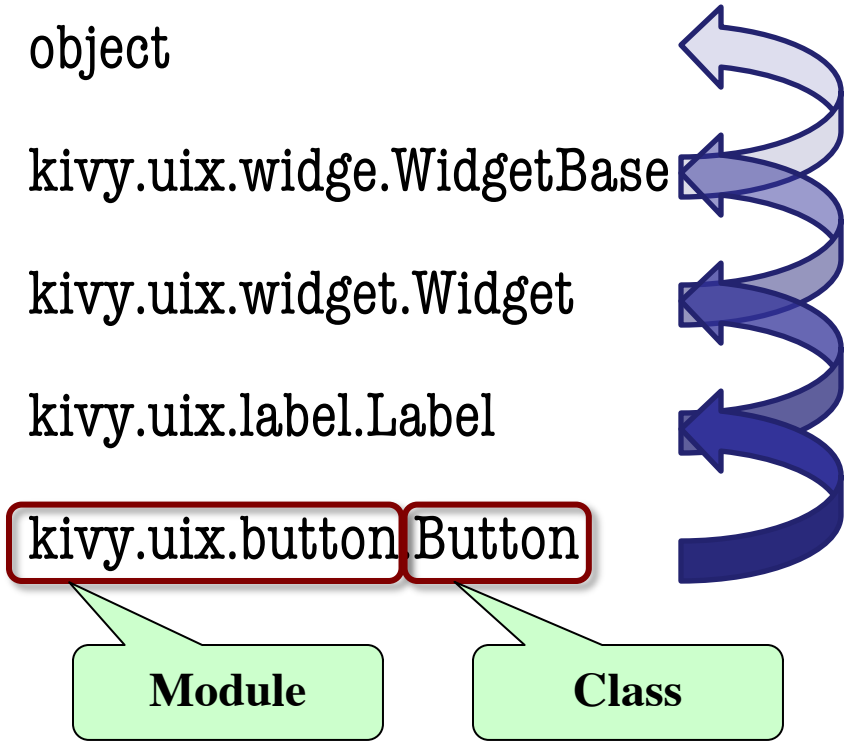
Class type to extend
(may need module name)

- Every class must extend *something*
- Previous classes all extended object

object and the Subclass Hierarcy

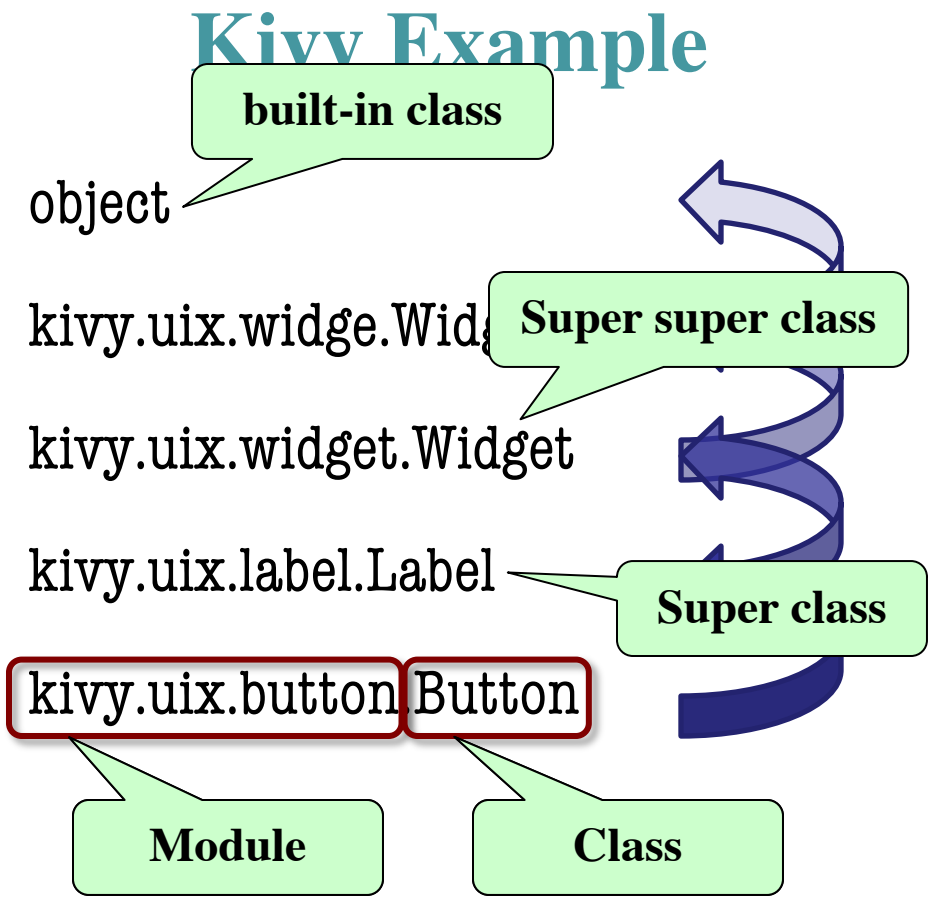
- Subclassing creates a **hierarchy** of classes
  - Each class has its own super class or parent
  - Until `object` at the "top"
- `object` has many features
  - Special built-in fields: `__class__`, `__dict__`
  - Special built-in methods: `__str__`, `__repr__`

