CS 1110:
Introduction to Computing Using Python

Lecture 19

Subclasses & Inheritance

[Andersen, Gries, Lee, Marschner, Van Loan, White]

Announcements

- Regrade Requests
  - Please put on the table

Announcements

- A3 solutions will be released soon
- A4 will be released by Wednesday morning
  - due Thursday, April 20th, 11:59pm
- Prelim 2
  - Tuesday, April 25th, 7:30-9:00pm
  - Please go to the same room you went for Prelim 1
  - Conflict arrangements being worked out; stay tuned
- Lab 10 is out

Review of Attributes and Variables

Goal: Make something like Powerpoint

text box with text

Goal: Make something like Powerpoint

text box with text

Image:

x, y
width, height
isSelected
pixels[][]
__init__()
draw()
select()

repetitive

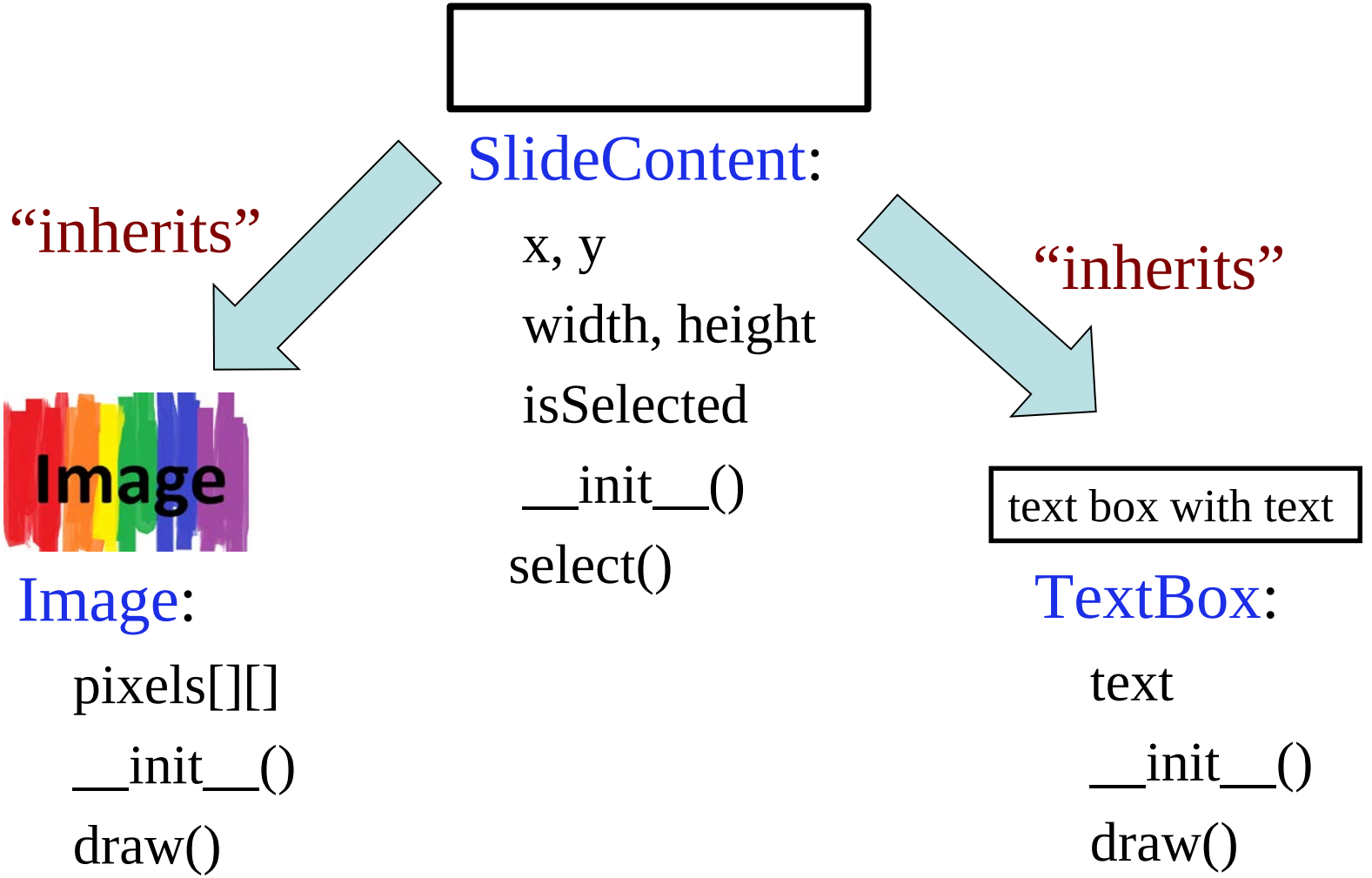
different

somewhat repetitive

TextBox:

x, y
width, height
isSelected
text
__init__()
draw()
select()

