Classes and Objects

Basics

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	Biology	Programming
General		
Specific		

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	Biology	Programming
General	Species *canis lupus*	Class `Vector`
Specific	Organism Waya	Object `velocity`

Define a new class with no behavior

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>>> class Empty(object):
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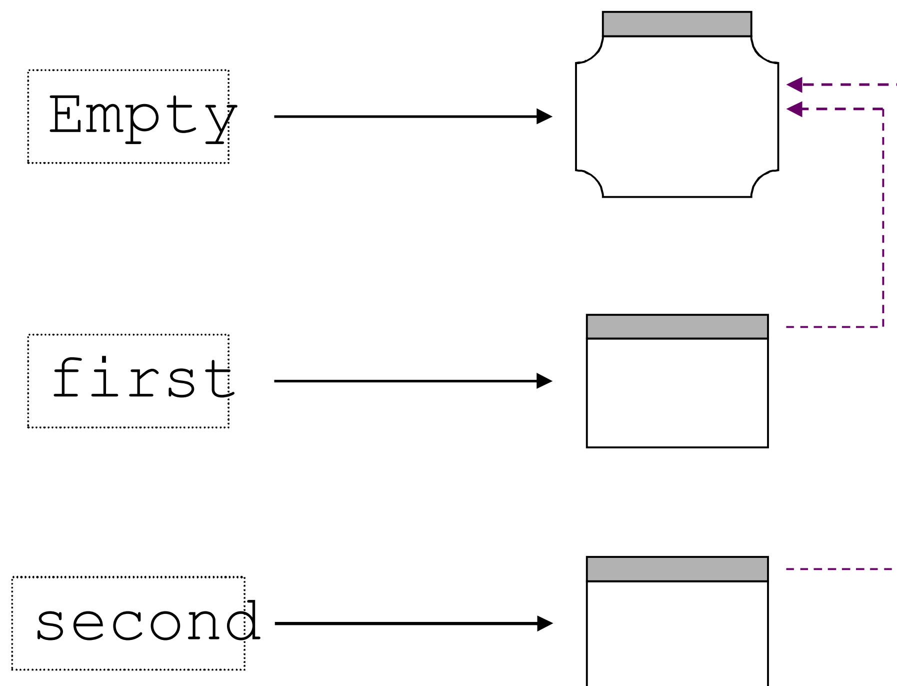
```
>>> first = Empty()
>>> second = Empty()
>>> print 'first is', id(first)
35855140
>>> print 'second is', id(second)
35855152
```

Contents of memory



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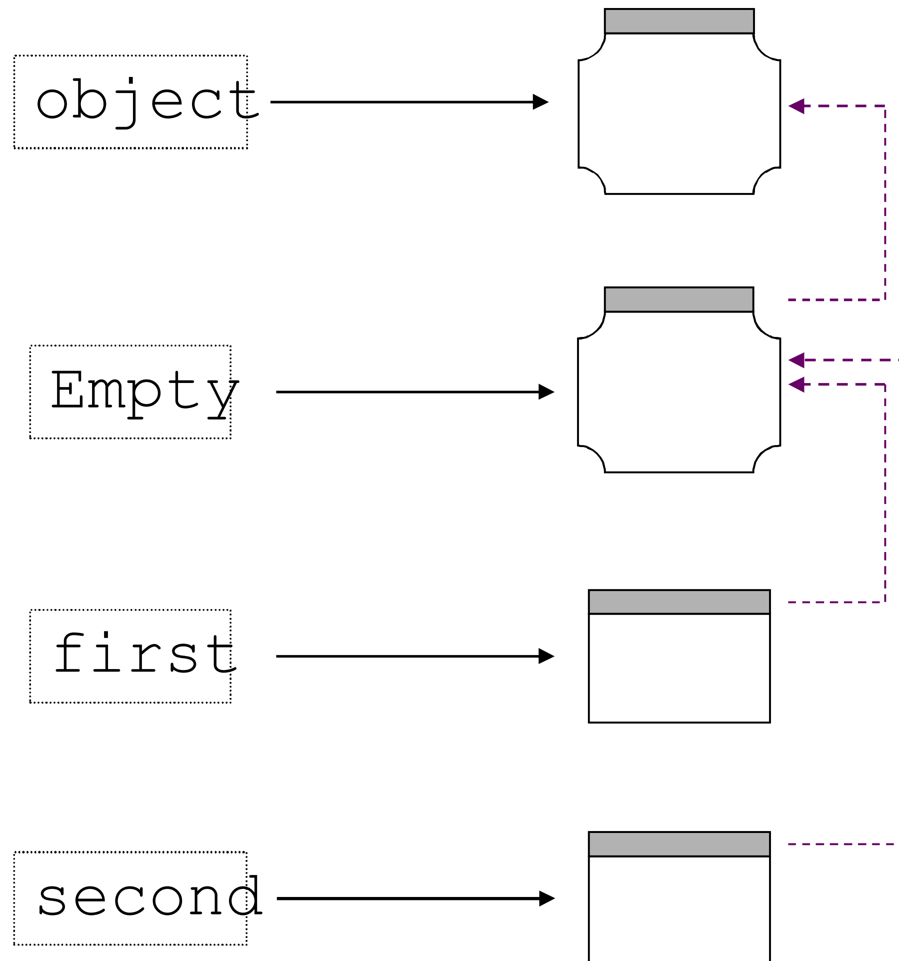