Kivy Example



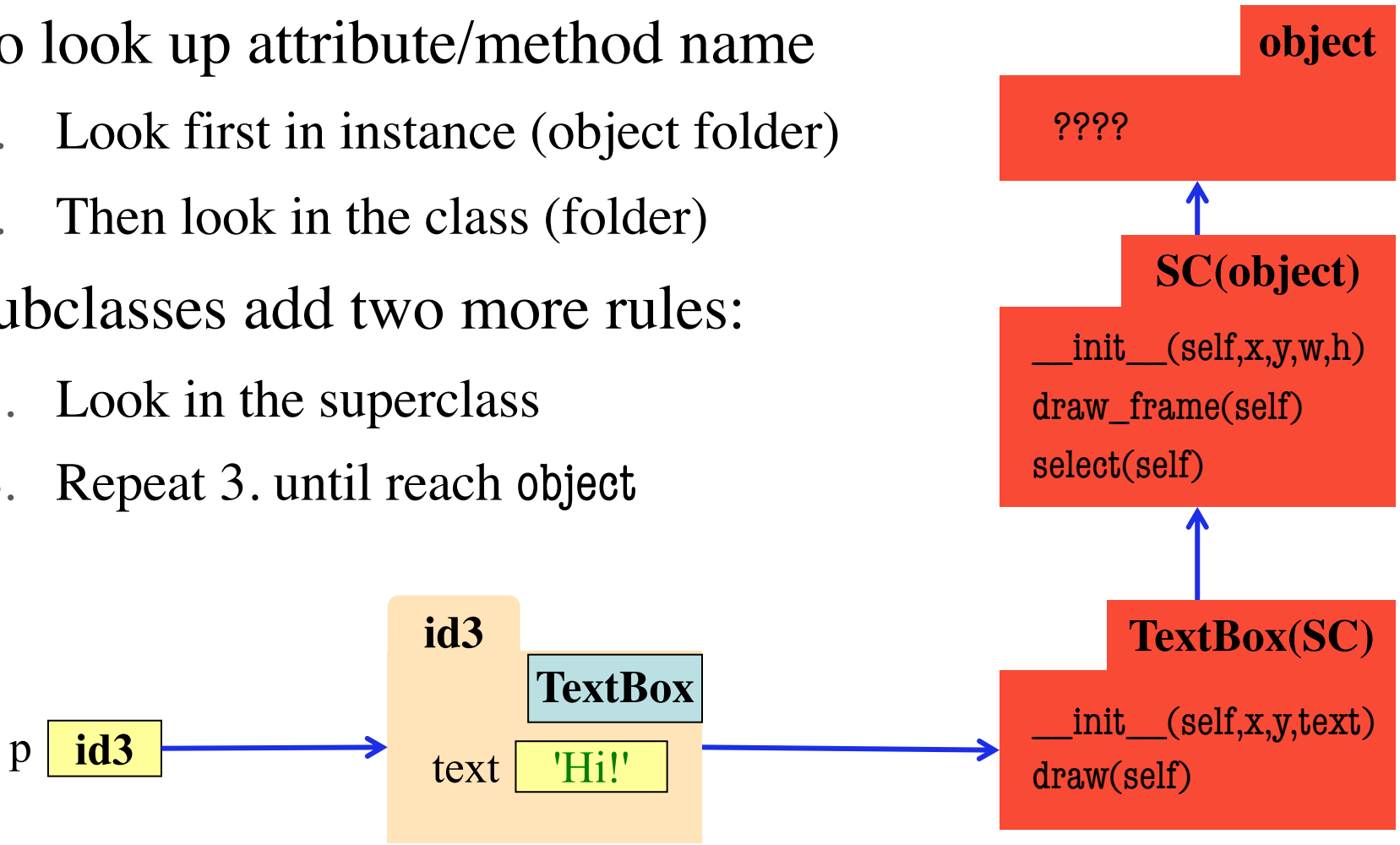
object and the Subclass Hierarcy

- Subclassing creates a **hierarchy** of classes
  - Each class has its own super class or parent
  - Until `object` at the "top"
- `object` has many features
  - Special built-in fields: `__class__`, `__dict__`
  - Special built-in methods: `__str__`, `__repr__`



