Lecture 19

Subclasses & Inheritance

Announcements for Today

Reading

- Today: Chapter 18
- Online reading for Thursday

- **Prelim, Nov 13th 7:30-9:00**
  - Material up to Thursday
  - Review posted on Thursday
  - Recursion + Loops + Classes
- **S/U Students are exempt**
- **Conflict with Prelim time?**
  - Prelim 2 Conflict on CMS
  - Submit by Thursday

Assignments

- A4 graded by end of week
  - Survey is still open
- A5 was posted Friday
  - Shorter written assignment
  - Due Thursday at Midnight
- A6 was posted yesterday
  - Due a **week after** prelim
  - Designed to take two weeks
  - Finish first part before exam

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

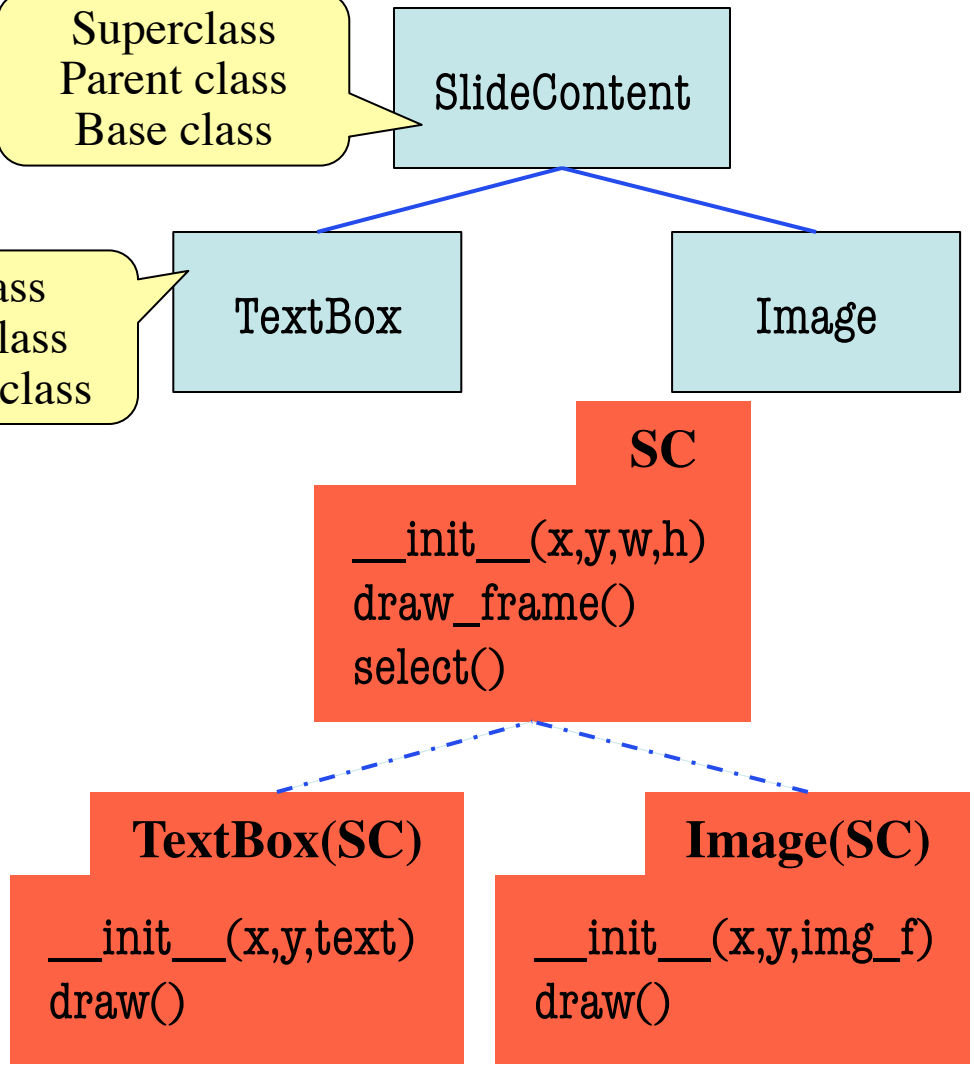
```
class SlideContent(object):
    """Any object on a slide."""
    def __init__(self, x, y, w, h): ...
    def draw_frame(self): ...
    def select(self): ...

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): ...
```

