CS 1110

Lecture 25: Subclasses and Inheritance

Announcements

Prelim 2 regrades

1. Read solution/grading guide posted on Exams page
2. Attach written note, with name, NetID, and explanation, to exam (do not write on exam)
3. Hand to us in class

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Program design

- Example: drawing program (e.g. PowerPoint)
- Many types of content can appear on slides
- Want do do things like

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

- No problem: define class for every type of content (text box, rectangle, image, …), make sure each has a `draw` method

Sharing work

- Defining separate classes for text box, image, etc. is fine, but could get repetitive
  - all have code for drawing selection handles, frames, backgrounds, …
- Solution: make these shapes *subclasses* of a single class, where the shared code lives

Defining a subclass

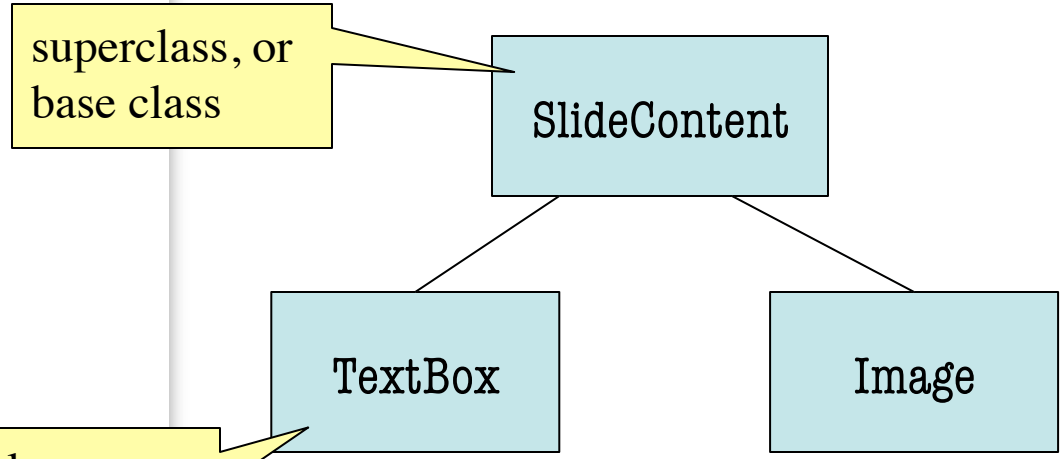
(abbreviated SC on this slide)

```
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, or base class



subclass, or derived class

SC

__init__(x,y,w,h)
draw_frame()