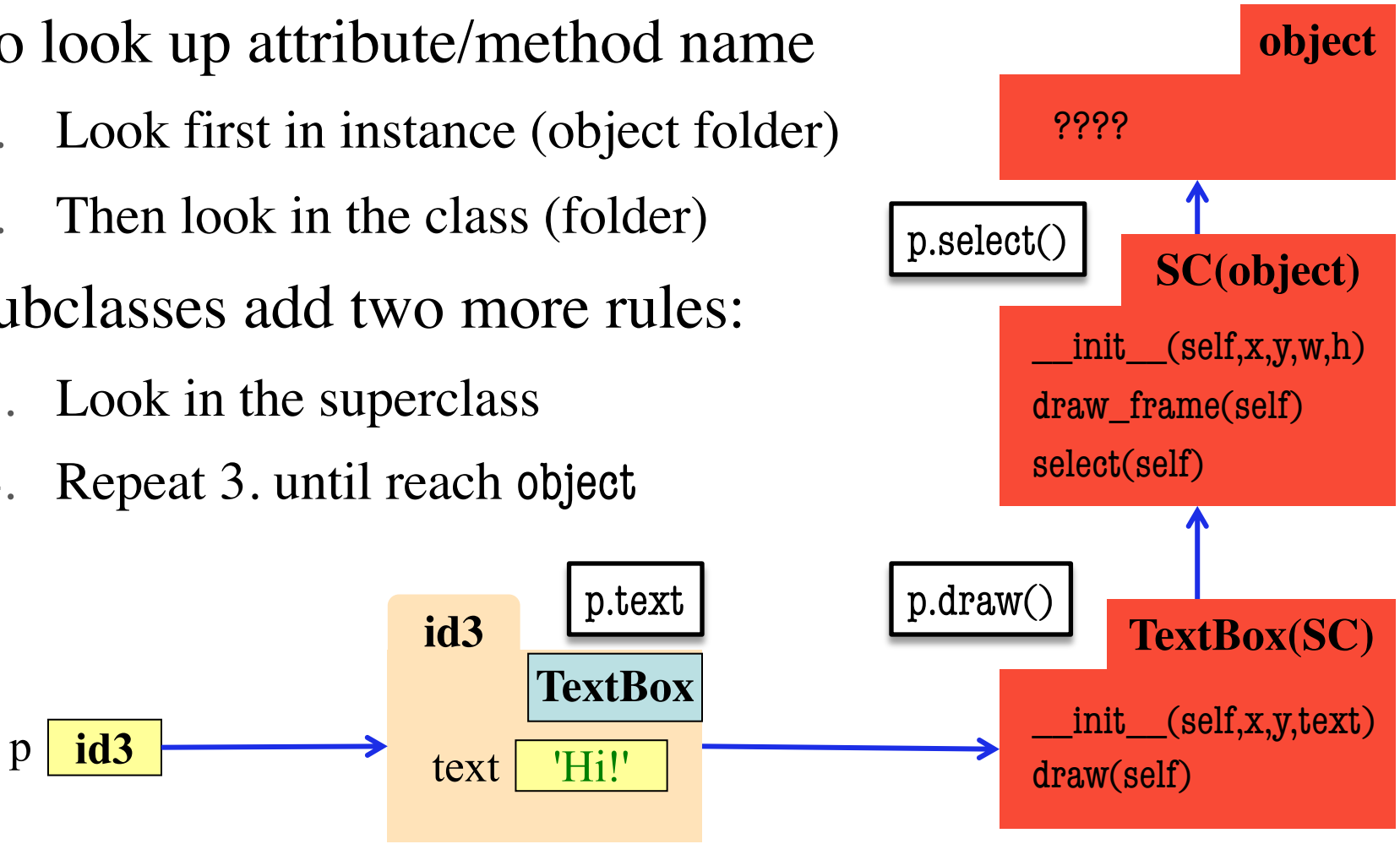
Name Resolution Revisited

- To look up attribute/method name
  1. Look first in instance (object folder)
  2. Then look in the class (folder)
- Subclasses add two more rules:
  3. Look in the superclass
  4. Repeat 3. until reach object



Name Resolution Revisited

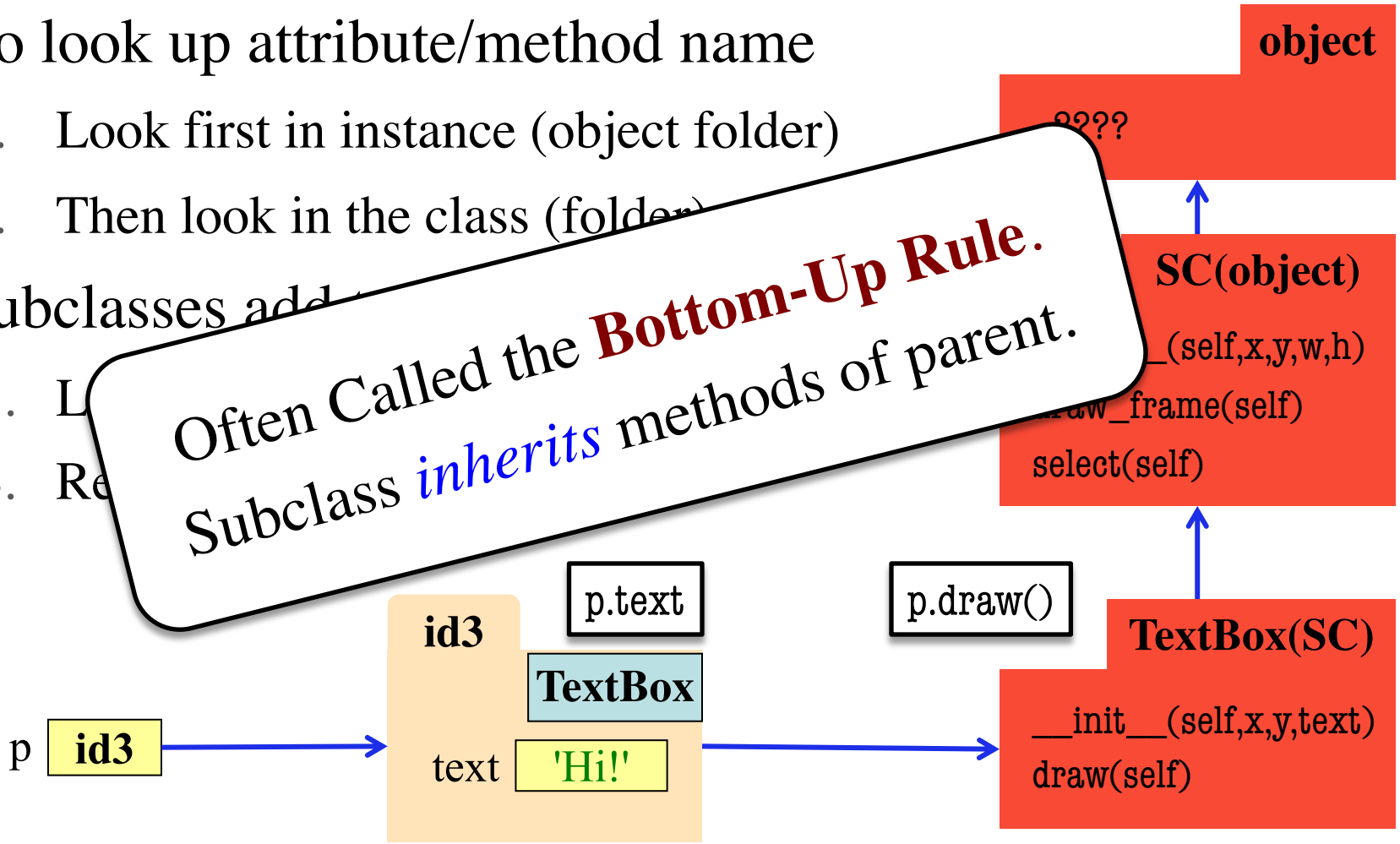
- To look up attribute/method name
  1. Look first in instance (object folder)
  2. Then look in the class (folder)
- Subclasses add two more rules:
  3. Look in the superclass
  4. Repeat 3. until reach object