Superclass
Parent class
Base class

Subclass
Child class
Derived class



Class Definition: Revisited

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

    """Class specification"""

    getters and setters

    initializer (__init__)

    definition of operators

    definition of methods

    anything else

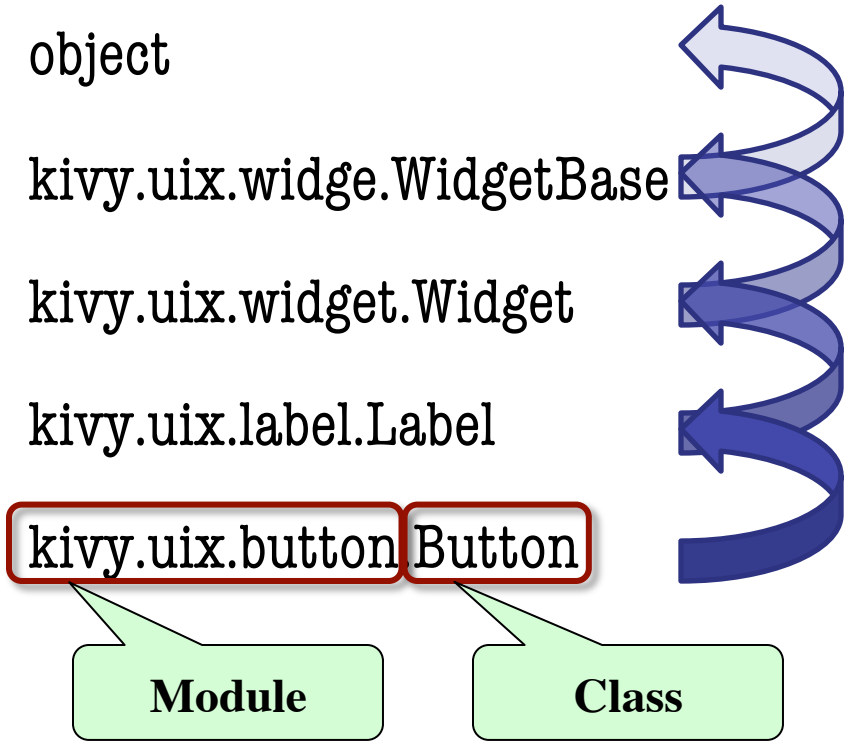
Class type to extend
(may need module name)

- 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__`
  - Default operators: `__str__`, `__repr__`