select()

TextBox(SC)

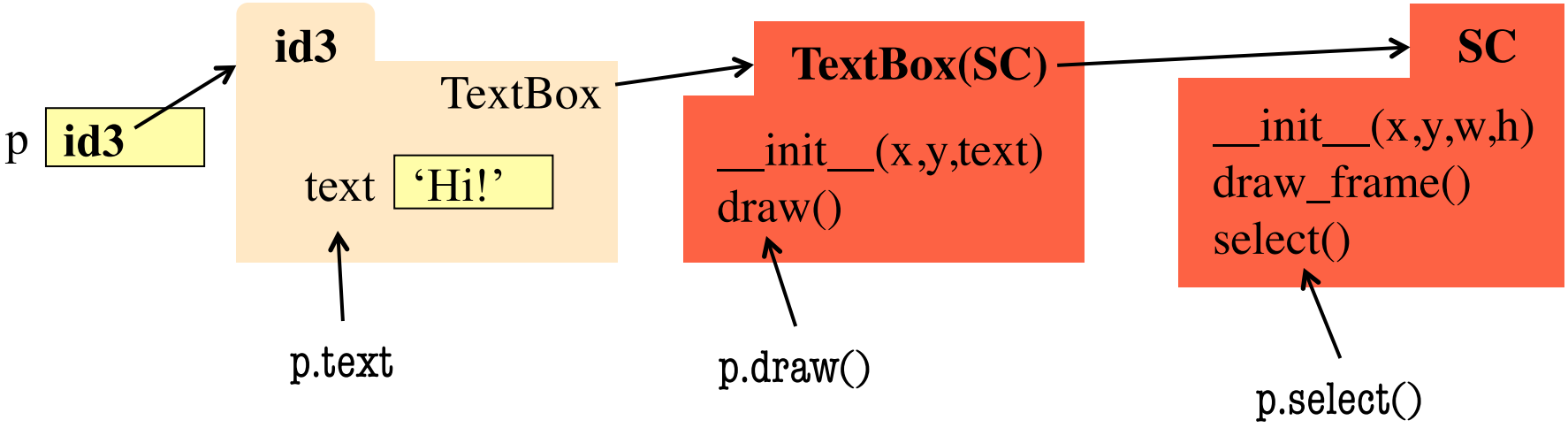
__init__(x,y,text)
draw()

Image(SC)

__init__(x,y,img_f)
draw()

Names in subclasses and superclasses

- Recall rule for looking up attribute names in classes: look first in the instance, then in the class.
- With inheritance, there's one simple addition: look in the instance, then in the class, then in the superclass.



Customizing a class

- Example: telephony program (e.g. Skype)
- Call and Hang Up buttons should be green and red (to follow convention from cell phones)
- Already have a class for normal buttons
- Implement from scratch? No, what a waste…
- Instead create a *subclass* of the button class that is just like a normal button, except it draws itself with a different color.

Defining a subclass

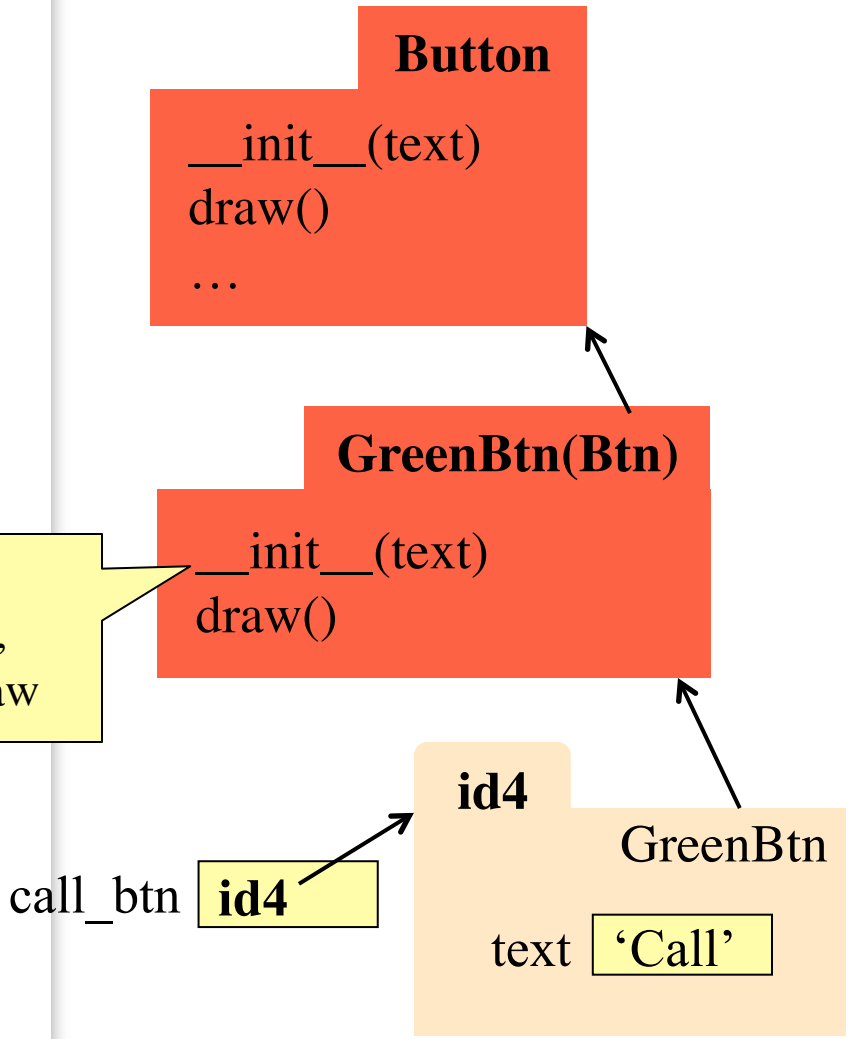
```
from favorite_gui_library import Button

class GreenButton(Button):
    """A regular old button, only green."""
    def __init__(self, text): ...
    def draw(self):
        set_color(GREEN)
        Button.draw(self)

call_btn = GreenButton("Call")

...

