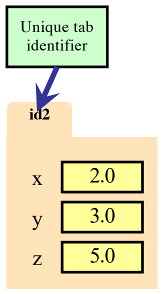
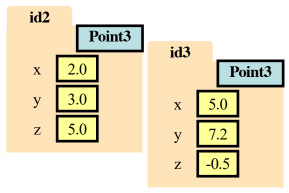
Recall: Objects as Data in Folders

- 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



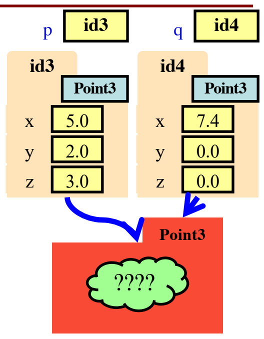
Classes Have Folders Too

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



Name Resolution for Objects

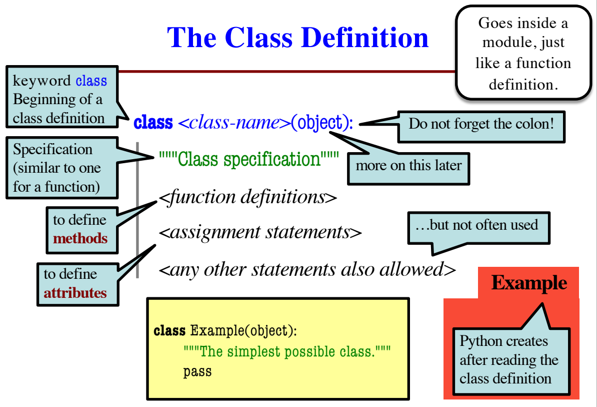
- ⟨*object*⟩.⟨*name*⟩ means
  - Go the folder for *object*
  - Find attribute/method *name*
  - If missing, check **class folder**
  - If not in either, raise error
- What is in the class folder?
  - Data common to **all** objects
  - First must understand the ***class definition***



The Class Definition

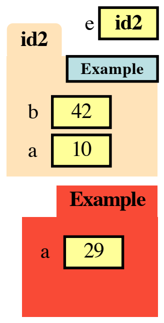
```
class <class-name>(object):
    """Class specification"""
    <function definitions>
    <assignment statements>
    <any other statements also allowed>
```

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


Goes inside a module, just like a function definition.
keyword class Beginning of a class definition
Do not forget the colon!
Specification (similar to one for a function)
more on this later
to define methods
to define attributes
…but not often used
Example
Python creates after reading the class definition

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

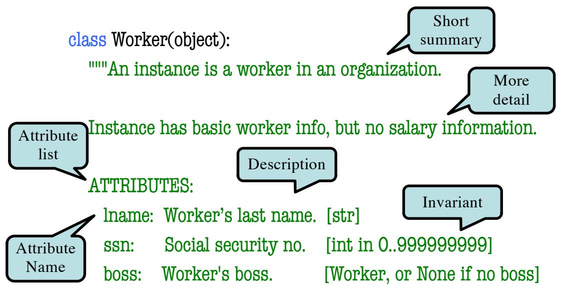


The Class Specification

```
class Worker(object):
    """An instance is a worker in an organization.

    Instance has basic worker info, but no salary information.

    ATTRIBUTES:
      lname: Worker's last name.  [str]
      ssn:   Social security no.  [int in 0..999999999]
      boss:  Worker's boss.       [Worker, or None if no boss]
```



Method Definitions

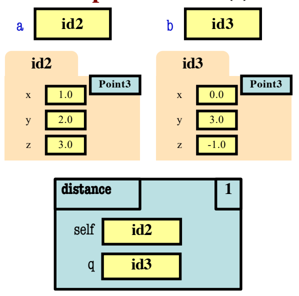
- Looks like a function def
  - But indented *inside* class
  - The first parameter is always called self
- In a method call:
  - Parentheses have one less argument than parameters
  - The object in front is passed to parameter self
- **Example**: a.distance(b)

self q

```
class Point3(object):
    """Instances are points in 3d space
        x: x coord [float]
        y: y coord [float]
        z: z coord [float]    """
    def distance(self,q):
        """Returns: dist from self to q
        Precondition: q a Point3"""
        assert type(q) == Point3
        sqrdst = ((self.x-q.x)**2 +
                  (self.y-q.y)**2 +
                  (self.z-q.z)**2)
        return math.sqrt(sqrdst)
```

Methods Calls

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



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        return math.sqrt(sqrdst)
```

Special Method: __init__

```
w = Worker('White', 1234, None)
```

two underscores

don't forget self

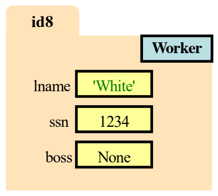
```
def __init__(self, n, s, b):
    """Initializer: creates a Worker

    Has last name n, SSN s, and boss b

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

use self to assign attributes

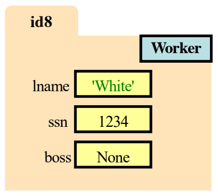
Called by the constructor



Evaluating a Constructor Expression

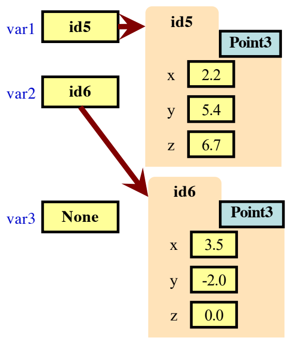
Worker('White', 1234, None)

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



Aside: The Value None

- The boss field is a problem.
  - boss refers to a Worker object
  - Some workers have no boss
  - Or maybe not assigned yet (the buck stops there)
- **Solution**: use value None
  - **None**: Lack of (folder) name
  - Will reassign the field later!
- Be careful with None values
  - var3.x gives error!
  - There is no name in var3
  - Which Point to use?



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)

```
class Point3(object):
    """Instances are points in 3d space
        x: x coord [float]
        y: y coord [float]
        z: z coord [float]    """

    def __init__(self,x=0,y=0,z=0):
        """Initializer: makes a new Point
        Precondition: x,y,z are numbers"""
        self.x = x
        self.y = y
        self.z = z
    …
```