Accelerating
Information Technology
Innovation

http://aiti.mit.edu

Kenya Summer 2011
Lecture 06 – Objects

The History of Objects

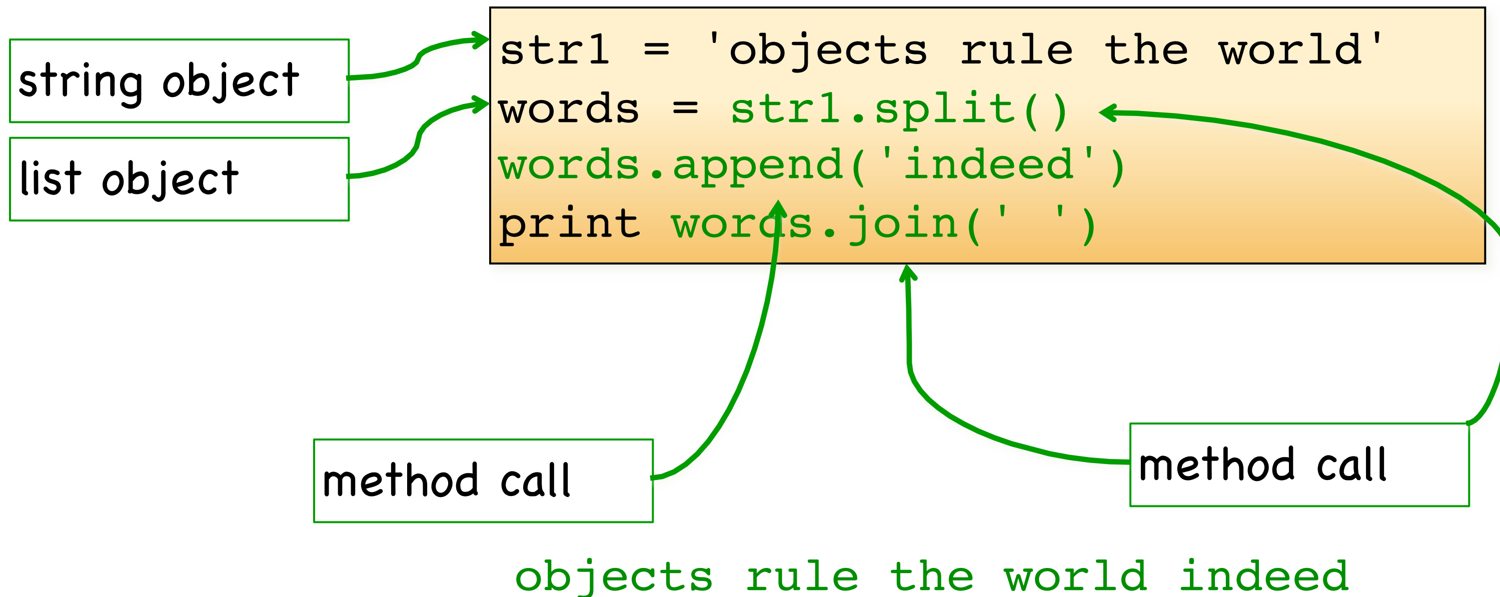
- Objects weren't always supported by programming languages
- Idea first originated at MIT in the 1960s and was officially incorporated in a few languages in the same decade
- OOP (Object Oriented Programming) has now become a core feature of nearly all languages

Object Oriented Programming (OOP)

- A certain style of computer programming
- Centered around data structures called “objects”
- Objects are a standard way to organize data
- Many pros and cons, but almost every language and decent sized project uses it

Using objects

- In Python everything is an object
- Object methods - string, list



Defining a Class

```
class Car():
    wheels = 4

print Car.wheels
myCar = Car() #instantiation
print myCar.wheels
Car.wheels = 5 # change the class variable
print Car.wheels
print myCar.wheels
```

The Constructor

```
class Car():

    wheels = 4

    def __init__(self, color):
        self.color = color

#print Car.color <-- AttributeError: class Car has
  no attribute 'color'
myCar = Car("red")
print myCar.color # red
```

Adding Procedures

```
class Car():
    wheels = 4
    def __init__(self, color):
        self.color = color
    def fade(self):
        self.color = self.color + "ish"

myCar = Car("red")
print myCar.color #red
myCar.fade()
print myCar.color #redish
```