Kivy Example



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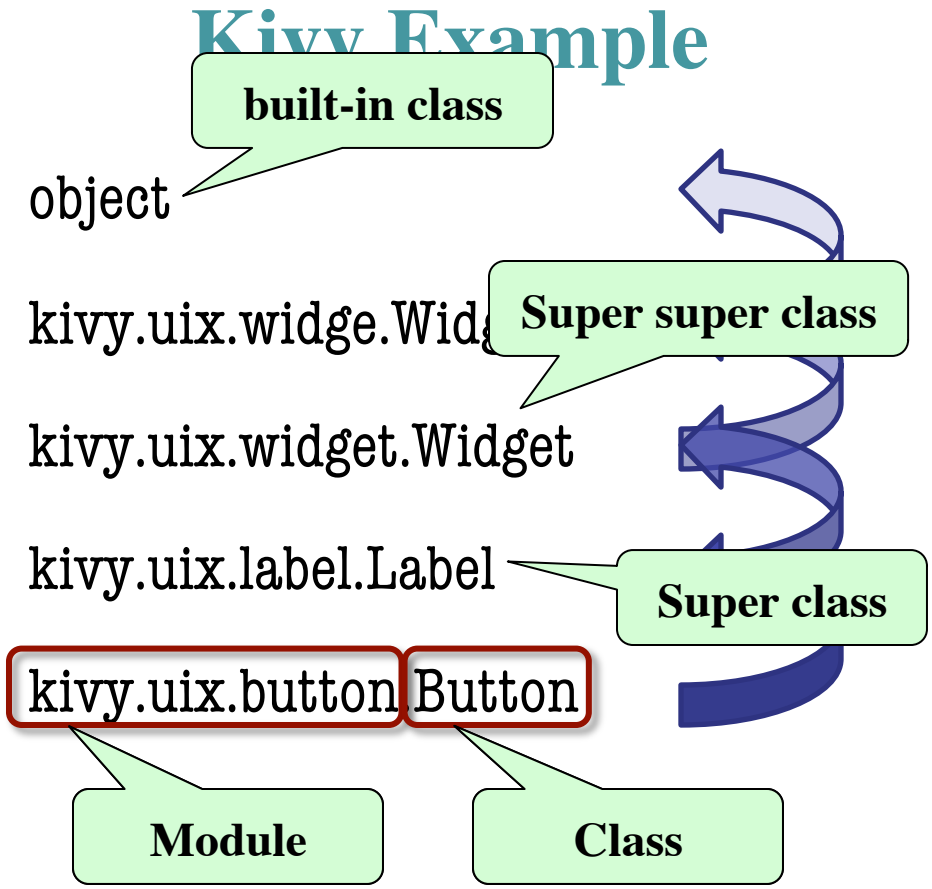
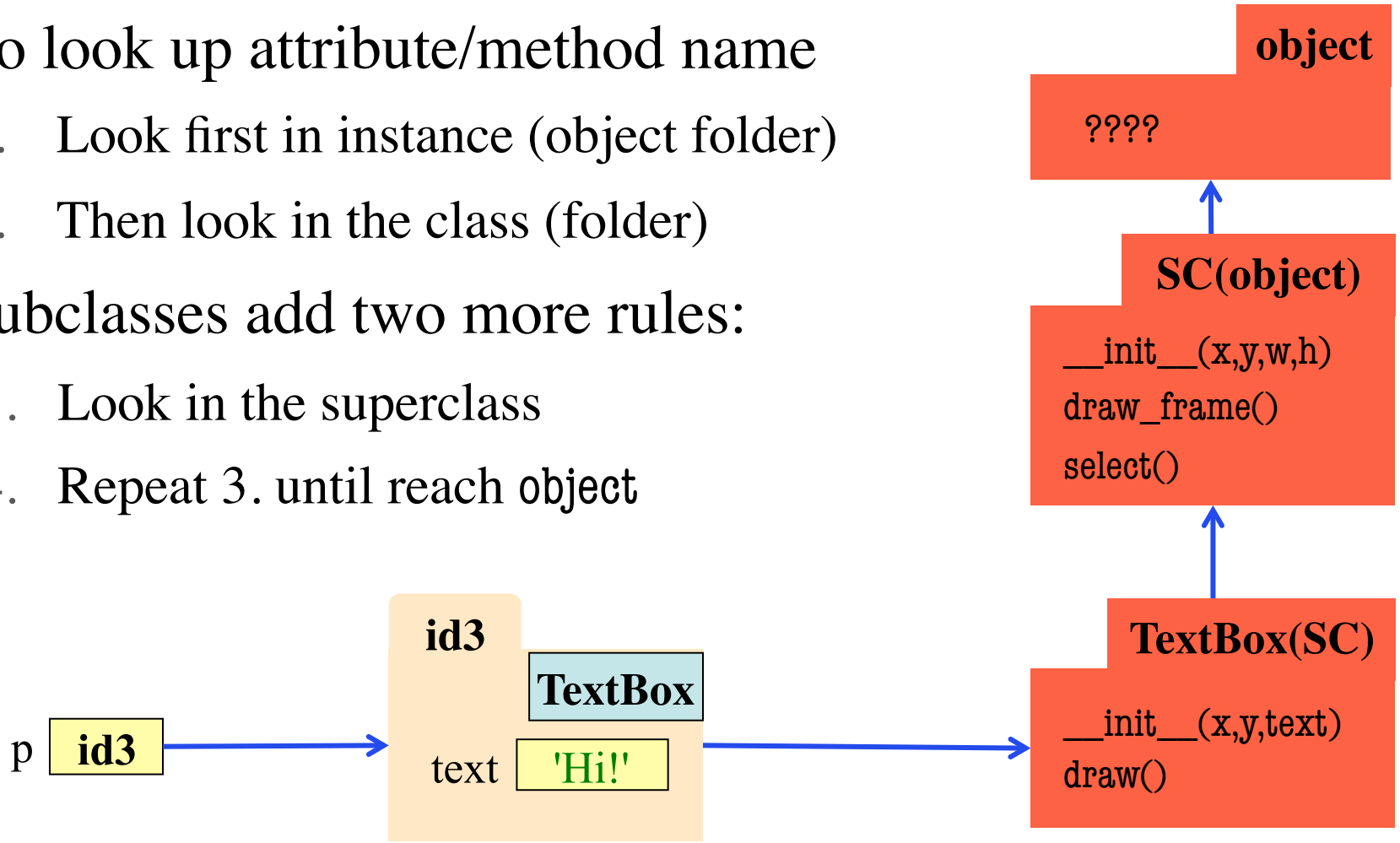


