http://www.cs.cornell.edu/courses/cs1110/2021sp

Lecture 23:
More on Subclassing
(Chapter 18)

CS 1110
Introduction to Computing Using Python

Revised after lecture: on slide 12, the class Shape folder's tab should read Shape(object); the class Circle folder's tab should read Circle(Shape)

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Announcements

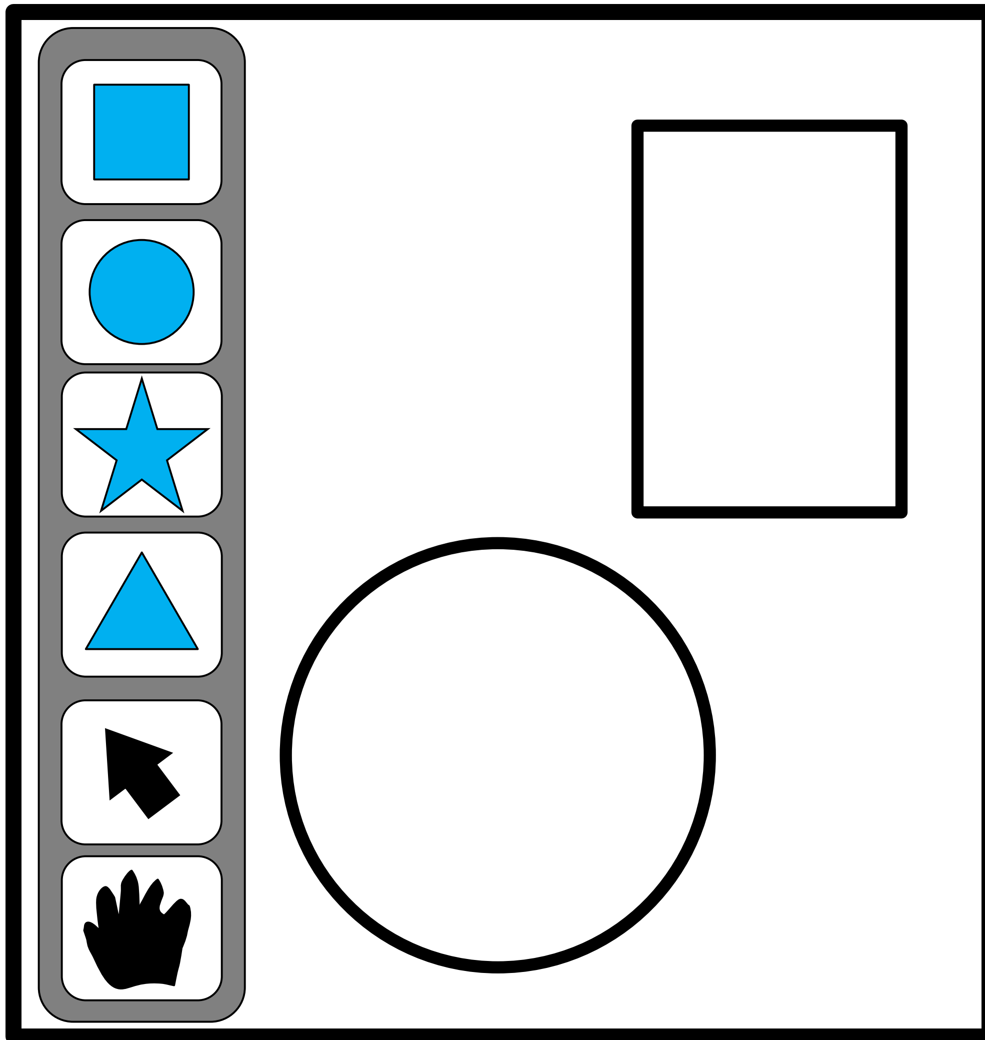
- Assignment 5 due Wedn May 5th
  - Minor update—read cover page of A5 pdf posted on course website
- Prelim 2: we expect feedback to be available on Monday
- WICC (student org Women in Computing At Cornell) invites responses from CIS students on how the semester has gone: https://forms.gle/L72qPkYvYJDJ8cdx9

Topics

Continuation from last lecture

- Design considerations for overriding methods
- Class attributes
- Different kinds of comparisons on objects

Goal: Make a drawing app



Rectangles, Stars, Circles, and Triangles have a lot in common, but they are also different in very fundamental ways....