Static Procedures

```
class Car():
    wheels = 4
    def __init__(self, color):
        self.color = color
    def fade(self):
        self.color = self.color + "ish"

    @staticmethod
    def isOld(miles):
        if miles < 50000:
            return False
        return True

print Car.isOld(30000) # False
```

Inner Classes

```
class Car():
   wheels = 4
      def __init__(self, color, horsepower):
            self.color = color
            self.engine = self.Engine(horsepower)

   class Engine():
            def __init__(self, horsepower):
                  self.horsepower = horsepower
            def getWatts(self):
                  return self.horsepower * 745.7

myCar = Car('red', 400)
print myCar.engine.getWatts() #298280.0
```

Program Organization

```
import MODULENAME

def func1():
    BODY1
...
def funcn(a):
    BODYN

class Class1(object):
    CLASSBODY1
...
class ClassN(object):
    CLASSBODYN

# start of the program
MAINBODY
```

import modules like math

Function definitions

Class definitions

your "main" program

Graphics Objects

- Use graphics.py module
- Graphics objects available:
  - Point
  - Line
  - Circle
  - Oval
  - Rectangle
  - Polygon
  - Text

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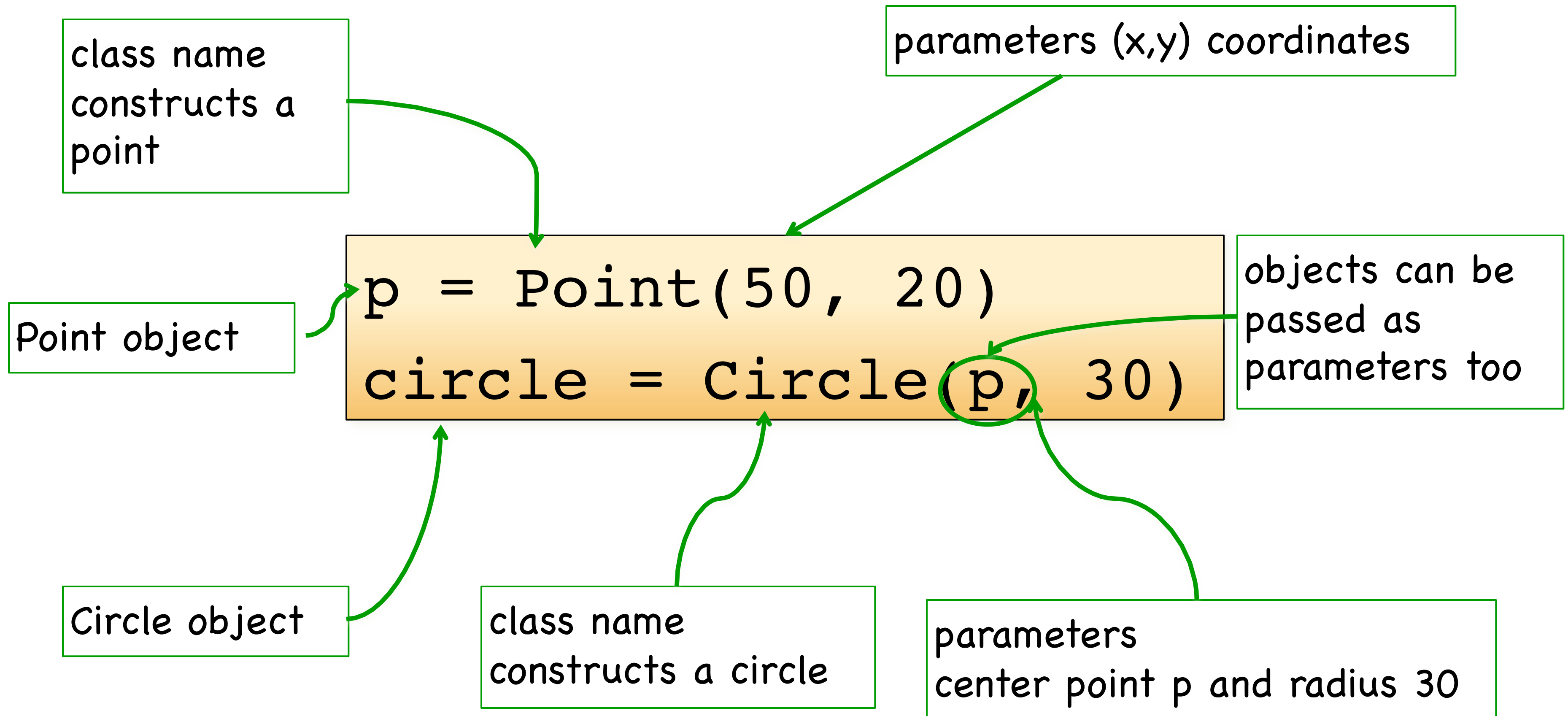
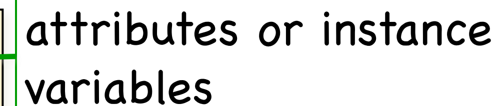
Creating an object



Accessing Attributes and Methods

- Using dot (.)