Ideally…


SlideContent:
x, y
width, height
isSelected
__init__()
select()
"inherits"
"inherits"
Image
Image:
pixels[][]
__init__()
draw()
text box with text
TextBox:
text
__init__()
draw()

Sharing Work

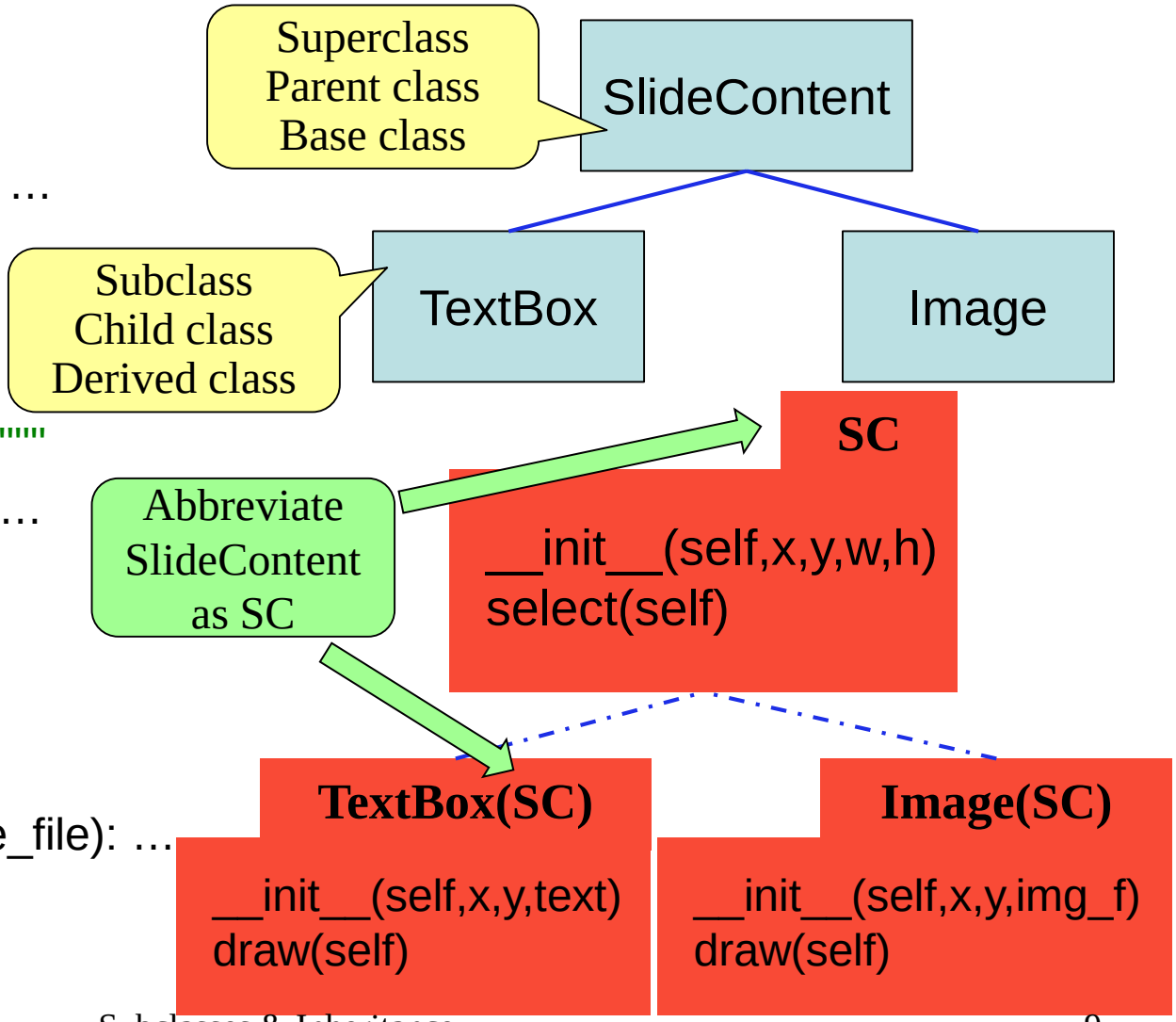
- **Solution**: Create a *parent* class with shared code
  - Then, create *subclasses* of the *parent* class

