
# Lecture 22: Subclasses & Inheritance

(Chapter 18)

CS 1110

Introduction to Computing Using Python

[E. Andersen, A. Bracy, D. Fan, D. Gries, L. Lee, S. Marschner, C. Van Loan, W. White]

## Announcements

- No new lab exercises this week. Lab sections cancelled but there'll be extra office hours. *Good opportunity to go over A4 if you have any questions.* (Hours are listed in the office hr calendar):
  - Tues 1:15-2:30pm (Jonathan C.)
  - Wedn 10:10-11am (Priya M.)
- Prelim 2: we expect feedback to be available on Monday
- Assignment 5: expected release tonight (Tues)

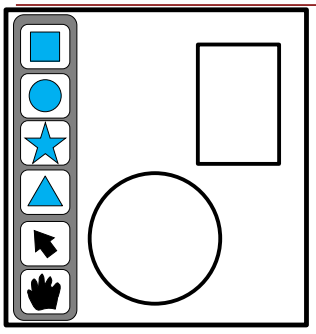


## Topics

- Why define subclasses?
  - Understand the resulting hierarchy
  - Design considerations
- How to define a subclass
  - Initializer
  - New methods
  - Write modified versions of inherited methods
  - Access parent's version using super()



## Goal: Make a drawing app



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



## Sharing Work

**Problem:** Redundant code.

(Any time you copy-and-paste code, you are likely doing something wrong.)

**Solution**: Create a *parent* class with shared code

- Then, create *subclasses* of the *parent* class
- A subclass deals with specific details different from the parent class

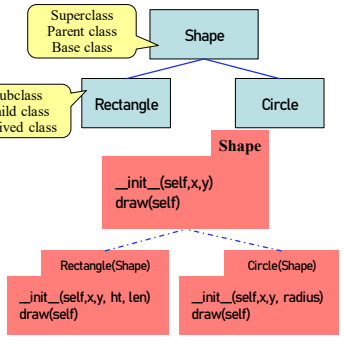


## Defining a Subclass

```
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): ...
```



## Extending Classes

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

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

So far, classes have implicitly extended object

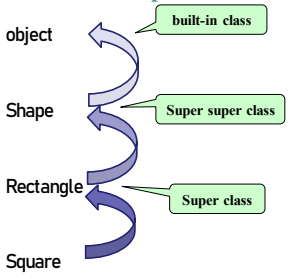


## object and the Subclass Hierarchy

- 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: __init__, __str__, __eq__

***Which of these need to be replaced?***

**Example**






## __init__: write new one, access parent's

```
class Shape:
    """A shape @ location x,y """
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

- Want to use the original version of the method?
  - New method = original+more
  - Don't repeat code from the original
- Call old method **explicitly**

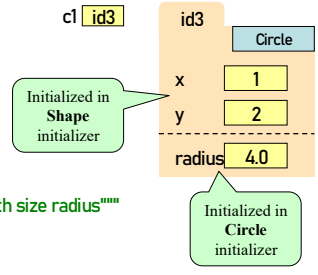
```
class Circle(Shape):
    """Instance is a Circle @ x,y with size radius"""
    def __init__(self, x, y, radius):
        super().__init__(x, y)
        self.radius = radius
```

## Object Attributes can be Inherited

```
class Shape:
    """A shape @ location x,y """
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

```
class Circle(Shape):
    """Instance is a Circle @ x,y with size radius"""
    def __init__(self, x, y, radius):
        super().__init__(x,y)
        self.radius = radius
```

```
c1 = Circle(1, 2, 4.0)
```

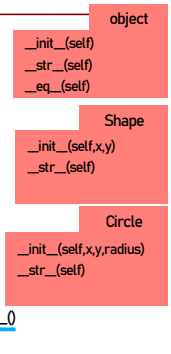





## Can override methods; can access parent's version

```
class Shape:
    """Instance is shape @ x,y"""
    def __init__(self,x,y):
    def __str__(self):
        return "Shape @ ("+str(self.x)+", "+str(self.y)+")"
    def draw(self):...
```

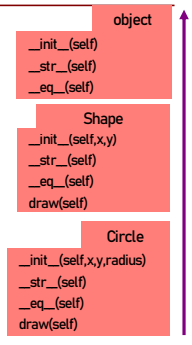
```
class Circle(Shape):
    """Instance is a Circle @ x,y with radius"""
    def __init__(self,x,y,radius):
    def __str__(self):
        return "Circle: Radius="+str(self.radius)+" "+super().__str__()
    def draw(self):...
```




## Understanding Method Overriding

```
c1 = Circle(1,2,4.0)
print(str(c1))
```

- Which __str__ do we use?
  - Start at bottom class folder
  - Find first method with name
  - Use that definition
- Each subclass automatically ***inherits*** methods of parent.
- New method definitions **override** those of parent.

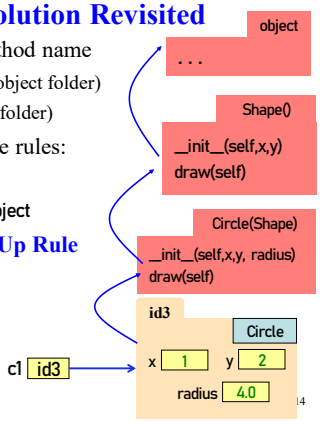


## Name Resolution Revisited

- 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**

Often called the **Bottom–Up Rule**

```
c1 = Circle(1,2,4.0)
r = c1.radius
c1.draw()
```

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## Q1: Name Resolution and Inheritance

```
class A:
    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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## Q2: Name Resolution and Inheritance

```
class A:
    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 b.f()?

A: 10
B: 14
C: 5
D: *ERROR*
E: *I don't know*

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## 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

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## 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

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