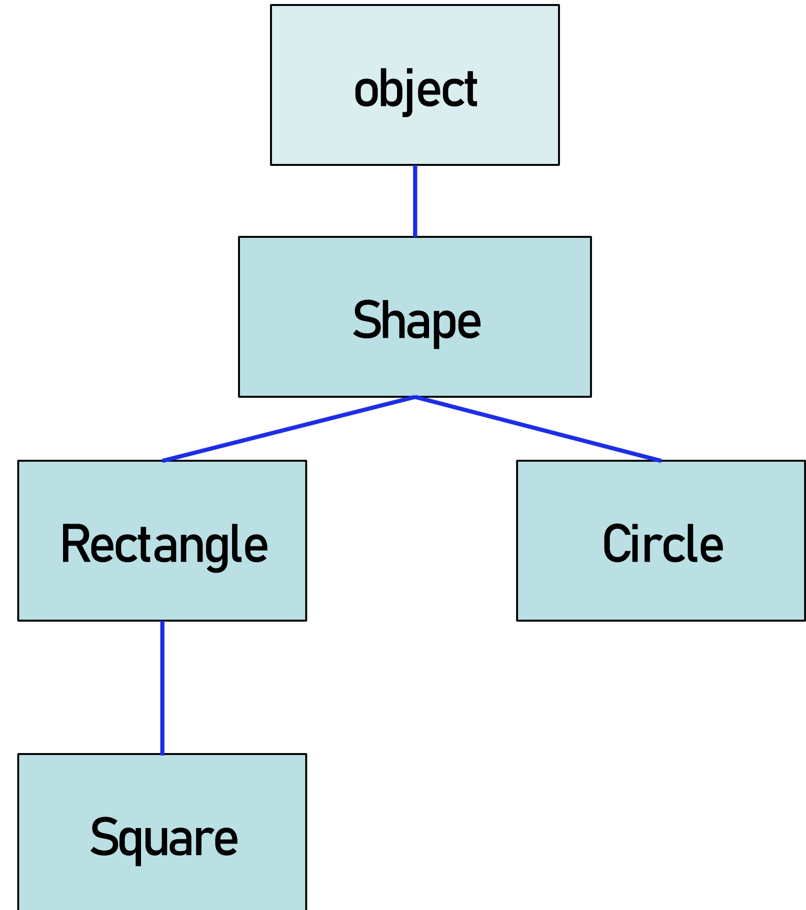
Example

```
class Shape:
    """A shape located at x,y """
        def __init__(self, x, y): ...
        def draw(self): ...

class Circle(Shape):
    """An instance is a circle."""
    def __init__(self, x, y, radius): ...
    def draw(self): ...

class Rectangle(Shape):
    """An in stance is a rectangle. """
    def __init__(self, x, y, ht, len): ...
    def draw(self): ...

...
```



*[**Optional**] wondering what's in the object class? See* https://docs.python.org/3/reference/datamodel.html#basic-customization

Extending Classes

```
class <name>(<superclass>):
    """Class specification"""
    <class variables>
    <initializer>
    <methods>
```

Class to extend
(may need module name:
`<modulename>.<superclass>`)

From last lecture:

- Parent class (superclass)
- Child class (subclass)
- Attributes, methods are inherited
- Can override parent’s method
- Function call `super()` to access method of parent

Design choices for method draw

Demo using Turtle Graphics

A turtle holds a pen and can draw as it walks! Follows simples commands:

- setx, sety – set start coordinate
- pendown, penup – control whether to draw when moving
- forward
- turn

Just a demo! You do *not* need to do anything with Turtle Graphics

Part of the turtle module in Python (docs.python.org/3.7/library/turtle.html)

- *You don't need to know it*
- Just a demo to explain design choices of draw() in our classes Shape, Circle, Rectangle, Square

Who draws what?

```
class Shape:
    """Moves pen to correct location"""
    def draw(self):
        turtle.penup()
        turtle.setx(self.x)
        turtle.sety(self.y)
        turtle.pendown()

class Circle(Shape):
    """Draws Circle"""
    def draw(self):
        super().draw()
        turtle.circle(self.radius)
```

Note: need to import the **turtle** module which allows us to move a pen on a 2D grid and draw shapes.

Job for Shape: No matter the shape, we want to pick up the pen, move to the location of the shape, put the pen down.

Job for subclasses: But only the shape subclasses know how to do the actual drawing.