Name Resolution Revisited

- 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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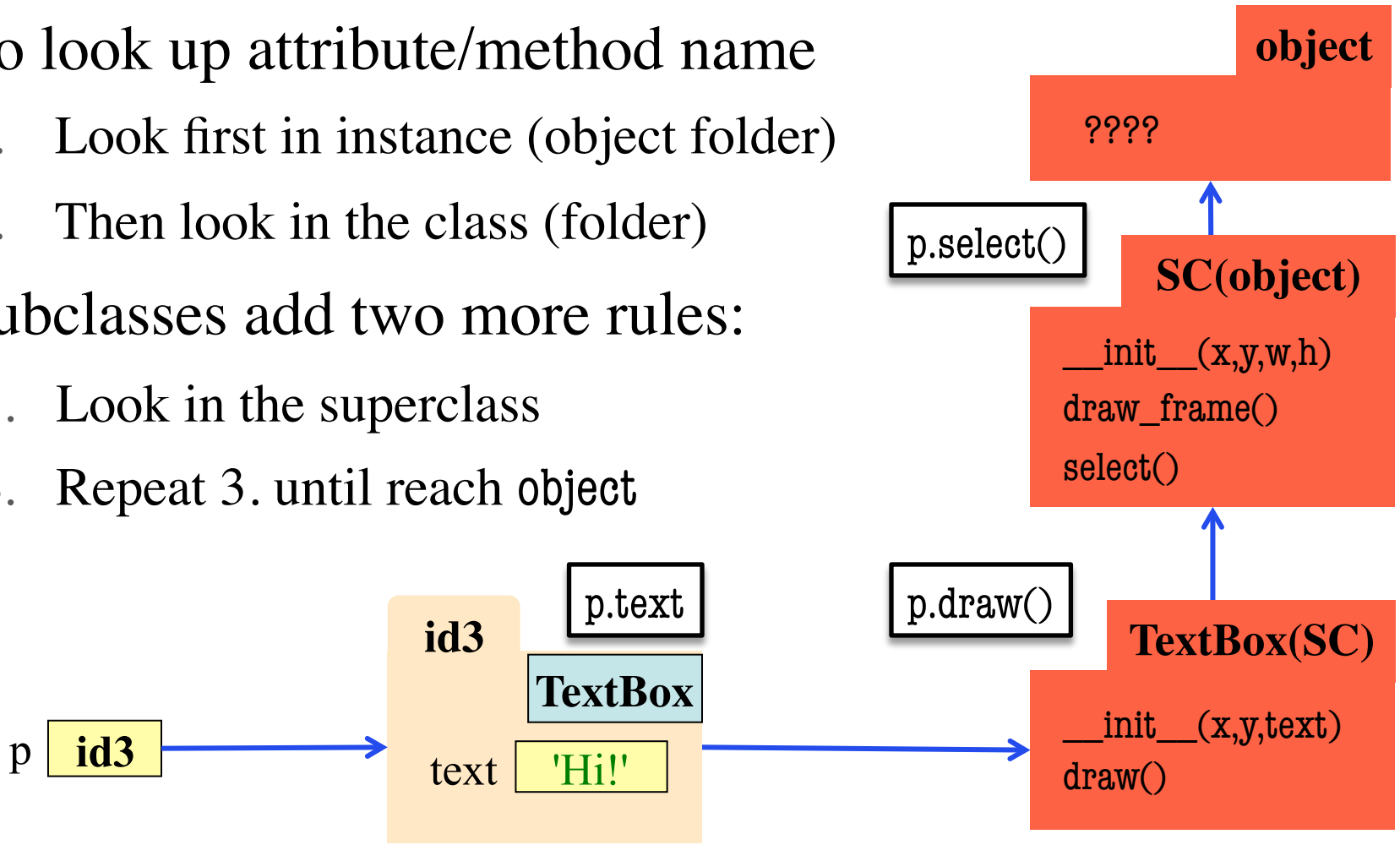