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  def greet(self, name):
    print 'hello', name, '!'
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class Greeter(object):
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g = Greeter()
g.greet('Waya')
hello Waya !
```

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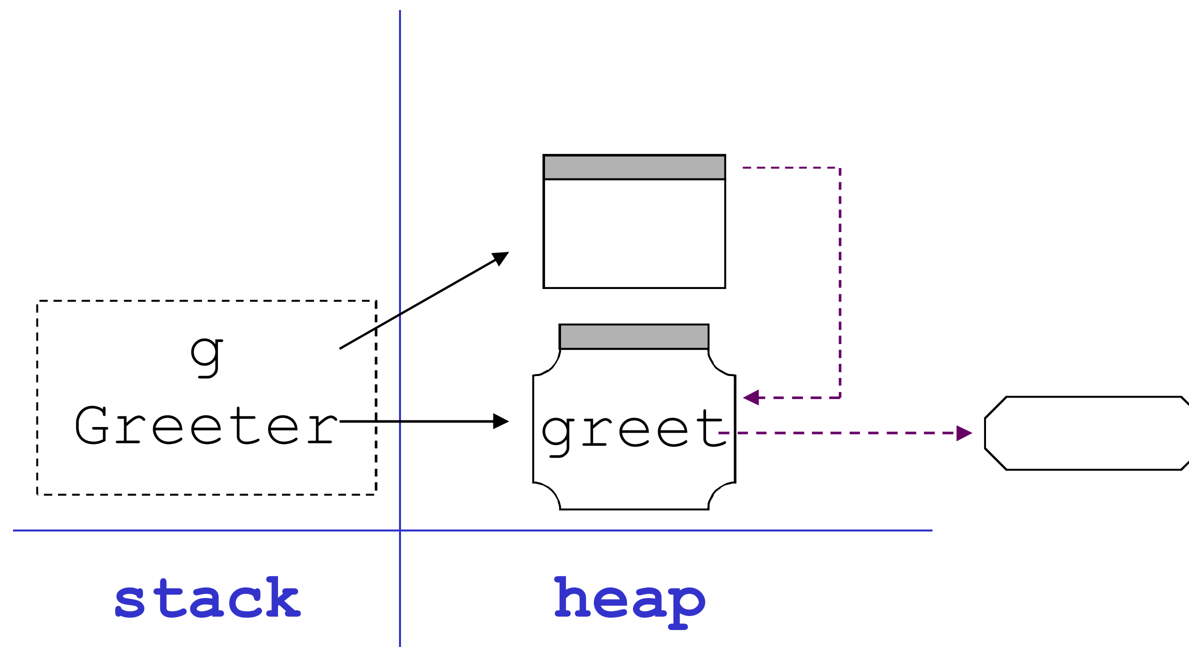

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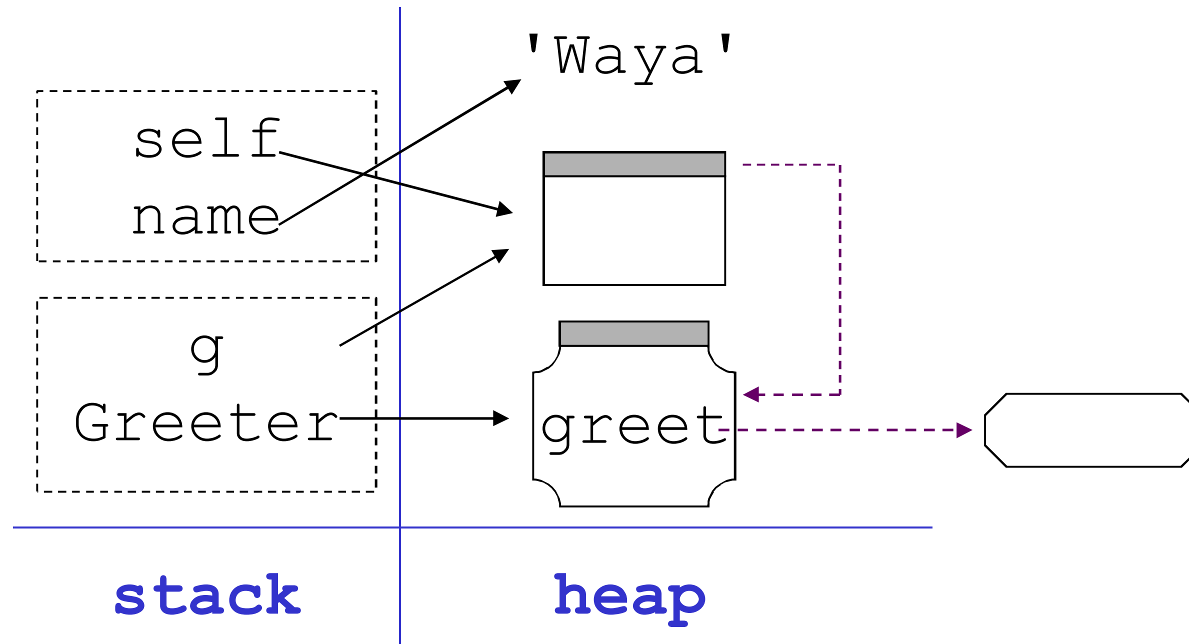

Every object has its own variables

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Every object has its own variables ← members

Every object has its own variables

Create new ones by assigning them values

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Create new ones by assigning them values

