Lecture 24: Subclasses and Inheritance
Program design

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

Name resolution examples

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
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

```python
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.
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()
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!