# in some other code somewhere
call_btn.draw()
```



Inheritance

- Superclass also called “parent”
- If subclass does nothing special, it has all the same attributes as the parent class—it *inherits* all the methods and variables
- Subclass can *add* new methods and variables (with different names)
- Subclass can *override* methods and class variables (by giving them the same names)

Review: names and instances

```
class A(object):
    x = 29
    y = 42
    def __init__(self):
        self.y = 2
        self.z = 3
    def f(self):
        print 'this is A.f'
        print 'self.x:', self.x
        print 'self.y', self.y
        print 'self.z', self.z
        print 'A.y', A.y

a = A()
print 'a.y:', a.y
print 'A.y:', A.y
a.f()
A.f(a)
```

which appears?
(A) a.y: 42
(B) a.y: 29
(C) a.y: 2
(D) an error

which appears?
(A) A.y: 42
(B) A.y: 29
(C) A.y: 2
(D) an error

which appears?
(A) self.y: 42
(B) self.y: 29
(C) self.y: 2
(D) an error

The two calls to A.f:
(A) do the same thing
(B) first is an error
(C) second is an error
(D) there are not two calls

Name resolution examples

```
class A(object):
    x = 3
    y = 5
    def f(self):
        self.g()
    def g(self):
        print "this is A.g"

class B(A):
    y = 4
    z = 42
    def g(self):
        print "this is B.g"
    def h(self):
        print "this is B.h"

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

a.f() prints:
(A) this is A.f
(B) this is B.g
(C) this is A.g
(D) an error

b.f() prints:
(A) this is A.f
(B) this is B.g
(C) this is A.g
(D) an error

b.y is:
(A) 4
(B) 5
(C) 42
(D) an error

A.y is:
(A) 4
(B) 5
(C) 42
(D) an error

b.x is:
(A) 3
(B) 4
(C) 5
(D) an error

B.x is:
(A) 3
(B) 4
(C) 5
(D) an error

Initialization

- We haven't said anything about instance variables—are they inherited too?
- Remember instance variables are created during initialization (or at other times but that is not a good idea)
- To create new instance variables in the subclass we need a subclass initializer
- For the superclass to work correctly we still need the superclass initializer
- How is this going to work?

Subclass initialization example

```
class SlideContent(object):
    """Any object on a slide."""
    def __init__(self, x, y, w, h):
        """Obj. with given pos'n and size"""
        self.x = x; self.y = y
        self.w = w; self.h = h
    ...

class TextBox(SlideContent):
    """An object containing text."""
    def __init__(self, x, y, text):
        w = width(text)
        h = height(text)
        SlideContent.__init__(self, x, y, w, h)
        self.text = text
    ...

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

SlideContent initializer sets up instance variables for the position and size of the object on the slide

TextBox initializer **overrides** the superclass initializer. Only the TextBox initializer is called to initialize a fresh TextBox instance.

In this example the size is computed in the initializer.

To ensure that the superclass still gets initialized, the subclass initializer must call the superclass initializer **explicitly**.

Instance variables in a subclass

```
class A(object):
    def __init__(self):
        self.x = 3
        self.y = 5
    def f(self):
        print "A.f: self.x:", self.x
        print "A.f: self.y:", self.y

class B(A):
    def __init__(self):
        A.__init__(self)
        self.y = 4
        self.z = 42
    def f(self):
        A.f(self)
        print "B.f self.y:", self.y
        print "B.f self.z:", self.z

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

a.f() prints: (among others)
(A) A.f self.y: 4
(B) A.f self.y: 3
(C) A.f self.y: 5
(D) an error

Subclass instance variable **overwrites** value set by superclass.

Subclass method **overrides** superclass method of the same name.

b.f() prints: (among others)
(A) B.f self.y: 4
(B) B.f self.y: 3
(C) B.f self.y: 5
(D) an error

Summary: defining a subclass

- **Methods** and **class variables** in the superclass can be **overridden** by definitions in the subclass
  - you can still get at them by accessing them explicitly through the superclass
- **Instance variables** set by the superclass initializer can be **overwritten** by initializations in the subclass
- Always *call the superclass initializer* from the subclass initializer, before initializing the subclass. Then these two not only *sound* similar but also *act* similarly!