

Lecture 19: More on Subclassing (Chapter 18)

CS 1110

Introduction to Computing Using Python

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Announcements

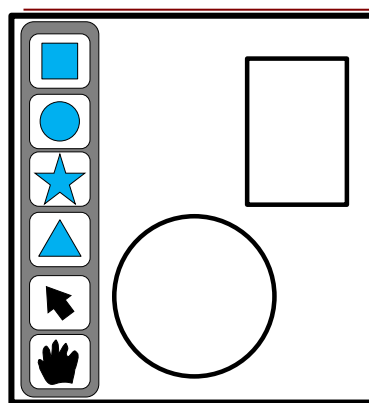
- Prelim 2 will be returned mid/late next week
- Don't Panic!
 - Final is 30% so you can make up for any mis-steps

Topics

Continuation from last lecture

- Design considerations for overriding methods
- Name resolution for attributes and methods
- Different kinds of comparisons on objects

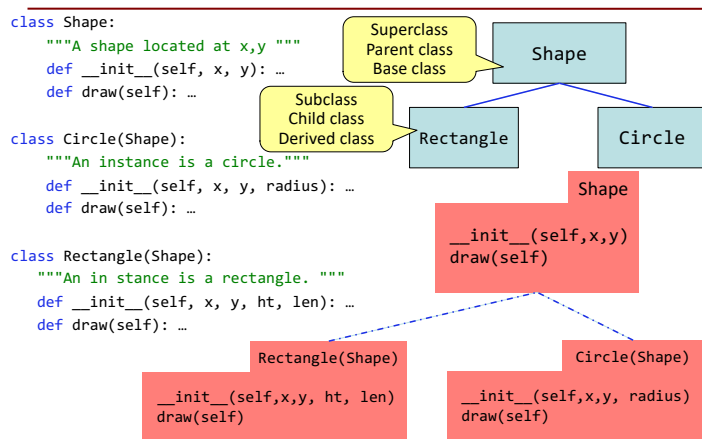
Goal: Make a drawing app



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

See shapes_v0.py

Recall: our Class Hierarchy



Recall : overriding & calling __init__

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

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

Subtle: **super()** calls the superclass' **__init__** method
super().super() ← not a thing

Demo using Turtle Graphics



A turtle holds a pen and can draw as it walks! Follows simple 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()
```

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

```
class Circle(Shape):
```

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

Job for Shape

Job for subclasses

No matter the shape, we want to pick up the pen, move to the location of the shape, put the pen down. But only the shape subclasses know how to do the actual drawing.

See `shapes_v3.py`, `draw_shapes.py`

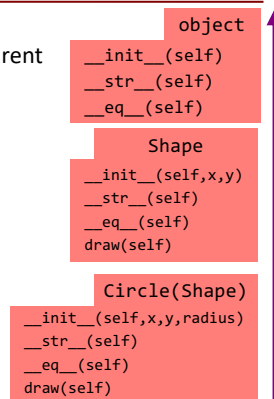
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Understanding Method Overriding

- Subclass **inherits** methods of parent
- Subclass definitions **override** those of parent

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

- Which `draw()` do we use?
 - Start at bottom class folder
 - Find first method with name
 - Use that definition



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

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()`?

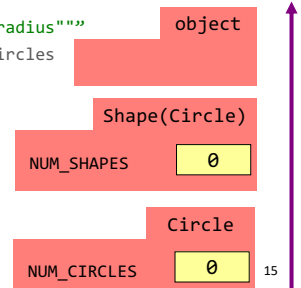
A: 10
B: 14
C: 5
D: ERROR
E: I don't know

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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
    ...
```



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Q3: 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

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Q4: 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

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A4: 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 CORRECT
 E: I don't know

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Inheritance-related terminology

- eq vs is
- isinstance

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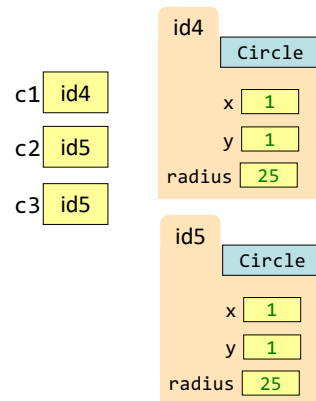
eq vs. is

== 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

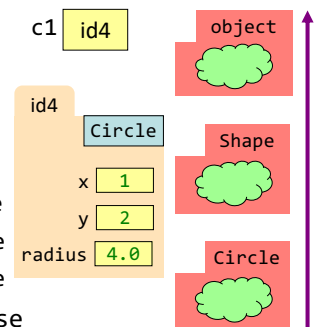
`isinstance(<obj>, <class>)`

- 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!

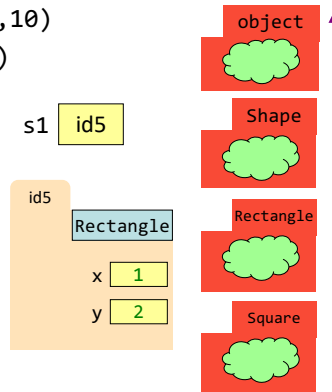


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Q5: isinstance and Subclasses

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

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

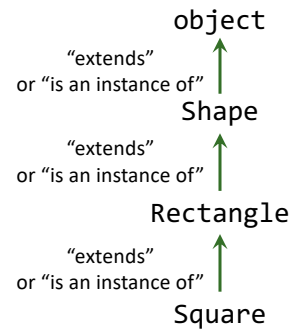


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A5: isinstance and Subclasses

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

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



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Next Lecture

- Programming Practice
- Develop classes: Animal, Bird, Fish, Penguin, Parrot
- Instances can **swim**, **fly**, and **speak** based on class membership

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Questions to ask

- What does the class hierarchy look like?
- What are class attributes? What are instance attributes? What are constants?
- What does the `__init__` function look like?
- How do we support default weights?
- How do we implement the class methods?
- What does a "stringified" `Animal` look like?
`str(a)`

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