```
class Empty(object):
  pass

e = Empty()
e.value = 123
print e.value
123
```

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Every object has its own variables

Create new ones by assigning them values

```
class Empty(object):
  pass

e = Empty()
e.value = 123
print e.value
123

e2 = Empty()
print e2.value
AttributeError: 'Empty' object has no attribute 'value'
```

The values of member variables customize objects

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Use them in methods

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class Greeter(object):
  def greet(self, name):
    print self.hello, name, '!'
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g = Greeter()
```

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Create new ones by assigning them values

```
class Greeter(object):
  def greet(self, name):
    print self.hello, name, '!'

g = Greeter()
g.hello = 'Bonjour'
```

Every object has its own variables

Create new ones by assigning them values

```
class Greeter(object):
  def greet(self, name):
    print self.hello, name, '!'

g = Greeter()
g.hello = 'Bonjour'
g.greet('Waya')
Bonjour Waya !
```

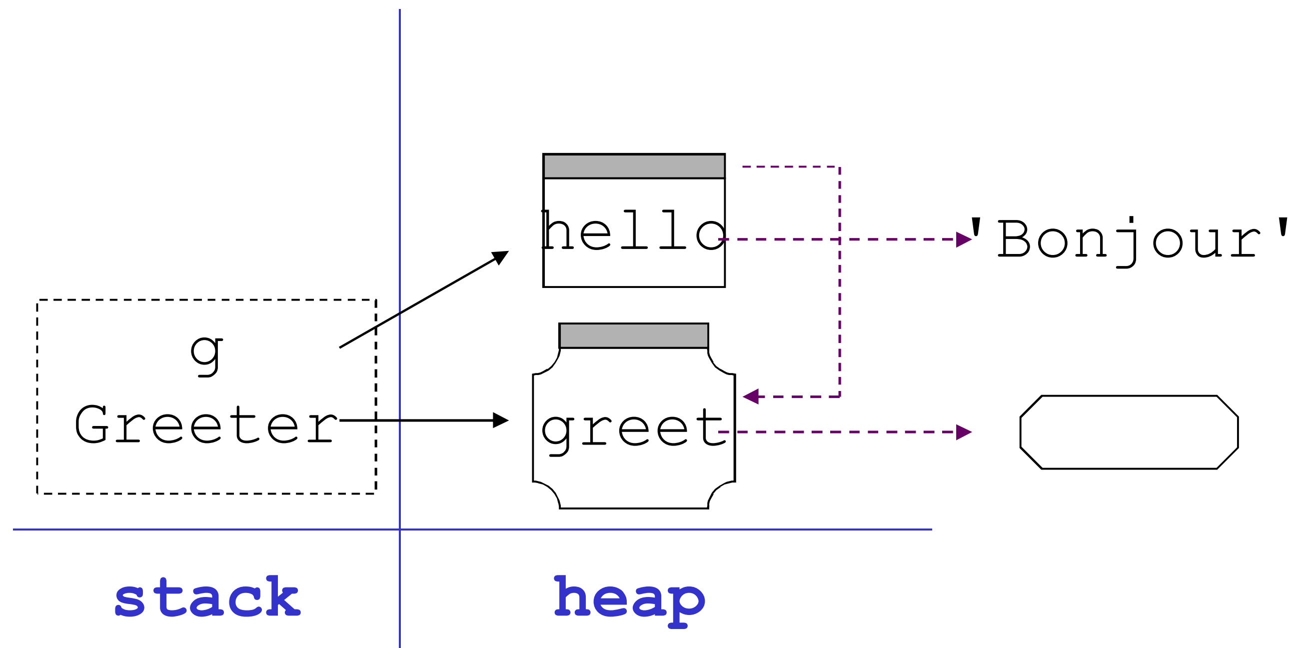
Every object has its own variables

Create new ones by assigning them values

```
class Greeter(object):
  def greet(self, name):
    print self.hello, name, '!'

g = Greeter()                g2 = Greeter()
g.hello = 'Bonjour'          g2.hello =
  'Salut'
g.greet('Waya')              g2.greet('Waya')
Bonjour Waya !               Salut Waya !
```

Contents of memory



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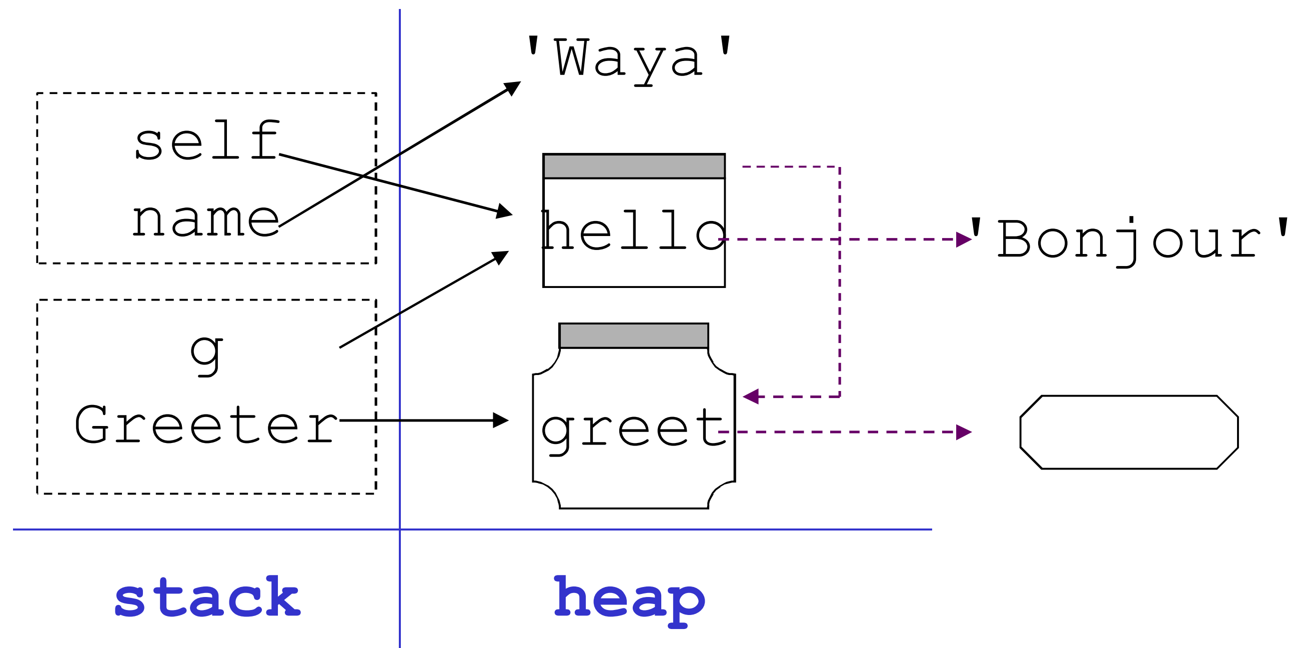