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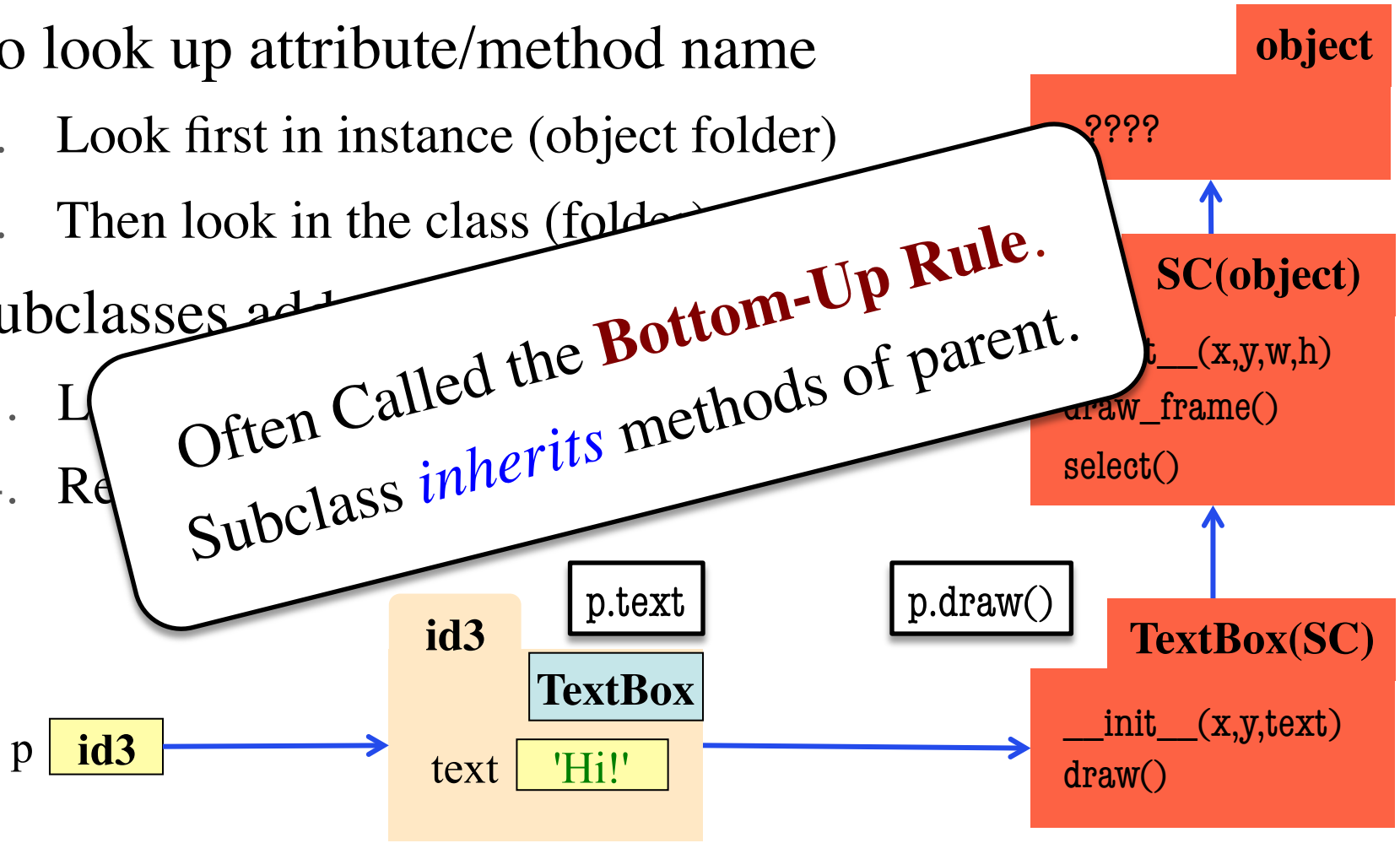
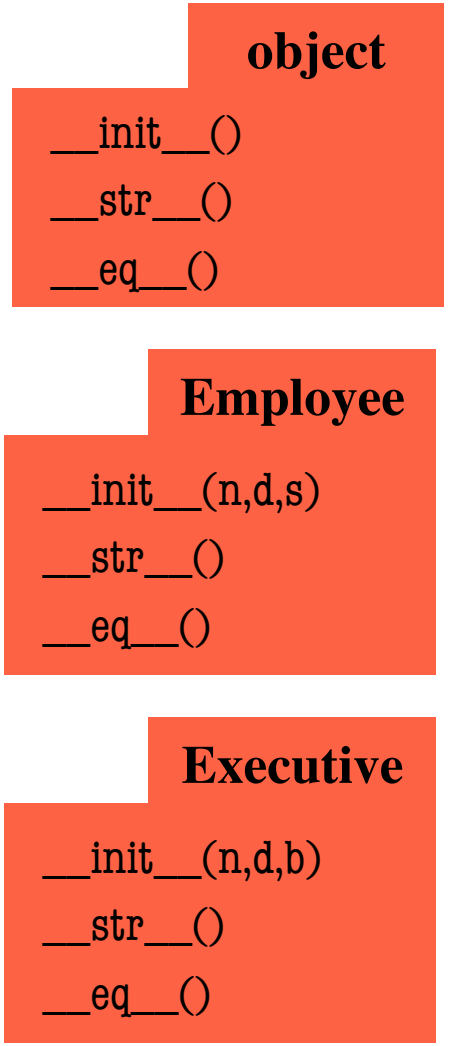
Often Called the **Bottom-Up Rule**.
Subclass *inherits* methods of parent.