Name Resolution Revisited

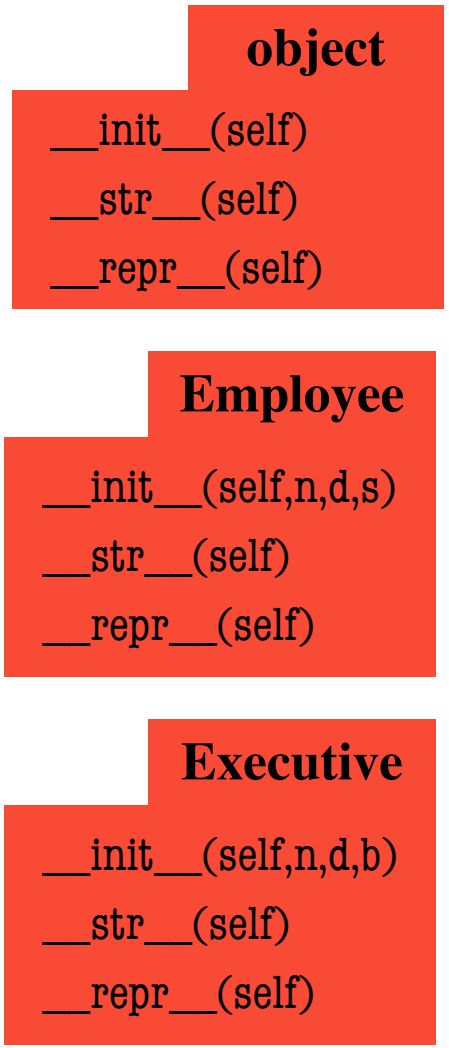
- To look up attribute/method name
  1. Look first in instance (object folder)
  2. Then look in the class (folder)
- Subclasses add
  3. L
  4. Re

Often Called the **Bottom-Up Rule**.
Subclass *inherits* methods of parent.



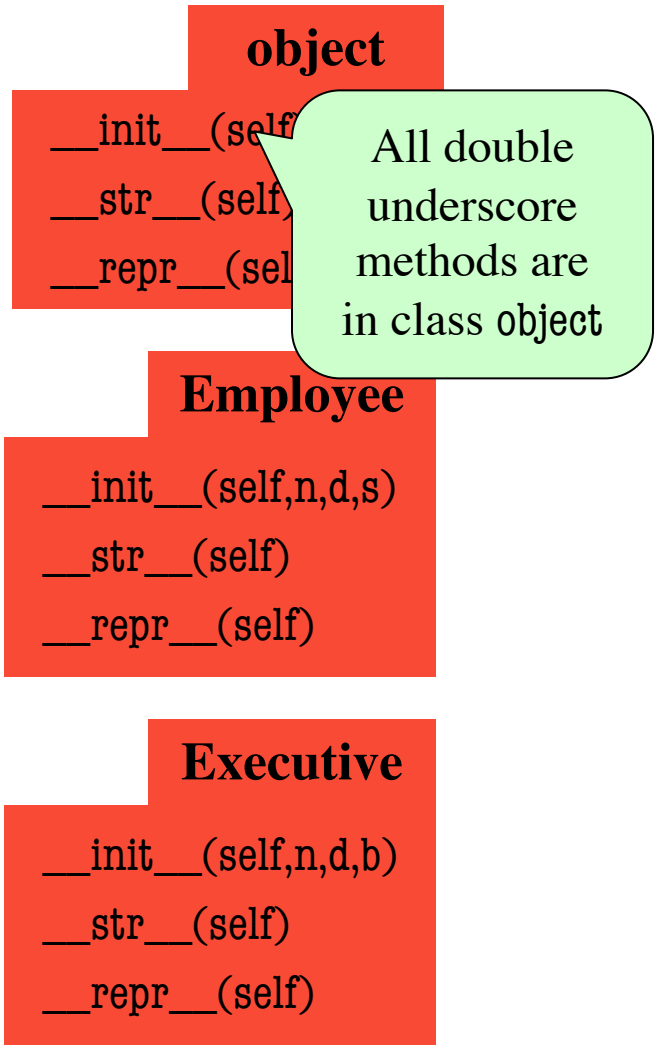
A Simpler Example

```
class Employee(object):
    """Instance is salaried worker"""
    # INSTANCE ATTRIBUTES:
    # _name:  full name, a string
    # _start:   first year hired,
    #   an int ≥ -1, -1 if unknown
    # _salary: yearly wage, a float

class Executive(Employee):
    """An Employee with a bonus"""
    # INSTANCE ATTRIBUTES:
    #_bonus: annual bonus, a float
```



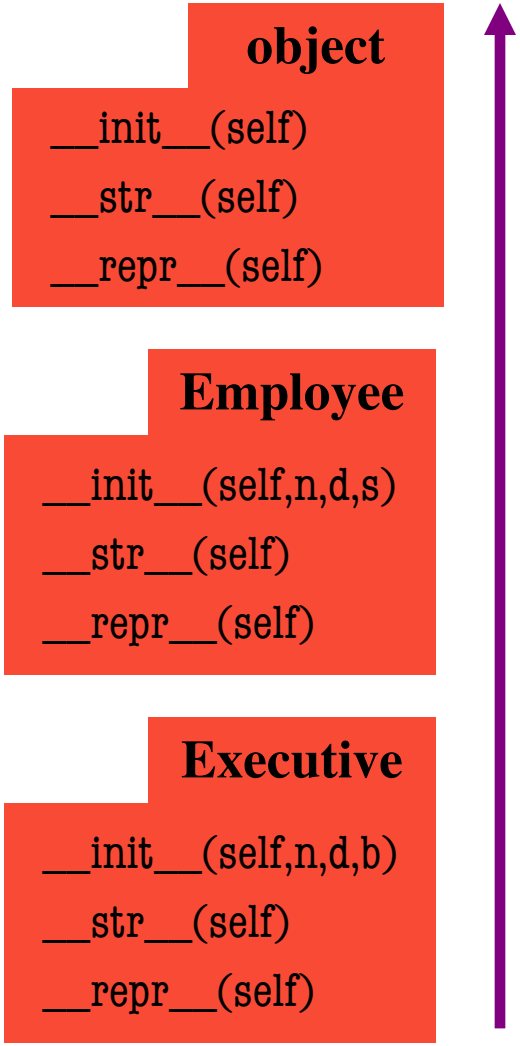
A Simpler Example

```
class Employee(object):
    """Instance is salaried worker"""
    # INSTANCE ATTRIBUTES:
    # _name:  full name, a string
    # _start:   first year hired,
    #   an int ≥ -1, -1 if unknown
    # _salary: yearly wage, a float

class Executive(Employee):
    """An Employee with a bonus"""
    # INSTANCE ATTRIBUTES:
    #_bonus: annual bonus, a float
```



Method Overriding

- Which __str__ do we use?
  - Start at bottom class folder
  - Find first method with name
  - Use that definition
- New method definitions **override** those of parent
  - Access to old version is **lost**
  - New version used instead
  - **Example**: __init__