Every object's names are separate

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```
class Greeter(object):
  def greet(self, name):
    print self.hello, name, '!'

hello = 'Hola'
g = Greeter()
g.hello = 'Bonjour'
g.greet('Waya')
Bonjour Waya !
```

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Automatically called as new object is being created

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A natural place to customize individual objects

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Define a *constructor* for the class

Automatically called as new object is being created

A natural place to customize individual objects

Python uses the special name `__init__(self, ...)`

A better `Greeter`

```
class Greeter(object):

  def __init__(self, what_to_say):
    self.hello = what_to_say

  def greet(self, name):
    print self.hello, name, '!'
```

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Why it's better

```
first = Greeter('Hello')
first.greet('Waya')
Hello Waya !
```

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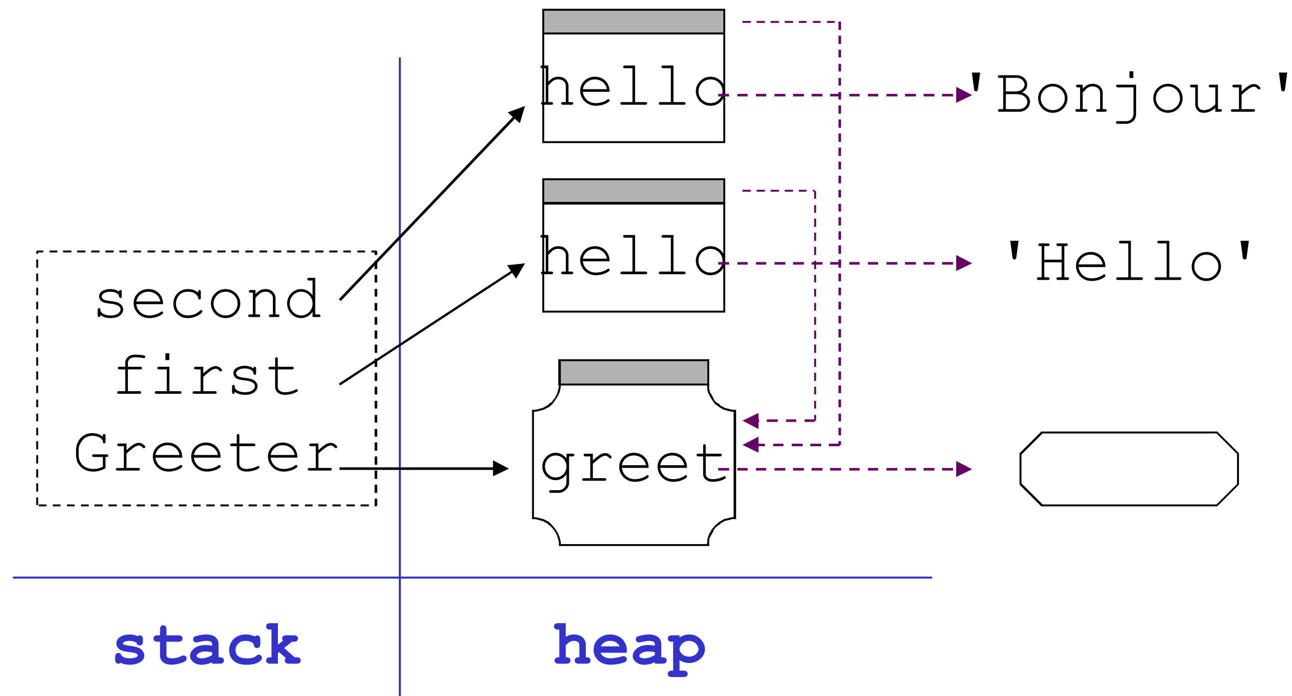
Why it's better