A Simpler Example

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

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



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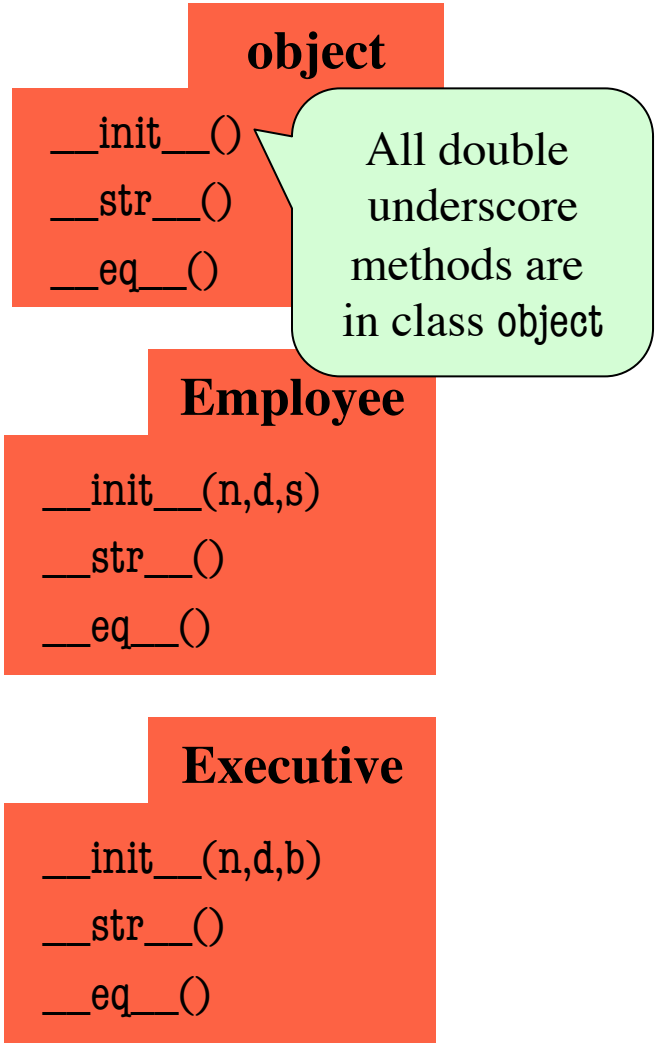
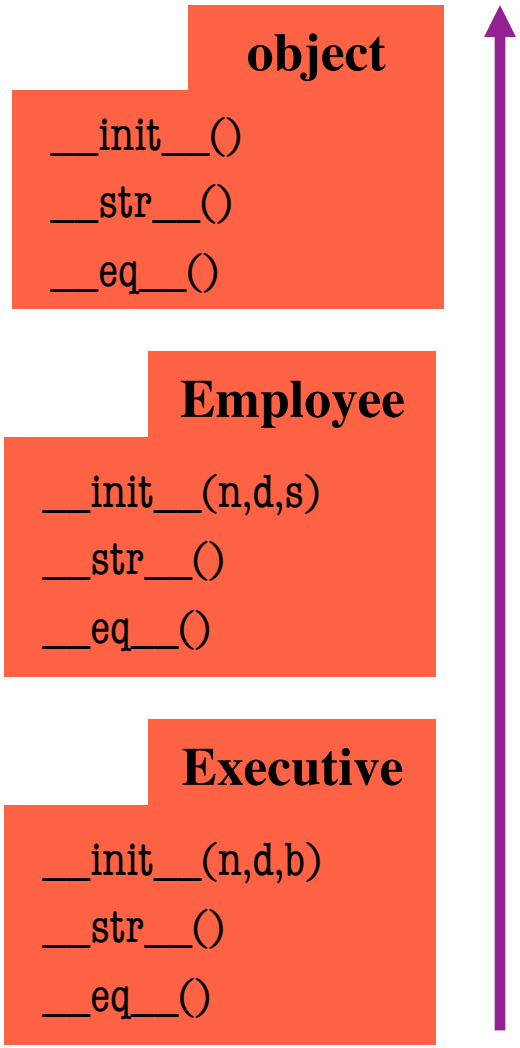


Method Overriding

- 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
- Also applies to
  - Initializers
  - Operators
  - Properties

} all "methods"