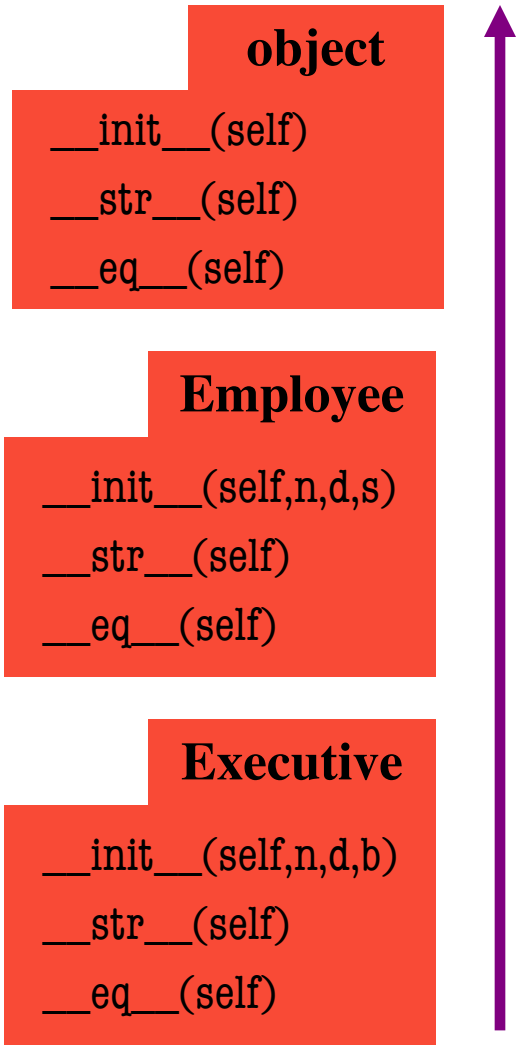


Accessing the "Previous" Method

- What if you want to use the original version method?
  - New method = original+more
  - Do not want to repeat code from the original version
- Use the function `super()`
  - "Converts" type to parent class
  - Now methods go to the class
- **Example**:

```
super().__str__()
```

In Python 2 self goes here



Accessing the "Previous" Method

- What if you want to use the original version method?
  - New method = original+more
  - Do not want to repeat code from the original version
- Use the function super()
  - "Converts" type to parent class
  - Now methods go to the class
- **Example**:

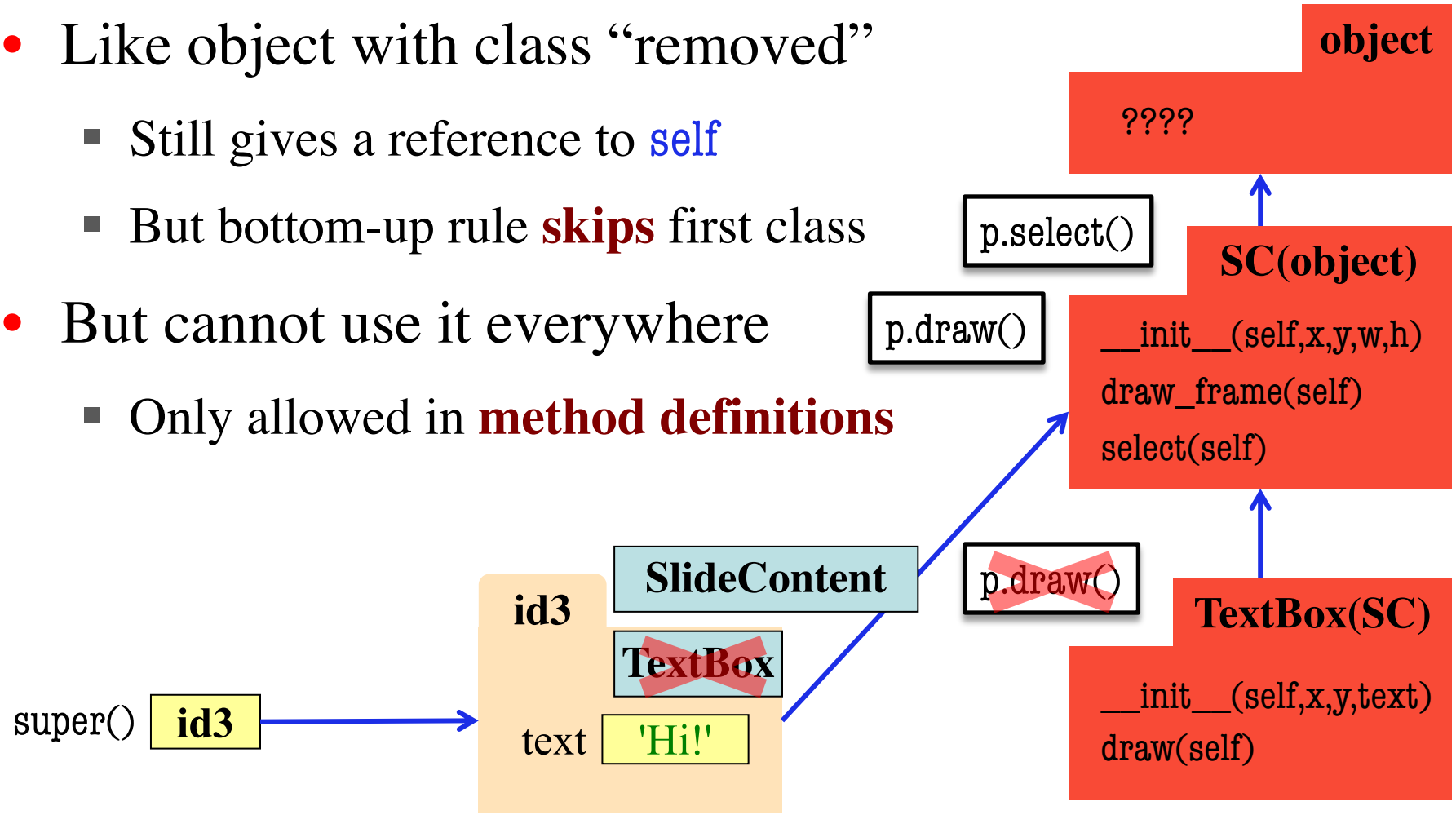
```
super().__str__()
```

self is implied

```
class Employee(object):
    """An Employee with a salary"""
    ...
    def __str__(self):
        return (self._name +
                ', year ' + str(self._start) +
                ', salary ' + str(self._salary))

class Executive(Employee):
    """An Employee with a bonus."""
    ...
    def __str__(self):
        return (super().__str__()
                + ', bonus ' + str(self._bonus) )
```

What is super()?

