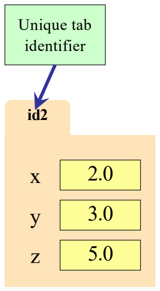
Recall: Objects as Data in Folders

- An object is like a **manila folder**
- It contains other variables
  - Variables are called **attributes**
  - Can change values of an attribute (with assignment statements)
- It has a "tab" that identifies it
  - Unique number assigned by Python
  - Fixed for lifetime of the object



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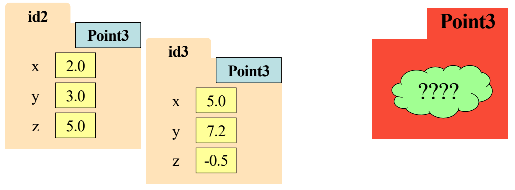
Classes Have Folders Too

Object Folders	Class Folders
Separate for each *instance*	Data common to all instances



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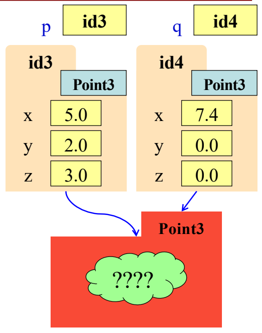
Name Resolution for Objects

- ⟨*object*⟩.⟨*name*⟩ means
  - Go the folder for *object*
  - Find attribute/method *name*
  - If missing, check **class folder**
  - If not in either, raise error
- What is in the class folder?
  - Data common to **all** objects
  - First must understand the ***class definition***



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The Class Definition

Goes inside a module, just like a function definition.

keyword class Beginning of a class definition

class <*class-name*>(object): — Do not forget the colon!

    """Class specification""" — more on this later
    <function definitions>
    <assignment statements>
    <any other statements also allowed>

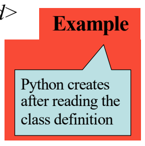
Specification (similar to one for a function)

to define **methods**

to define **attributes**

…but not often used

```
class Example(object):
    """The simplest possible class."""
    pass
```



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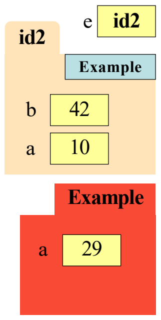
Instances and Attributes

- Assignments add object attributes
  - <object>.<att> = <expression>
  - **Example**: e.b = 42
- Assignments can add class attributes
  - <class>.<att> = <expression>
  - **Example**: Example.a = 29
- Objects can access class attributes
  - **Example**: print e.a
  - But assigning it creates object attribute
  - **Example**: e.a = 10
- **Rule**: check object first, then class



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The Class Specification

```
class Worker(object):
    """A class representing a worker in a certain organization

    Instance has basic worker info, but no salary information.

    Attribute lname: The worker last name
    Invariant: lname is a string

    Attribute ssn: The Social Security number
    Invariant: ssn is an int in the range 0..999999999

    Attribute boss: The worker's boss
    Invariant: boss is an instace of Worker, or None if no boss"""
```

Short summary

More detail

Description

Invariant

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Method Definitions

- Looks like a function def
  - Indented *inside* class
  - First param is always self
  - But otherwise the same
- In a **method call**:
  - One less argument in ()
  - Obj in front goes to self
- **Example**: a.distance(b)

self q

```
1.  class Point3(object):
2.      """Class for points in 3d space
3.      Invariant: x is a float
4.      Invariant y is a float
5.      Invariant z is a float    """
6.      def distance(self,q):
7.          """Returns dist from self to q
8.          Precondition: q a Point3"""
9.          assert type(q) == Point3
10.         sqrdst = ((self.x-q.x)**2 +
11.                   (self.y-q.y)**2 +
12.                   (self.z-q.z)**2)
13.         return math.sqrt(sqrdst)
```

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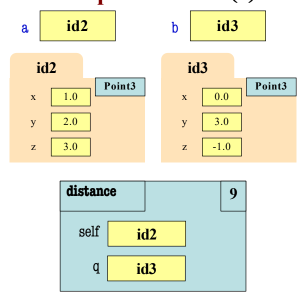
Methods Calls

- **Example**: a.distance(b)



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```

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Methods and Folders

- Function definitions…
  - make a folder in heap
  - assign name as variable
  - variable in global space
- Methods are similar...
  - Variable in **class folder**
  - But otherwise the same
- **Rule of this course**
  - Put header in class folder
  - Nothing else!

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3.      Invariant: x is a float
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6.      def distance(self,q):
        ....
```

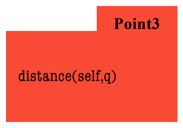

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Special Method: __init__

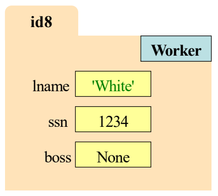
```
w = Worker('Whi… 1234, None)

def __init__(self, n, s, b):
    """Initializes a Worker object

    Has last name n, SSN s, and boss b

    Precondition: n a string,
    s an int in range 0..999999999,
    b either a Worker or None.  """
    self.lname = n
    self.ssn  = s
    self.boss = b
```

two underscores

don't forget self

use self to assign attributes

Called by the constructor



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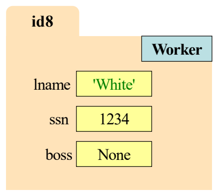
Evaluating a Constructor Expression

Worker('White', 1234, None)

1. Creates a new object (folder) of the class Worker
   - Instance is initially empty
2. Puts the folder into heap space
3. Executes the method __init__
   - Passes folder name to self
   - Passes other arguments in order
   - Executes the (assignment) commands in initializer body
4. Returns the object (folder) name



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Making Arguments Optional

- We can assign default values to __init__ arguments
  - Write as assignments to parameters in definition
  - Parameters with default values are optional
- **Examples**:
  - p = Point3()   # (0,0,0)
  - p = Point3(1,2,3)   # (1,2,3)
  - p = Point3(1,2)   # (1,2,0)
  - p = Point3(y=3)   # (0,3,0)
  - p = Point3(1,z=2)   # (1,0,2)

```
1.  class Point3(object):
2.      """Class for points in 3d space
3.      Invariant: x is a float
4.      Invariant y is a float
5.      Invariant z is a float    """
6.
7.      def __init__(self,x=0,y=0,z=0):
8.          """Initializes a new Point3
9.          Precond: x,y,z are numbers"""
10.         self.x = x
11.         self.y = y
12.         self.z = z
13.     ...
```

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