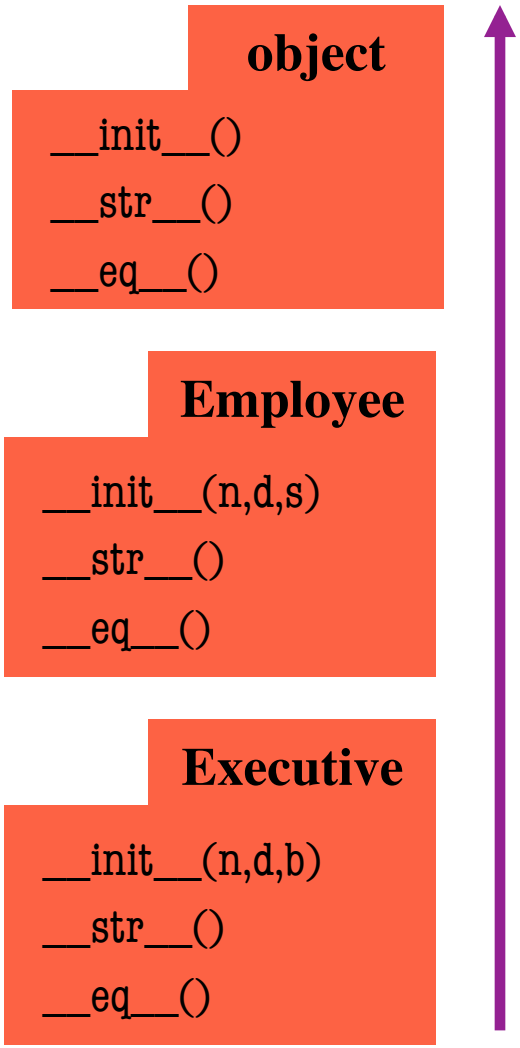


Accessing the "Previous" Method

- What if you want to use the original version method?
  - New method = original+more
  - Do not want to repeat code from the original version
- Call old method **explicitly**
  - Use method as a function
  - Pass object as first argument
- **Example**:

```
Employee.__str__(self)
```

- **Cannot do with properties**



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  - Use method as a function
  - Pass object as first argument
- **Example**:

  Employee.__str__(self)
- **Cannot do with properties**

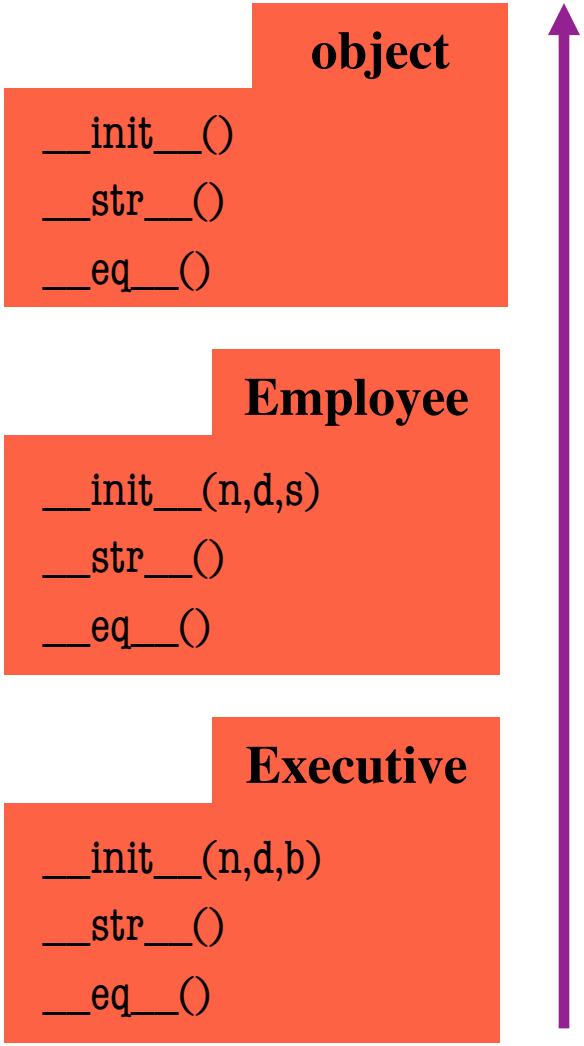
```
class Employee(object):
    """An Employee with a salary"""
    ...
    def __str__(self):
        return (self.name +
                ', year ' + str(self.start) +
                ', salary ' + str(self.salary))

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
```