```
first = Greeter('Hello')
first.greet('Waya')
Hello Waya !
second = Greeter('Bonjour')
second.greet('Waya')
Bonjour Waya !
```

Contents of memory



A comon mistake

```
class Greeter(object):

  def __init__(self, what_to_say):
    hello = what_to_say

  def greet(self, name):
    print self.hello, name, '!'
```

What goes wrong

```
first = Greeter('Hello')
```

What goes wrong

```
first = Greeter('Hello')
first.greet('Waya')
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Attribute Error: 'Greeter' object has no attribute 'hello'

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first = Greeter('Hello')
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`self.name` stores the value in the object

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`name` on its own is a local variable on the stack

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`name` on its own is a local variable on the stack

```
class Greeter(object):
  def __init__(self, what_to_say)
    hello = what_to_say
```

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Object data is not protected or hidden in Python

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```
first = Greeter('Hello')
first.greet('Waya')
Hello Waya !
first.hello = 'Kaixo'
Kaixo Waya !
```

Object data is not protected or hidden in Python

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first = Greeter('Hello')
first.greet('Waya')
Hello Waya !
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Kaixo Waya !
```

Some languages prevent this

Object data is not protected or hidden in Python

```
first = Greeter('Hello')
first.greet('Waya')
Hello Waya !
first.hello = 'Kaixo'
Kaixo Waya !
```

Some languages prevent this

All discourage it

A more practical example

```
class Rectangle(object):

  def __init__(self, x0, y0, x1, y1):
    assert x0 < x1, 'Non-positive X 
  extent'
    assert y0 < y1, 'Non-positive Y 
  extent'
    self.x0 = x0
    self.y0 = y0
    self.x1 = x1
    self.y1 = y1
```

A more practical example

```
class Rectangle(object):

  def __init__(self, x0, y0, x1, y1):
    assert x0 < x1, 'Non-positive X extent'
    assert y0 < y1, 'Non-positive Y extent'
    self.x0 = x0
    self.y0 = y0
    self.x1 = x1
    self.y1 = y1
```

Benefit #1: fail early, fail often

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```
# Programmer thinks rectangles are
  written
# [[x0, x1], [y0, y1]]
>>> field = [[50, 100], [0, 200]]
```

Benefit #1: fail early, fail often

```
# Programmer thinks rectangles are
  written
# [[x0, x1], [y0, y1]]
>>> field = [[50, 100], [0, 200]]
>>>

# Class knows rectangles are (x0, y0,
  x1, y1)
>>> field = Rectangle(50, 100, 0, 200)
AssertionError: non-positive X extent
```

Benefit #2: readability

```
class Rectangle(object):
  ...

  def area(self):
    return (self.x1-self.x0)*(self.y1-
  self.y0)

  def contains(self, x, y):
    return (self.x0 <= x <= self.x1)
  and \
           (self.y0 <= y <= self.y1)
```

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Compare

List of Lists	Object
`field = [[0, 0], [100, 100]]`	`field = Rectangle(0, 0, 100, 100)`
`rect_area(field)`	`field.area()`
`rect_contains(field, 20, 25)`	`field.contains(20, 25)`

Compare

List of Lists	Object
`field = [[0, 0], [100, 100]]`	`field = Rectangle(0, 0, 100, 100)`
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Make it even clearer by creating a `Point2D` class

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`field = [[0, 0], [100, 100]]`	`field = Rectangle(0, 0, 100, 100)`
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Make it even clearer by creating a `Point2D` class

Then re-defining `Rectangle` in terms of it

created by

Greg Wilson

January 2011

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