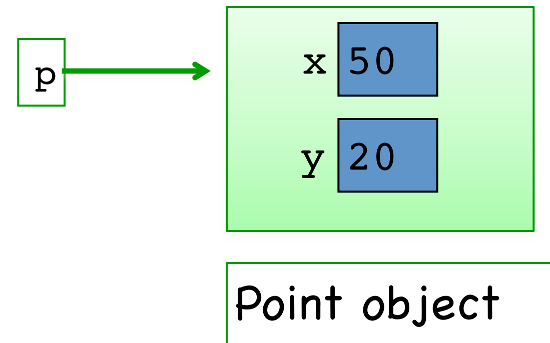
```
p = Point(50, 20)
print p.x, p.y
print p.getX(), p.getY()
```




```
50 20
50 20
```

Objects are mutable

```
1  p = Point(50, 20)
2  p.x = p.x - 20
3  p2 = p
4  p2.x = p2.x + 10
5  print p.getX(), p.getY()
```



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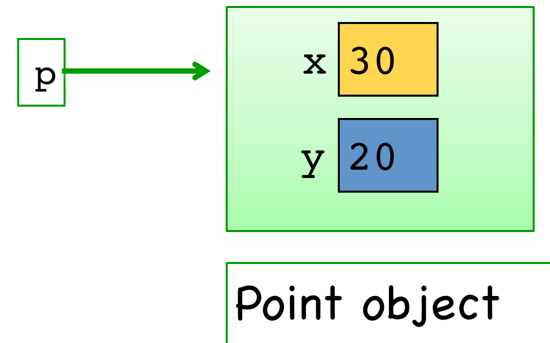

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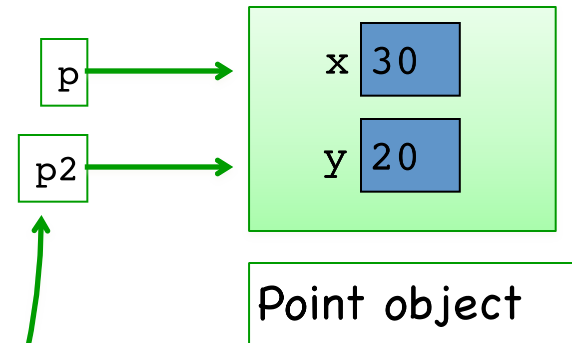

p2 is an alias of p, i.e. it refers to the same point object

Objects are mutable

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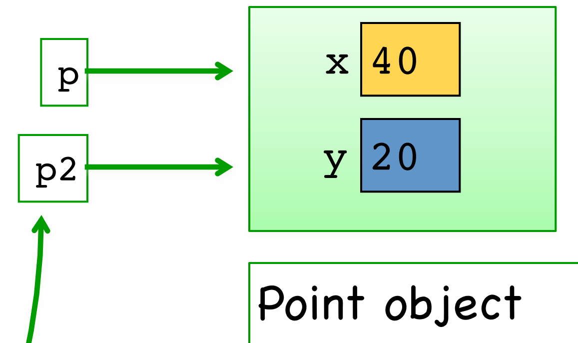

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Objects are mutable

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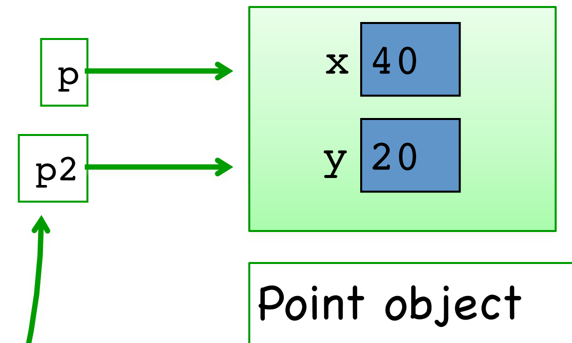

p2 is an alias of p, i.e. it refers to the same point object

```
40 20
```

Scoping in functions

- Basic types - create a copy of the variable inside the function

```
def move_by_10(x, y):
   x = x + 10
   y = y + 10

x = 10
y = 10
move_by_10(x, y)
print x, y
```

What does this print? 10 10

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Scoping in functions

- Objects - create an alias of the variable inside the function

```
def move_by_20(p):
  p.x = p.x + 20
  p.y = p.y + 20

p1 = Point(10, 10)
move_by_20(p1)
print p1.getX(), p1.getY()
```

creates an alias to the object that is passed as a parameter; not a copy of the object

What does this print?