Defining a Subclass

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



Extending Classes

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

    """Class specification"""

    initializer (__init__)

    methods

    class variables

    anything else

Class to extend
(may need module name)

So far, classes have extended object

object and the Subclass Hierarchy

- Subclassing creates a **hierarchy** of classes
  - Each class has its own super class or parent
  - Until object at the "top"
- object has many features
  - Default operators: __str__, __repr__

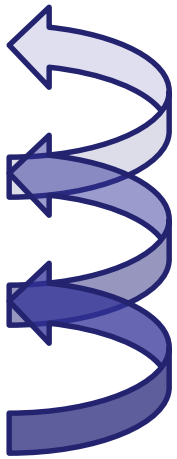
Example

object

SlideContent

TextBox

InputTextBox



object and the Subclass Hierarchy

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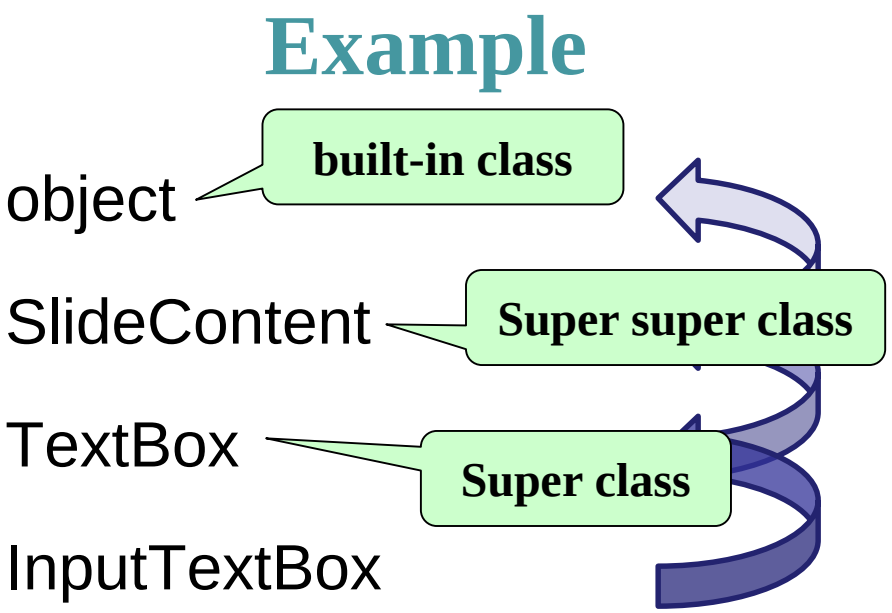
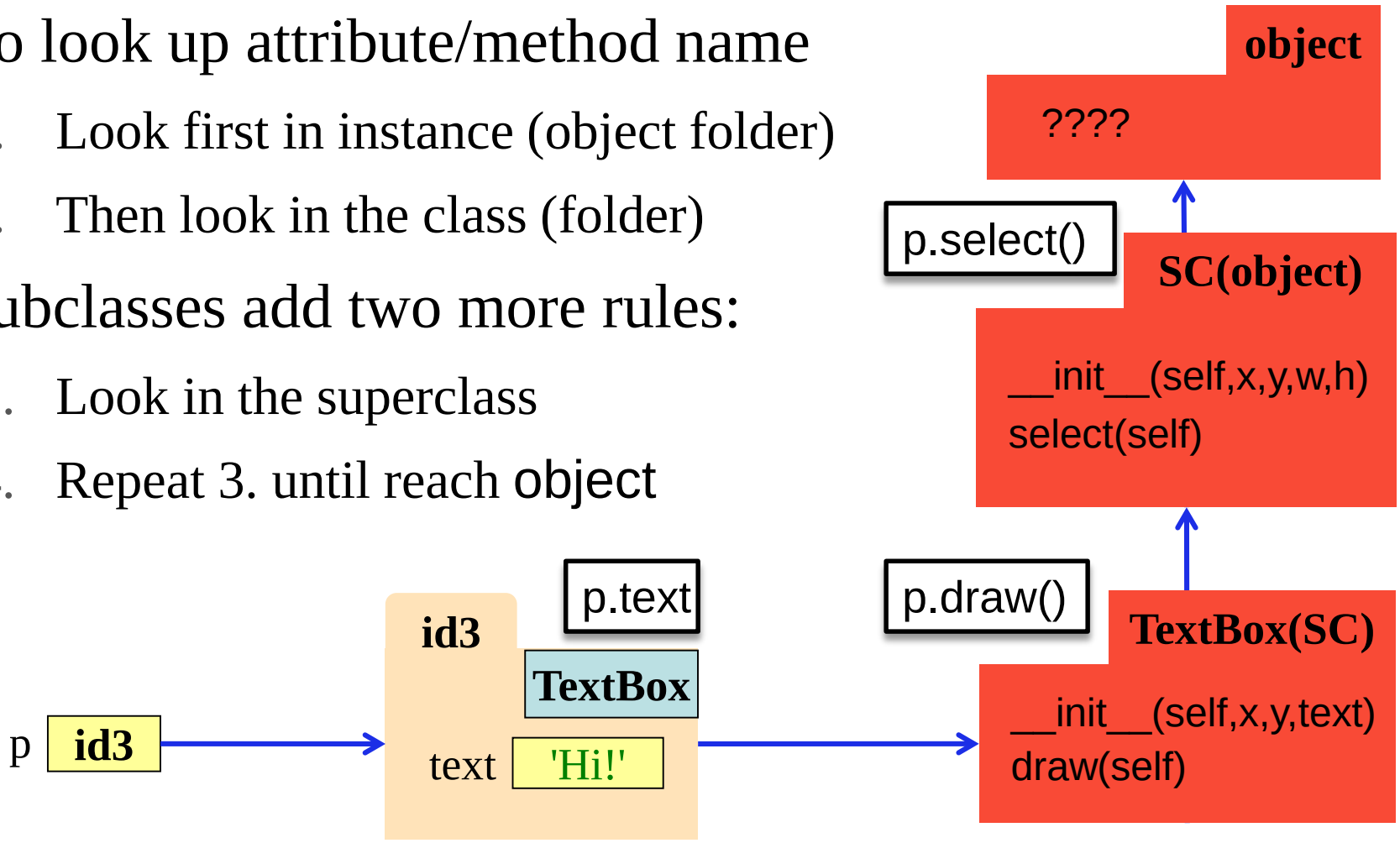