- Like object with class "removed"
  - Still gives a reference to self
  - But bottom-up rule **skips** first class
- But cannot use it everywhere
  - Only allowed in **method definitions**



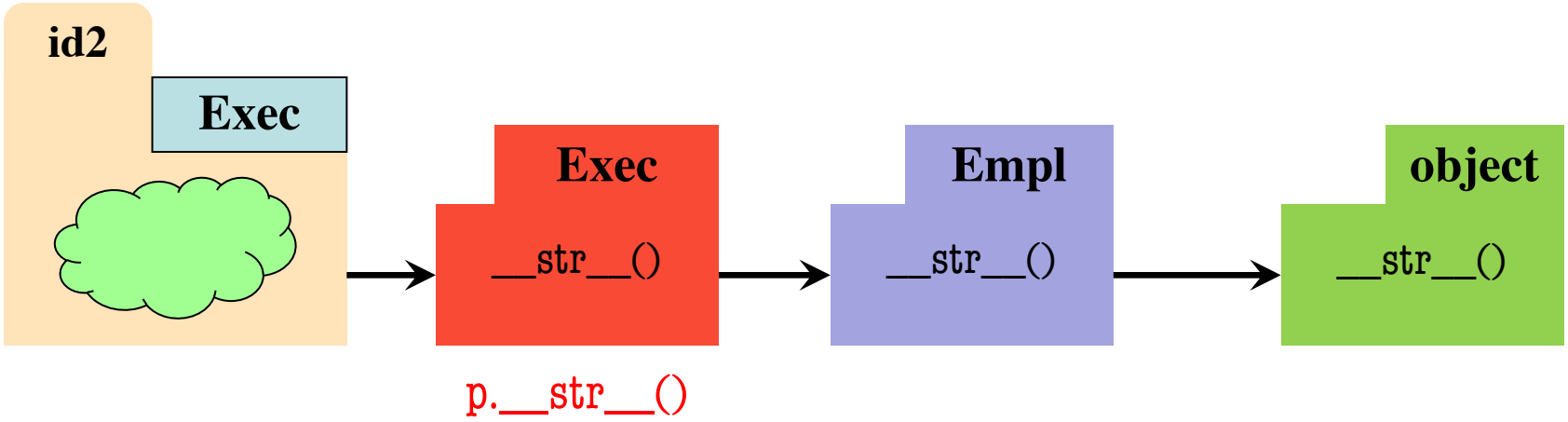
What is super()?

- super() is very limited
  - Can only go one level
  - **BAD**: super().super()
- Need arguments for more
  - super(class,self)

The **subclass**

Object in the method

p **id2**



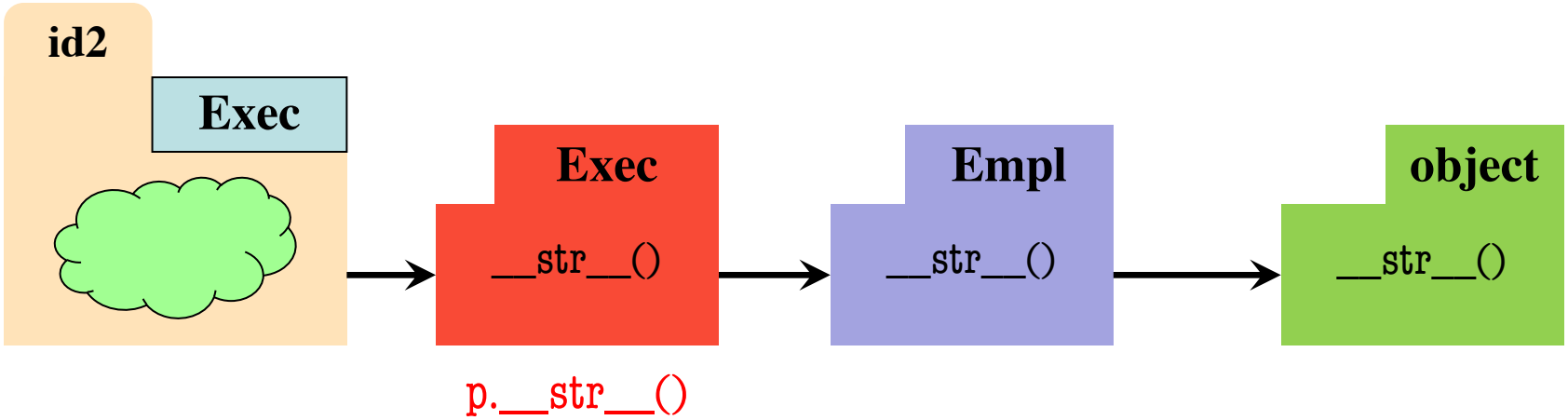
What is super()?