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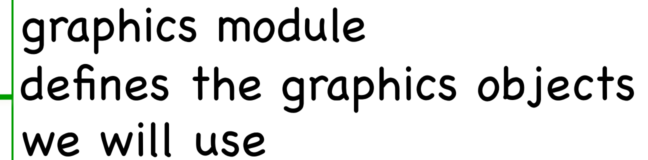
Simple Graphics Program




```
from graphics import *

win = GraphWin('My Circle', 100, 100)
c = Circle(Point(50,50), 10)
c.setFill('red')
c.draw(win)

win.mainloop()
```

Simple Graphics Program

```
from graphics import *

win = GraphWin('My Circle', 150, 150)
c = Circle(Point(50,50), 10)
c.setFill('red')
c.draw(win)

win.mainloop()
```

Creates a window with a canvas to draw on

Inverted coordinate system (units are pixels)

Window title

Canvas width

Canvas height

(0, 0)

(150, 150)

x

y

My C...

Simple Graphics Program

create a Circle object

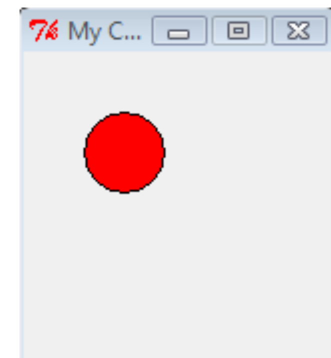
```
from graphics import *

win = GraphWin('My Circle', 150, 150)
c = Circle(Point(50,50), 10)
c.setFill('red')
c.draw(win)

win.mainloop()
```

Circle center

Circle radius



Simple Graphics Program

```
from graphics import *

win = GraphWin('My Circle', 150, 150)
c = Circle(Point(50,50), 10)
c.setFill('red')
c.draw(win)

win.mainloop()
```

every graphics program must end with this line; it allows the window to process mouse clicks and keyboard input

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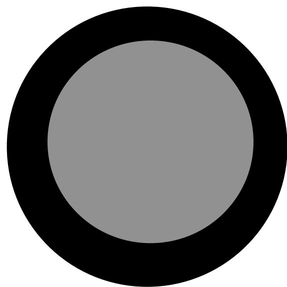
User-defined types

- What if we want to create our own class?
- E.g. let's create a class that draws a car wheel. For simplicity, the wheel will look like this:



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Wheel class

- Attributes
  - `tire_circle`
  - `wheel_circle`
- Methods
  - `draw`
  - `move`
  - `get_size`
  - `get_center`
  - `set_color`

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Wheel Class Definition

class name

the King of objects (it says that the wheel is an object)

```
class Wheel(object):

  def __init__(self, center, wheel_radius, tire_radius):
          self.tire_circle = Circle(center, tire_radius)
          self.wheel_circle = Circle(center, wheel_radius)
```

Special method (constructor): it is called when the object is constructed and sets the initial state of the object

defines the objects attributes

Wheel Class Definition

```
class Wheel(object):

  def __init__(self, center, wheel_radius, tire_radius):
        self.tire_circle = Circle(center, tire_radius)
        self.wheel_circle = Circle(center, wheel_radius)
```

- What is this `self` parameter?
- `self` is an alias to the object instance
- Must use it to access any of the object's attributes or methods
- it must always be the first parameter in a method signature