Name Resolution Revisited

- 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



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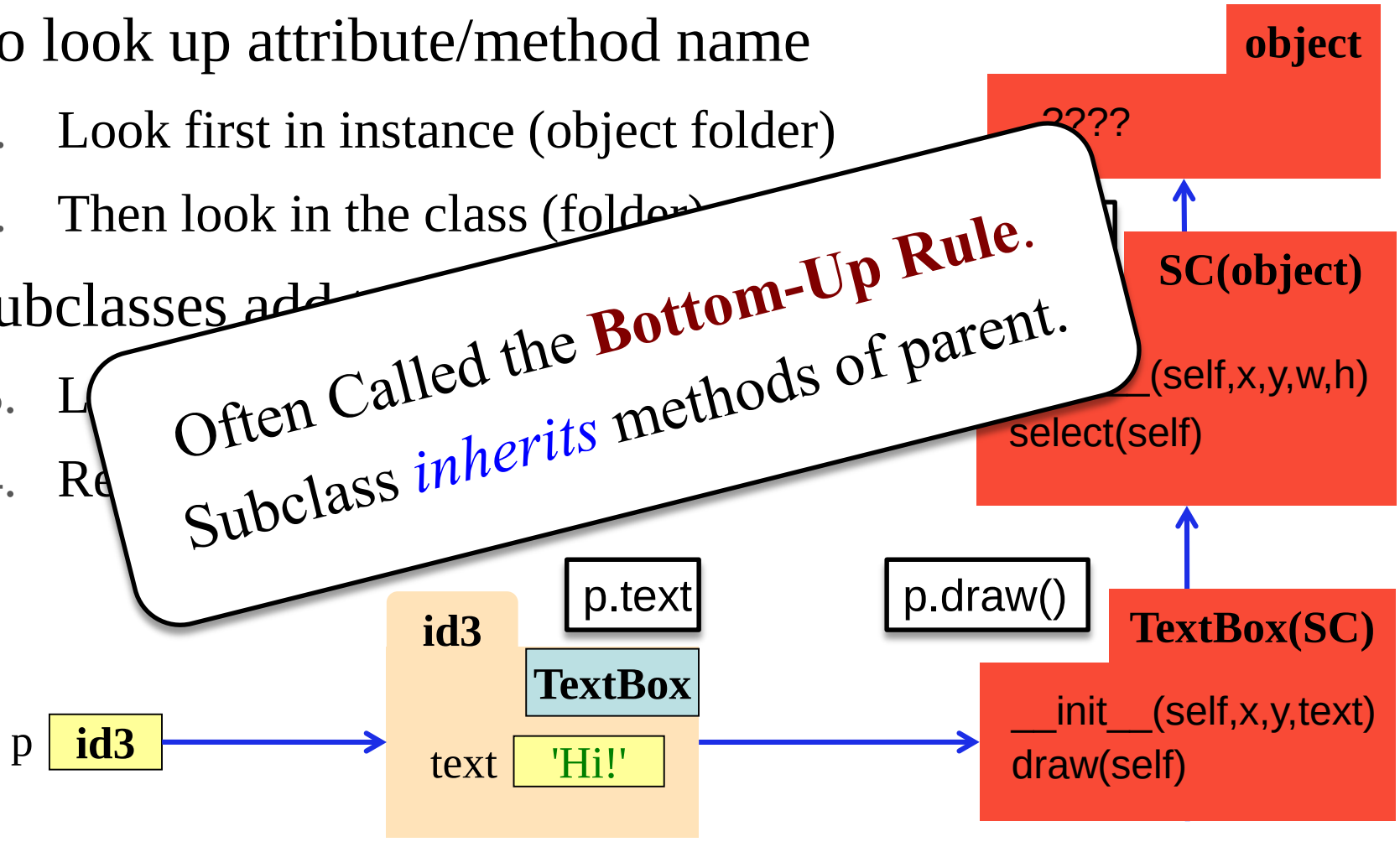
  3. L
  4. Re