See **shapes_v3.py**, **draw_shapes.py**

Class attributes

Class Variables can also be Inherited

```
class Shape:  # inherits from object by default
    """Instance is shape @ x,y"""
    # Class Attribute tracks total num shapes
    NUM_SHAPES = 0
    . . .

class Circle(Shape):
    """Instance is a Circle @ x,y with radius"""
    # Class Attribute tracks total num circles
    NUM_CIRCLES = 0
    . . .
```

object

Shape(object)

NUM_SHAPES 0

Circle(Shape)

NUM_CIRCLES 0

Q1: Name Resolution and Inheritance

```
class A:
    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*

Q2: Name Resolution and Inheritance

```
class A:
    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 a.z?

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

Different kinds of comparisons

Why override __eq__ ? Compare equality

```
class Shape:
  """Instance is shape @ x,y"""
  def __init__(self,x,y):
  def __eq__(self, other):
        """If position is the same, then equal as far as Shape knows"""
        return self.x == other.x and self.y == other.y

class Circle(Shape):
  """Instance is a Circle @ x,y with radius"""
  def __init__(self,x,y,radius):
  def __eq__(self, other):
  """If radii are equal, let super do the rest"""
      return self.radius == other.radius and super().__eq__(other)
```

Want to compare equality ***of the values (data)*** of two instances, not the id of the two instances!

Q3: eq vs. is

`==` compares **equality**

`is` compares **identity**

```
c1 = Circle(1, 1, 25)
c2 = Circle(1, 1, 25)
c3 = c2
```

```
c1 == c2 → ?
c1 is c2 → ?
c2 == c3 → ?
c2 is c3 → ?
```

The isinstance Function

isinstance(<obj>,<class>)

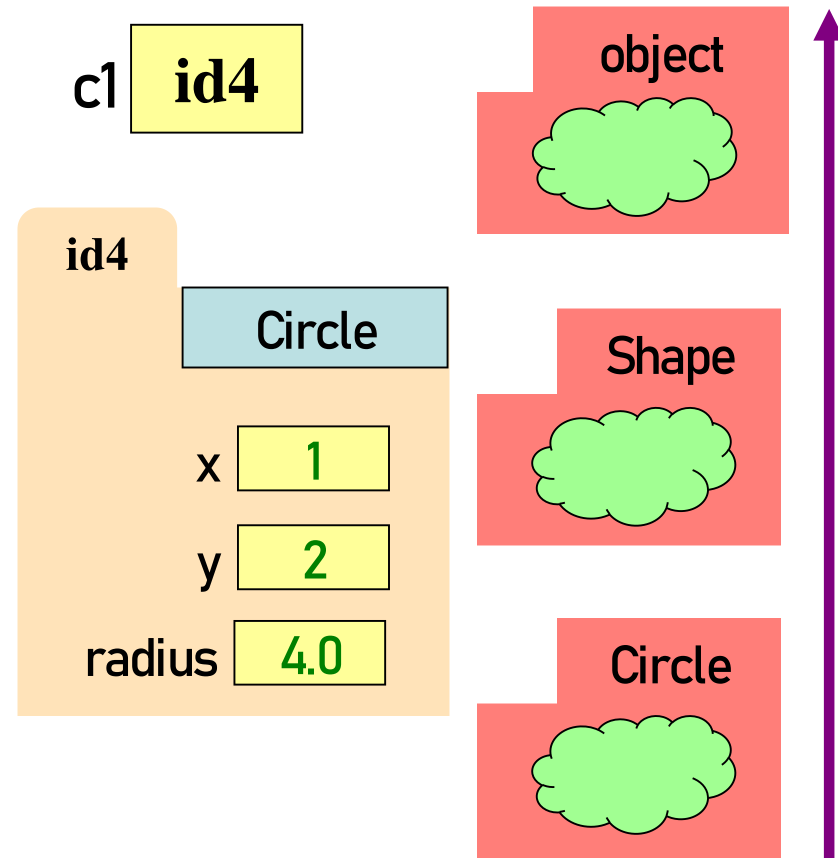
- True if <obj>'s class is same as or a subclass of <class>
- False otherwise

Example:

c1 = Circle(1,2,4.0)

- isinstance(c1,Circle) is True
- isinstance(c1,Shape) is True
- isinstance(c1,object) is True
- isinstance(c1,str) is False

- Generally preferable to type
  - Works with base types too!



Q4: isinstance and Subclasses

```
>>> s1 = Rectangle(0,0,10,10)
>>> isinstance(s1, Square)
???
```

A: True
B: False
C: *Error*
D: *I don't know*