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):
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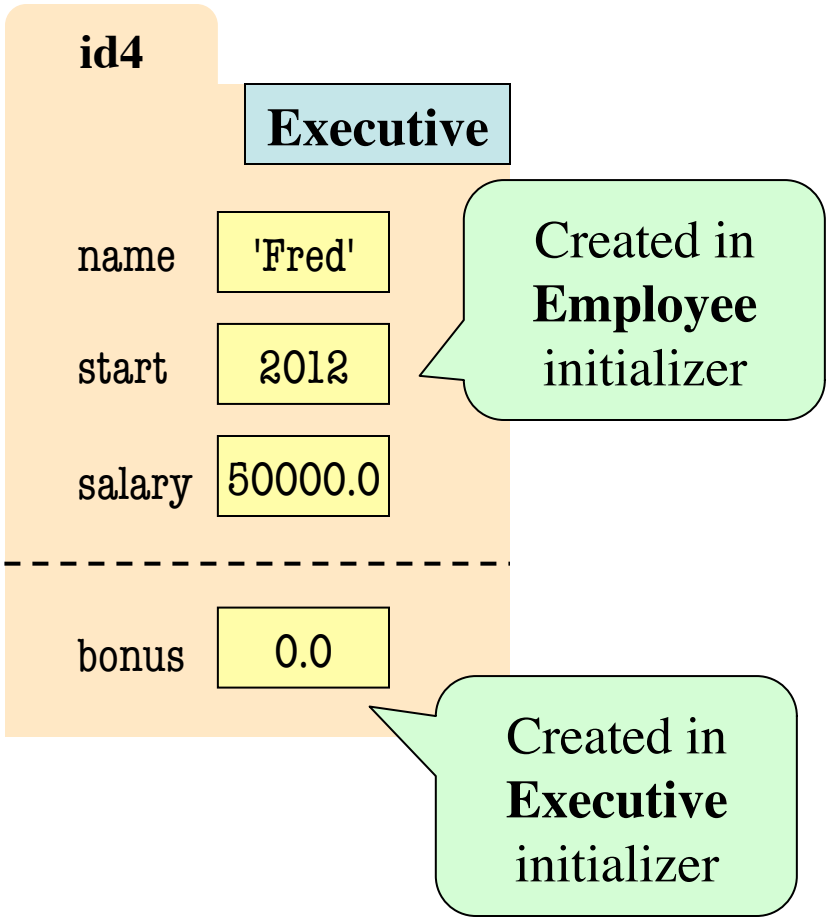
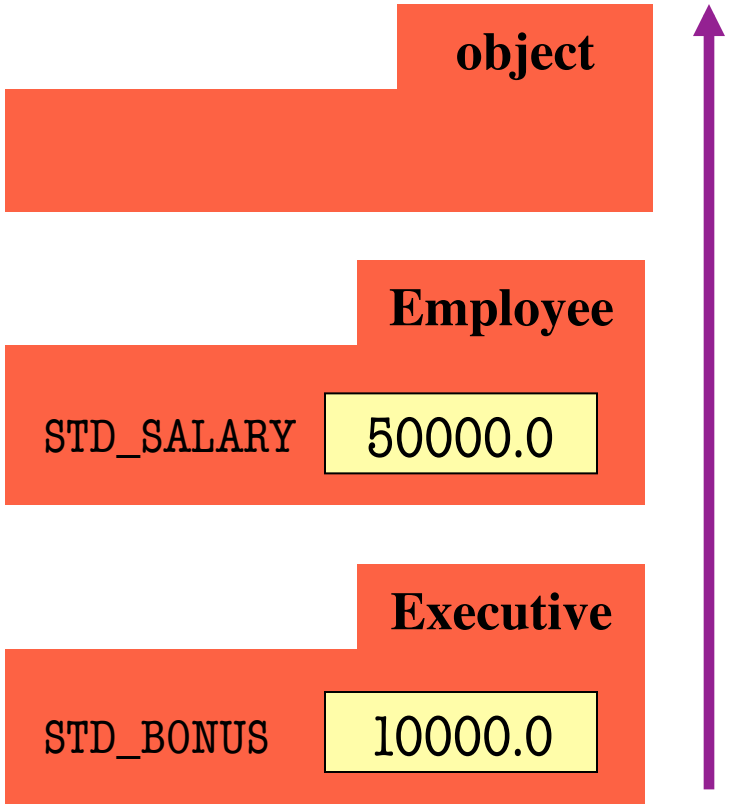


Also Works With Class Attributes

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

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Properties and Inheritance

- Properties: all or nothing
  - Typically inherited
  - Or fully overridden (both getter and setter)
- When override property, **completely** replace it
  - Cannot use super()
- Very rarely overridden
  - **Exception**: making a property read-only
  - See employee2.py

```
class Employee(object):
    ...
    @property
    def salary(self):
        return self._salary

    @salary.setter
    def salary(self,value):
        self._salary = value
```

```
class Executive(Employee):
    ...
    @property  # no setter; now read-only
    def salary(self):
        return self._salary
```