- super() is very limited
  - Can only go one level
  - **BAD**: super().super()
- Need arguments for more
  - super(class,self)

The **subclass**

Object in the method

p **id2**



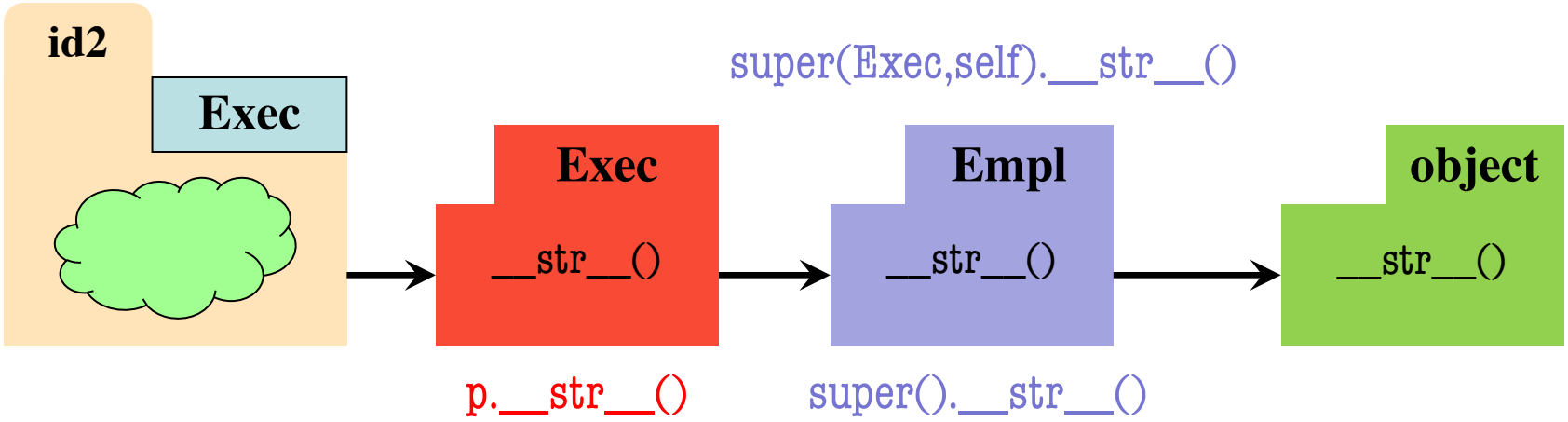
What is super()?

- super() is very limited
  - Can only go one level
  - **BAD**: super().super()
- Need arguments for more
  - super(class,self)

The **subclass**

Object in the method

p **id2**



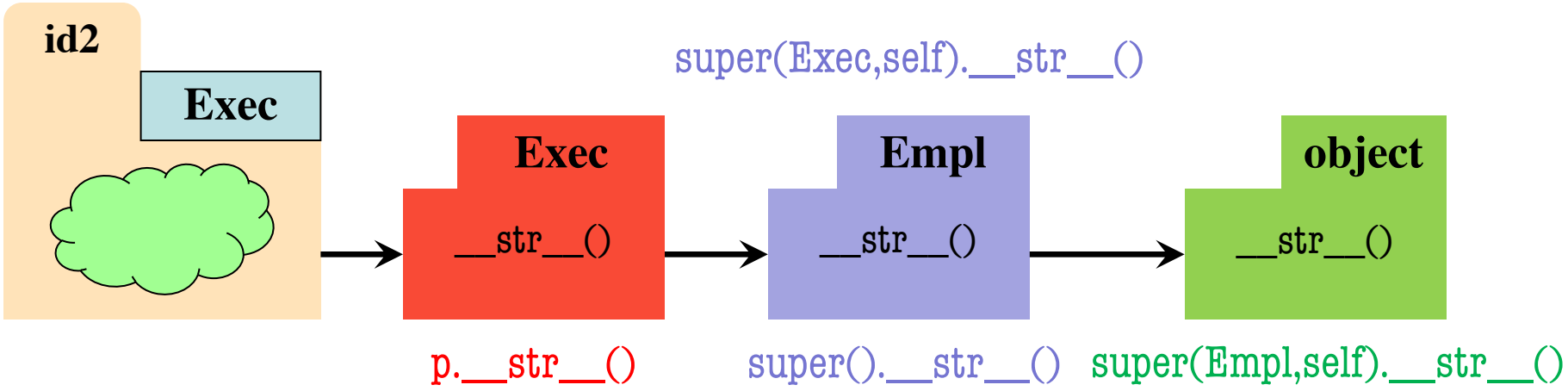
What is super()?

- super() is very limited
  - Can only go one level
  - **BAD**: super().super()
- Need arguments for more
  - super(class,self)

The **subclass**

Object in the method

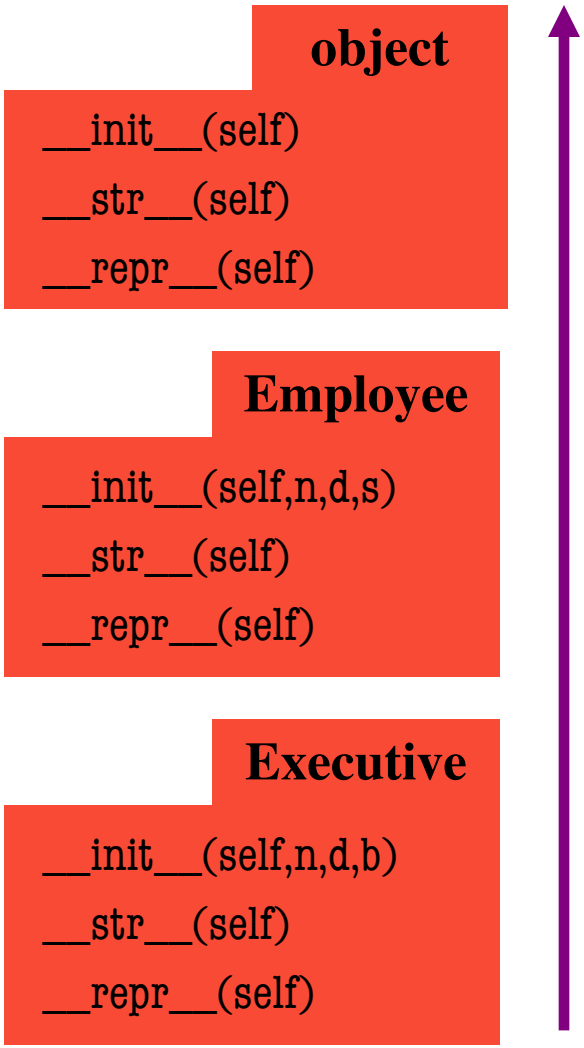
p **id2**



Primary Application: Initializers

```
class Employee(object):
    ...
    def __init__(self,n,d,s=50000.0):
        self._name = n
        self._start = d
        self._salary = s
```

