Py ch15-17: Making an ADT the OO Way

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CMPT14x
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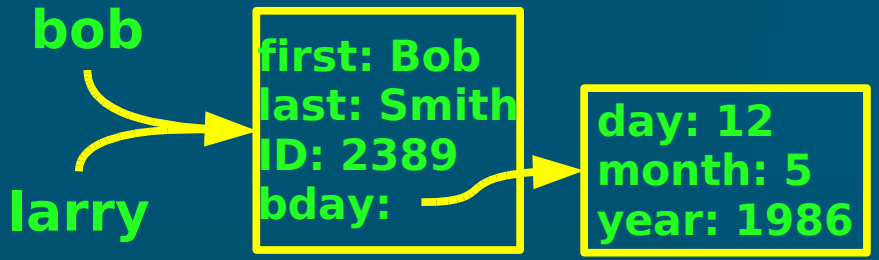
Classes and instances

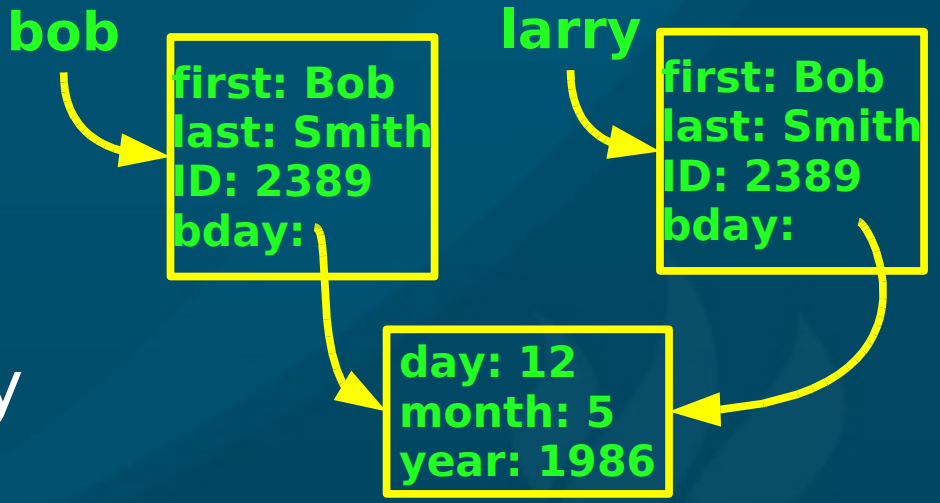
- We define (declare) object classes (types)
  - Attributes
  - Methods (interface)
    - Constructor and destructor
- Then we instantiate the class (declare variables)
- e.g., frac1 is a variable of type Fraction
  - frac1 is the instance,
  - Fraction is the class