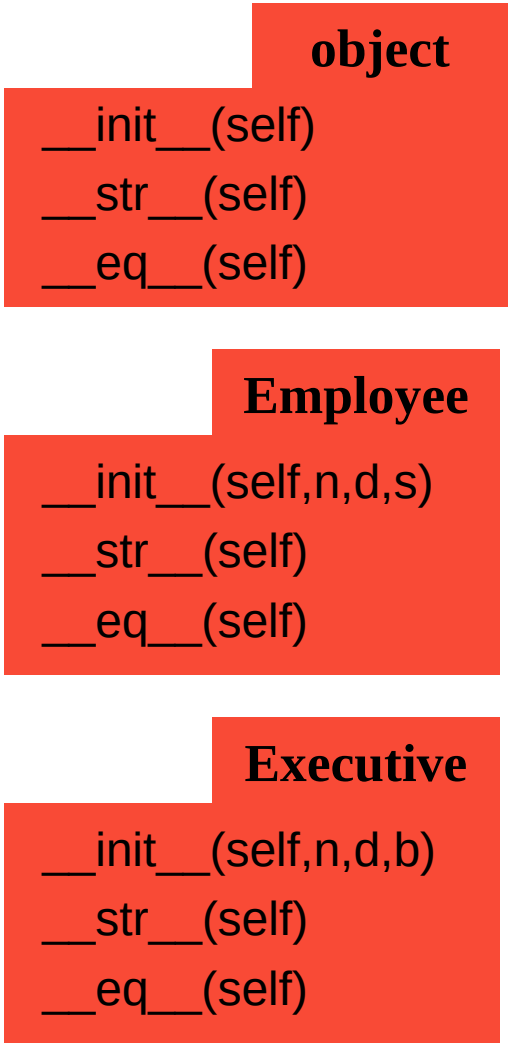
Often Called the **Bottom-Up Rule**.
Subclass *inherits* methods of parent.