Wheel Class Definition

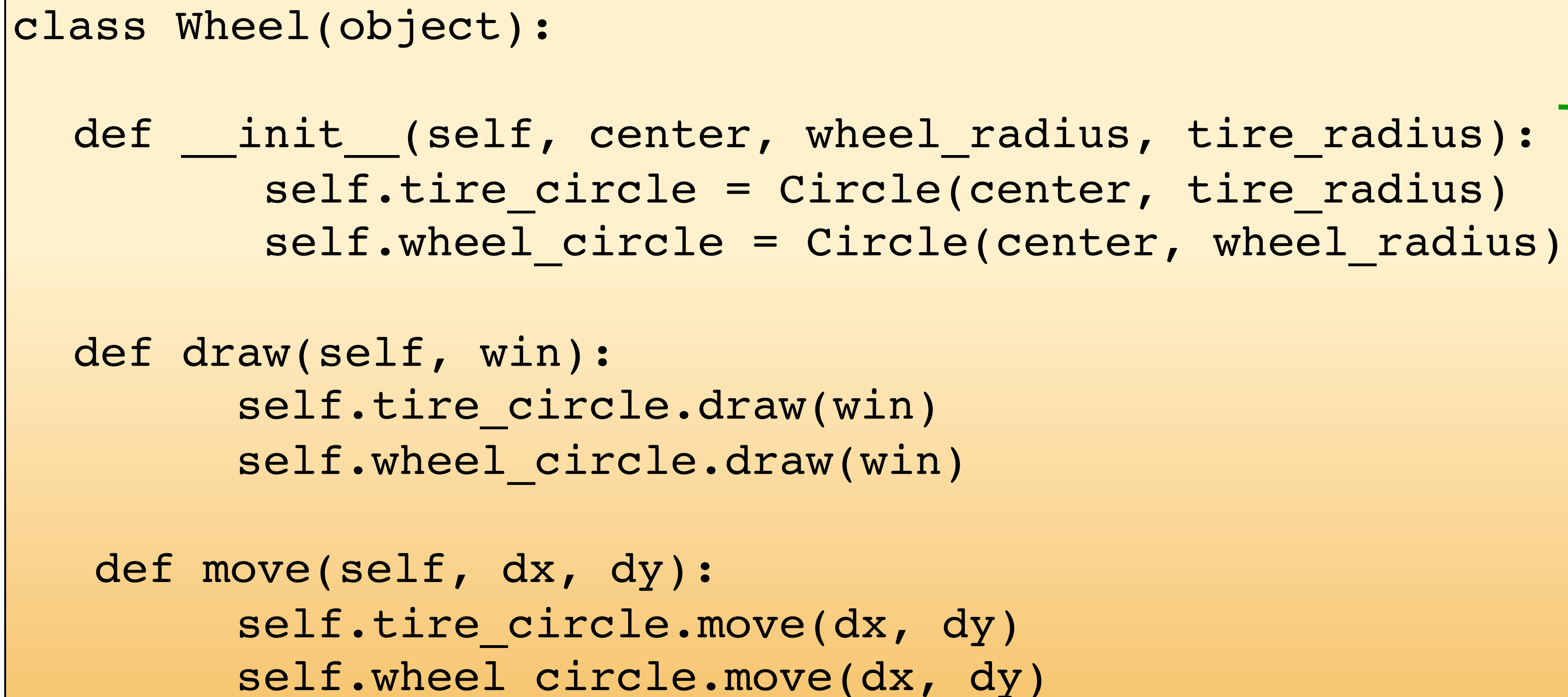
```
class Wheel(object):

  def __init__(self, center, wheel_radius, tire_radius):
      self.tire_circle = Circle(center, tire_radius)
      self.wheel_circle = Circle(center, wheel_radius)
```

Attributes are defined inside the __init__ method using the self parameter.

Attributes vs Local Variables

- Attribute
  - Defined in the __init__ method
  - Belongs to a specific object
  - Exists as long as the containing object exists
- Local variable
  - Declared within a method or a function
  - Exists only during the execution of its containing method or function

Wheel Class Definition



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Wheel Class Definition

```
class Wheel(object):
   ''' This class defines a wheel template with two circles.
       Attributes: tire_circle, wheel_circle
    '''

   def __init__(self, center, wheel_radius, tire_radius):
         self.tire_circle = Circle(center, tire_radius)
         self.wheel_circle = Circle(center, wheel_radius)

   def draw(self, win):
         self.tire_circle.draw(win)
         self.wheel_circle.draw(win)

    def move(self, dx, dy):
         self.tire_circle.move(dx, dy)
         self.wheel_circle.move(dx, dy)

    def set_color(self, wheel_color, tire_color):
         self.tire_circle.setFill(tire_color)
         self.wheel_circle.setFill(wheel_color)
```