More on copy vs. alias

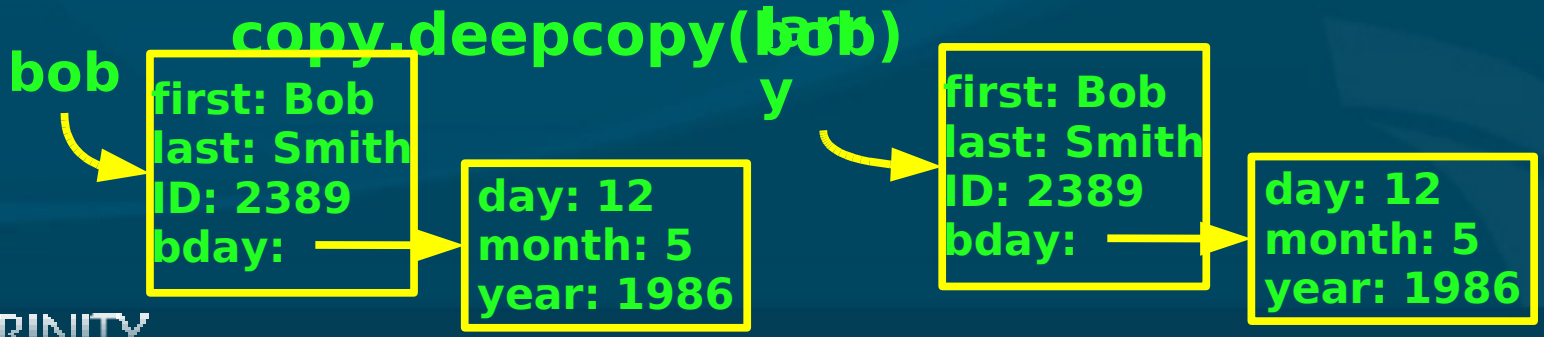
- Assignment: alias
  - **larry = bob**



- copy.copy(): shallow copy
  - **larry = copy.copy(bob)**



- copy.deepcopy(): deep copy
  - **larry = copy.deepcopy(bob)**



Using 'id' to look at aliases

- We can check whether two names are aliases or separate copies by using the Python built-in 'id':
  - `id(student1)` `# 11563216`
  - `student2 = student1` `# alias`
  - `id(student2)` `# 11563216`
  - `student2 = copy.deepcopy(student1)` `# copy`
  - `id(student2)` `# 18493888`

Creating a list of objects

- Our student db is a list of StudentRecords
- Because of aliasing, we can't use this shortcut:
  - student = StudentRecord()
  - studentDB = [student] * 35
    - A list of 35 aliases to the same object!
- Use a for loop to create separate objects:
  - **studentDB = [0] * 35**
  - **for idx in range(len(studentDB)):**
    - **studentDB[idx] = StudentRecord()**

Creating a Fractions ADT

- In ch6 we sketched a Fractions library
  - Fractions were really tuples
  - Hard to hide that from the user
- OO lets us do fractions the 'right' way:
  - Fractions class:
  - Two attributes: num, denom
  - Methods: add, sub, mul, div
  - Constructor method: calls __init__()
  - See oofraction.py

OO: Methods

- In OO, procedures are methods of an object:
  - Messages that can be passed to the object
  - Defined within the class declaration
- First parameter to the method is always a reference to the current object: 'self'

```
class Fraction:
    def __str__(self):
        """A pretty-printed form of the fraction."""
        return "%d / %d" % (num, denom)
```

- __str__ is an example of a customization:
  - Gets called by print

Listing all entities in a class

- Special Python attribute '__dict__'
- Dictionary of all entities in the class
  - import math
  - math.__dict__
    - Lists all functions, constants, etc.
    - Can be very long for some modules!

Creating a new class

- Most class definitions will have __init__ and __str__:

```
class Fraction:
    def __init__(self):
        self.numer = 0
        self.denom = 1
    def __str__(self):
        return '%d / %d' % (self.numer, self.denom)
```

- Refer to instance variables via self.*variable*
- Docstrings for __init__ and __str__ are not usually needed unless something special is happening

Instantiating our new class

- We can now make an instance of our class:
  - f1 = Fraction()
  - f1.numer = 2
  - f2.denom = 3
  - print f1 # 2 / 3
-

Adding a method: multiply()

- Multiply takes two parameters: self, and the other fraction to add.
  - This definition goes inside the class definition:

```
def multiply(self, f2):
    """Multiply two fractions."""
    product = Fraction()
    product.numer = self.numer * f2.numer
    product.denom = self.denom * f2.denom
    return product
```

  - Need to create a new Fraction to return as the result

Using the multiply() method

- We can now multiply two fractions:
  - print f1 # 2 / 3
  - f2 = Fraction()
  - f2.numer = 1
  - f2.denom = 2
  - print f1.multiply(f2) # 2 / 6

Python customizations

- Certain method names are special in Python:
  - __init__: Called by the constructor when we setup a new instance
  - __str__: Called by print
  - __mul__: Overloads the (*) operator
  - __add__: Overloads the (+) operator
  - __le__: Overloads the (<) operator
  - etc. (pretty much any operator can be overloaded!)
- **http://docs.python.org/ref/specialnames.html**

Using customizations

- So if we name our multiply() method __mul__() instead, we can do:
  - print f1 # 2 / 3
  - print f2 # 1 / 2
  - print f1 * f2 # 2 / 6

Parameters to the constructor

- We can pass parameters to the constructor:
  - **f1 = Fraction(2,3)**
- We just need to extend the __init__ function to accept more parameters:
  - **def __init__(self, n, d):**
    - **self.numer = n**
    - **self.denom = d**

Default parameters

- Python functions can specify defaults for the tail-end parameters:
  - **def __init__(self, n=0, d=1):**
    - **self.numer = n**
    - **self.denom = d**
- If __init__ is called with no parameters, n=0 d=1
- If __init__ is called with one parameter:
  - n is given and d=1
- If __init__ is called with two parameters:
  - both n and d are given.