Method Overriding

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

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



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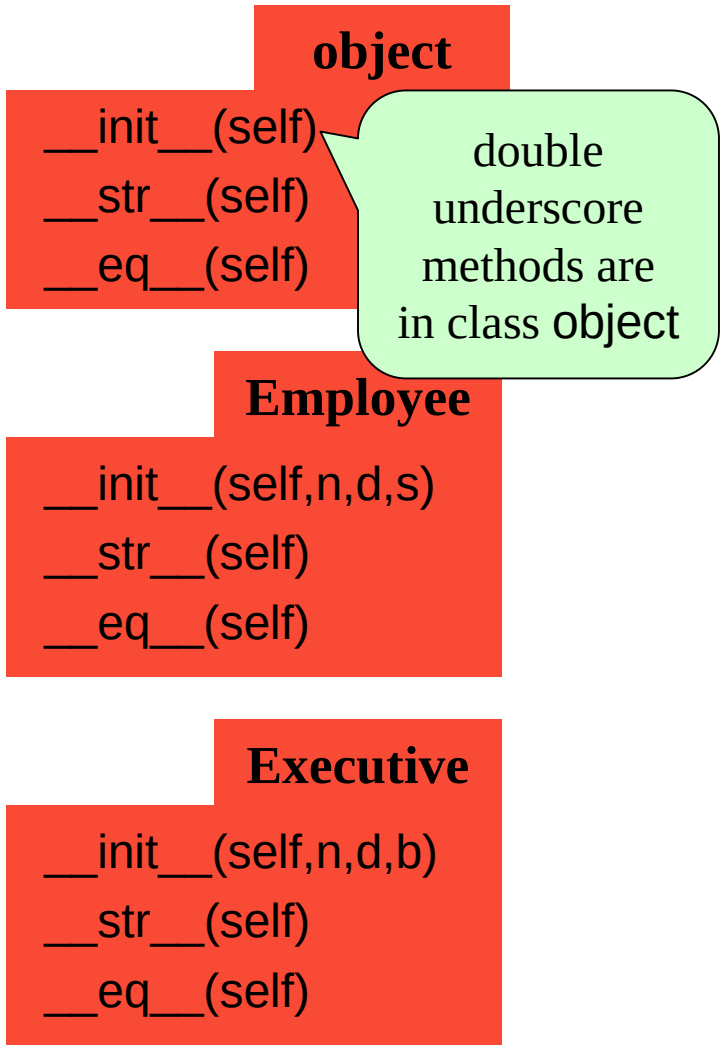
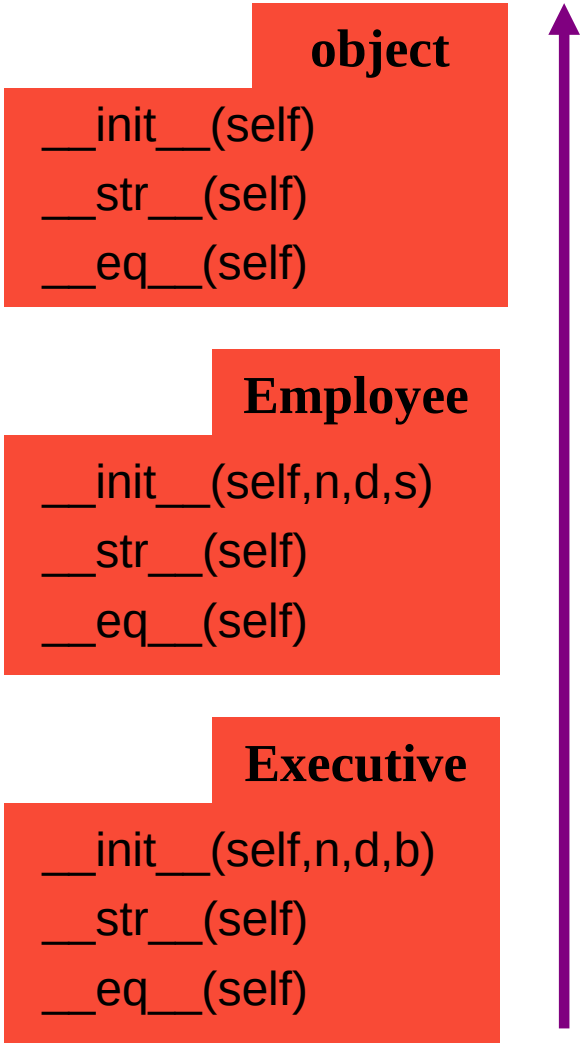