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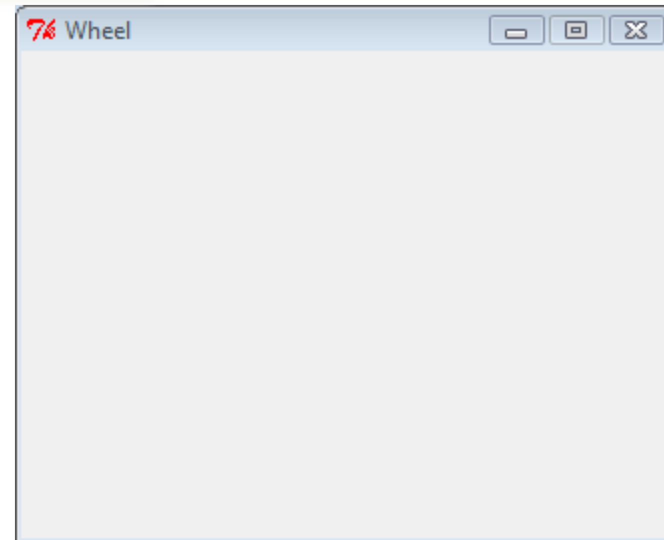
Wheel Class Definition

```
……..  .  .

def undraw(self):
      self.tire_circle.undraw()
      self.wheel_circle.undraw()

 def get_size(self):
      return self.tire_circle.getRadius()

def get_center(self):
 return tire_circle.getCenter()
```

Using our Wheel class

```
win = GraphWin('Wheel', 320, 240)
w = Wheel(Point(100, 100), 50, 70)
w.draw(win)
w.set_color('gray', 'black')
w.undraw()
win.mainloop()
```



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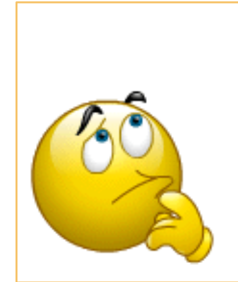

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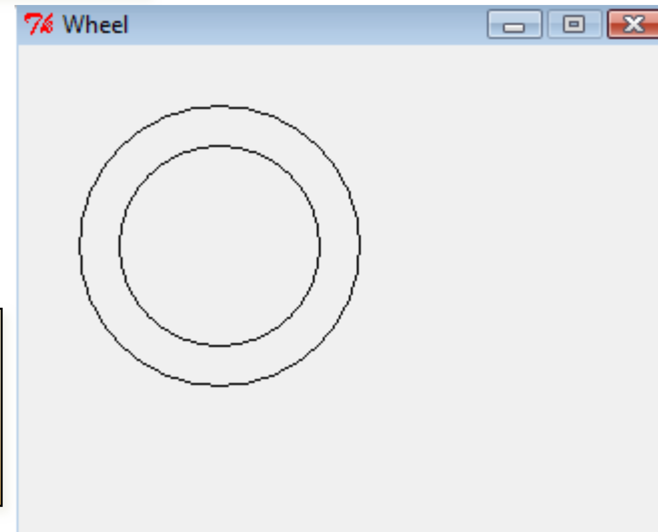
What happened to the mysterious self parameter?




```
self = w
```

```
def draw(self, win):
   self.tire_circle.draw(win)
   self.wheel_circle.draw(win)
```

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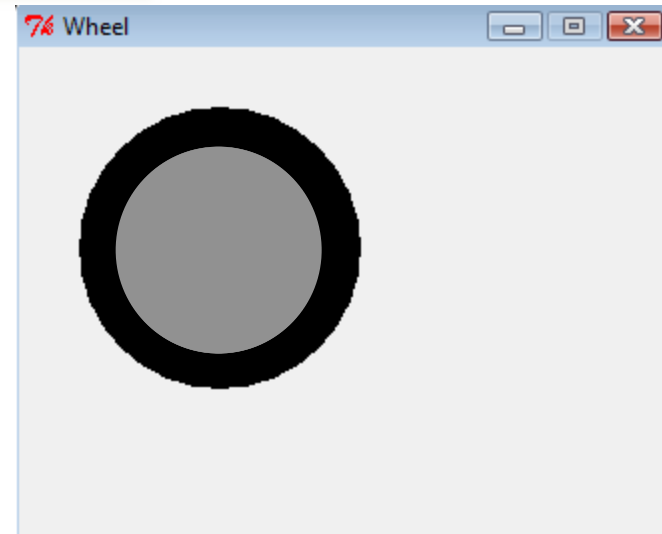

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