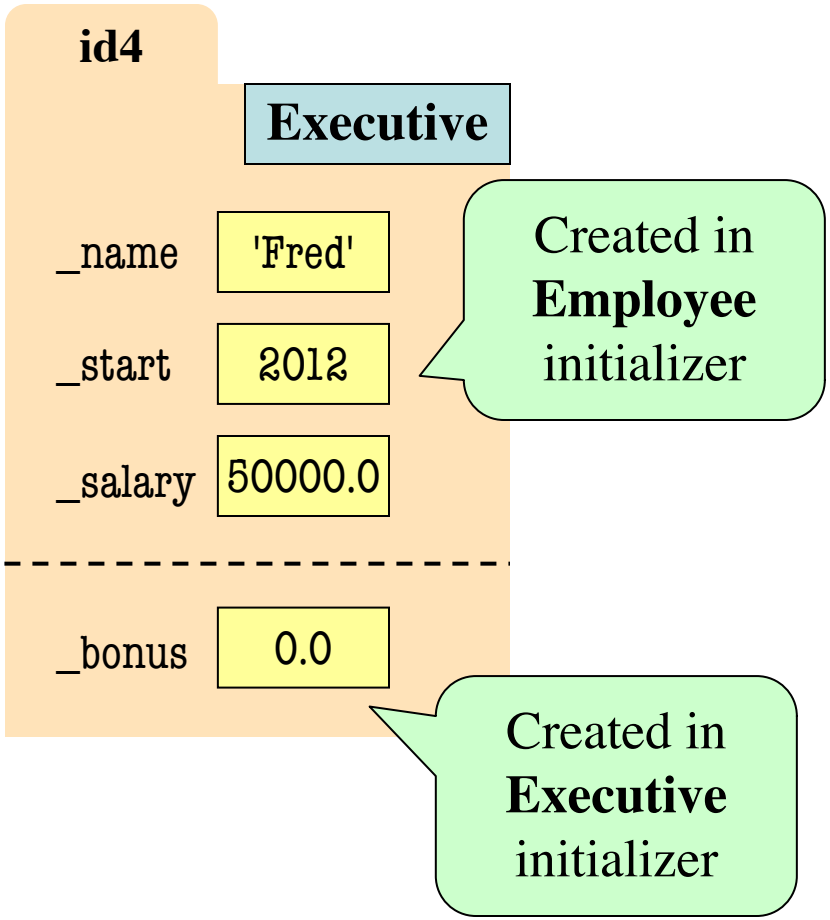
```
class Executive(Employee):
    ...
    def __init__(self,n,d,b=0.0):
        super().__init__(n,d)
        self._bonus = b
```



Instance Attributes are (Often) Inherited

```
class Employee(object):
    ...
    def __init__(self,n,d,s=50000.0):
        self._name = n
        self._start = d
        self._salary = s
```

```
class Executive(Employee):
    ...
    def __init__(self,n,d,b=0.0):
        super().__init__(n,d)
        self._bonus = b
```

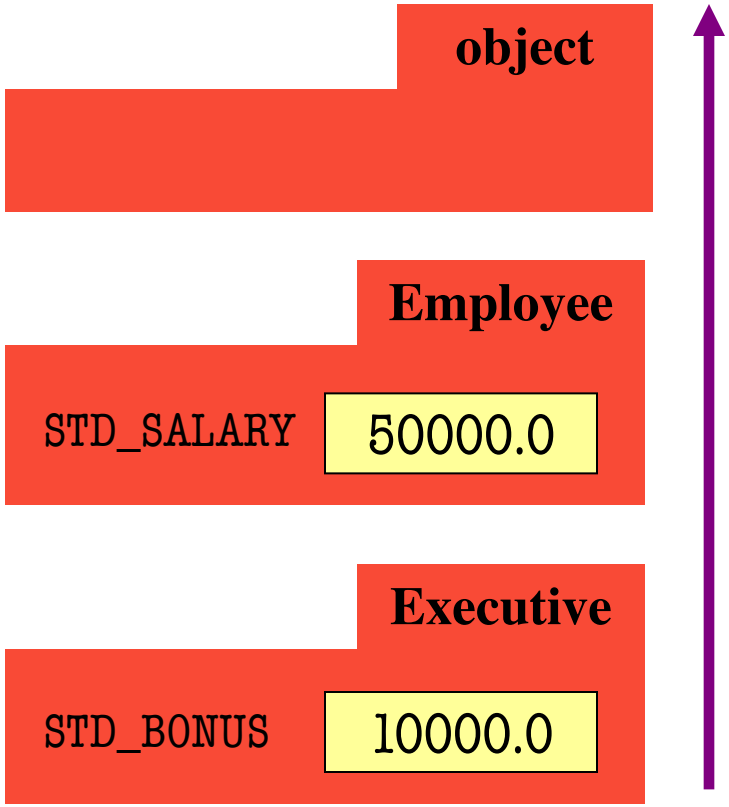


Also Works With Class Attributes

Class Attribute: Assigned outside of any method definition

```
class Employee(object):
    """Instance is salaried worker"""
    # Class Attribute
    STD_SALARY = 50000.0
```

```
class Executive(Employee):
    """An Employee with a bonus."""
    # Class Attribute
    STD_BONUS = 10000.0
```



Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of a.f()?

A: 10
B: 14
C: 5
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of a.f()?

A: 10 **CORRECT**
B: 14
C: 5
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of b.f()?

A: 10
B: 14
C: 5
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of b.f()?

A: 10
B: 14 **CORRECT**
C: 5
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of b.x?

A: 4
B: 3
C: 42
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of b.x?

A: 4
B: 3 **CORRECT**
C: 42
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

  >>> a = A()

  >>> b = B()

- What is value of a.z?

A: 4
B: 3
C: 42
D: **ERROR**
E: I don't know

Name Resolution and Inheritance

```
class A(object):
    x = 3 # Class Attribute
    y = 5 # Class Attribute

    def f(self):
        return self.g()

    def g(self):
        return 10

class B(A):
    y = 4    # Class Attribute
    z = 42   # Class Attribute

    def g(self):
        return 14

    def h(self):
        return 18
```

- Execute the following:

```
>>> a = A()
>>> b = B()
```

- What is value of a.z?

A: 4
B: 3
C: 42
D: **ERROR** **CORRECT**
E: I don't know