Method Overriding

```
>>> e = Executive("Megan", 2009, 10000.0)
>>> print e
```

- 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



Name Resolution and Inheritance

```
class A(object):
    def f(self):
        return self.g()
    def g(self):
        return 10

class B(A):
    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

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B: 14 **CORRECT**

C: 5

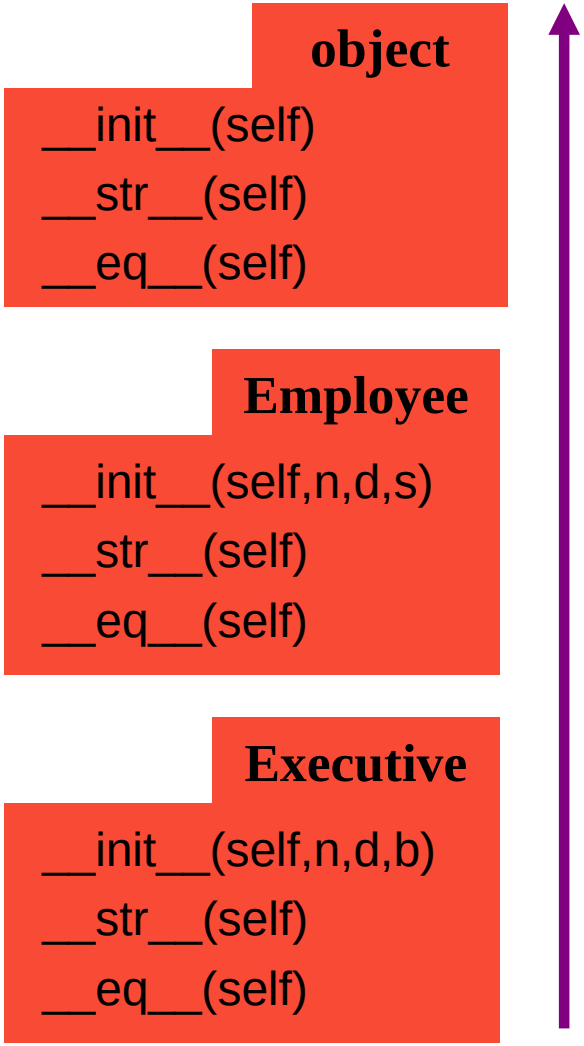
D: **ERROR**

E: I don't know

Accessing the "Original" 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
- Call old method **explicitly**
  - Use method as a function
  - Pass object as first argument
- **Example**:

  Employee.__str__(self)



Accessing the "Original" 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
- Call old method **explicitly**
  - Use method as a function
  - Pass object as first argument
- **Example**:

  Employee.__str__(self)

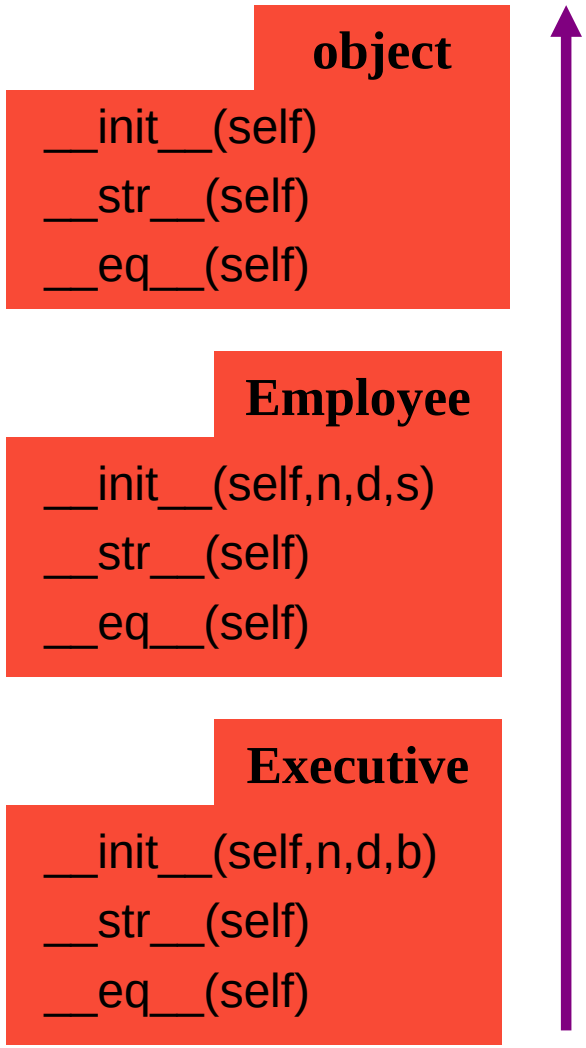
```
class Employee(object):
    """An Employee with a salary"""
    …
    def __str__(self):
        return (self._name +
                ', year ' + str(self._start) +
                ', salary ' + str(self._salary))

