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

Unique tab identifier

id2

x	2.0
y	3.0
z	5.0

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Classes Have Folders Too

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

id2 Point3

x	2.0
y	3.0
z	5.0

id3 Point3

x	5.0
y	7.2
z	-0.5

Point3

????

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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*

p id3   q id4

id3 Point3

x	5.0
y	2.0
z	3.0

id4 Point3

x	7.4
y	0.0
z	0.0

Point3

????

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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!

Specification (similar to one for a function)

"""Class specification"""

more on this later

to define **methods**

<function definitions>

to define **attributes**

<assignment statements>

…but not often used

<any other statements also allowed>

Example

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

Python creates after reading the class definition

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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

e id2   id2

id2 Example

| b | 42 |
| a | 10 |

Example

| a | 29 |

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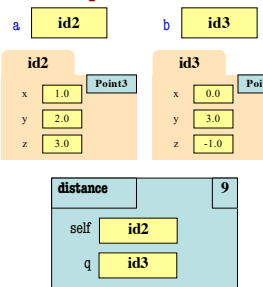
- Looks like a function def
  - Indented *inside* class
  - First param is always self
  - But otherwise the same
- In a **method call**:
  - One less argument in ()
  - Obj in front goes to self
- **Example**: a.distance(b)

```
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)
```

self   q

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Methods Calls

- **Example**: a.distance(b)
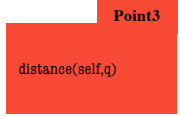
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1.   class Point3(object):
2.       """Class for points in 3d space
3.       Invariant: x is a float
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12.                    (self.z-q.z)**2)
13.          return math.sqrt(sqrdst)
```
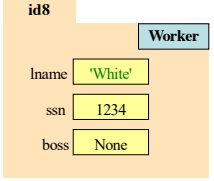
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Methods and Folders

- 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!

```
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):
         ....
```
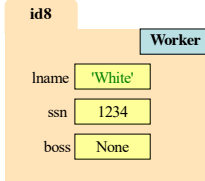
Point3

distance(self,q)

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Special Method: __init__

two underscores
w = Worker(... 1234 None)
don't forget self

Called by the constructor

```
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
```

use self to assign attributes

id8
Worker

lname   'White'

ssn   1234

boss   None

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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

id8
Worker

lname   'White'

ssn   1234

boss   None

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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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