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

Primary Application: Initializers

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

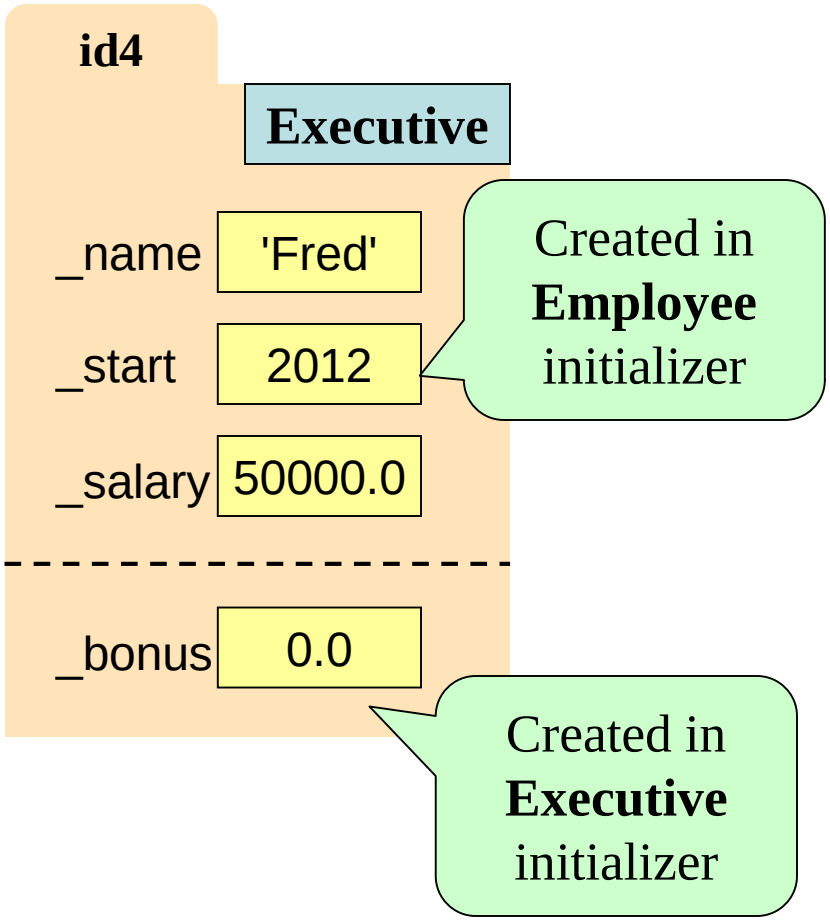
```
class Executive(Employee):
    …
    def __init__(self,n,d,b=0.0):
        Employee.__init__(self,n,d)
        self._bonus = b
```



Object Attributes can be 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):
        Employee.__init__(self,n,d)
        self._bonus = b
```

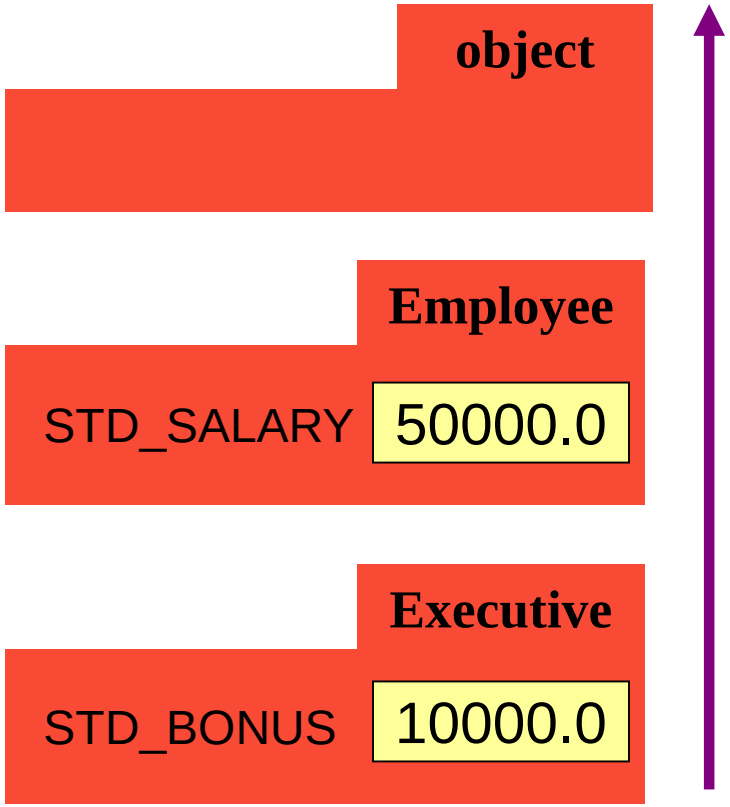


Also Works With Class Variables

Class Variable: 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 Variable
    y = 5 # Class Variable

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

    def g(self):
        return 10

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

    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

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```

- Execute the following:

  >>> a = A()

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- What is value of b.x?

A: 4

B: 3 **CORRECT**

C: 42

D: **ERROR**

E: I don't know

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        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):
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```

- Execute the following:

  >>> a = A()

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- What is value of a.z?

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

Mixed Number Example