Lecture #15: OOP

Public Service Announcement: Hackers@Berkeley will be hosting a HackJam this Saturday—

- Low-pressure hackathon for both experienced makers and newbies.
- Work together, eat food, and

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- Hack something together in just 12 hours.
- Workshops to help you make something cool.
- Judges, prizes, and most importantly food.
- RSVP by joining the Facebook event page: https://www.facebook.com/events/1448019312098352/

Guerrilla Section #2: Extra groupwork-based section on mastering Recursion. Sunday (March 2nd) at 4pm in 271 Soda (cardkey entry). Check Piazza for details.

Extending the Mutable Objects: Classes

- We've seen a variety of builtin mutable types (sets, dicts, lists).
- ... And a general way of constructing new ones (functions referencing nonlocal variables).
- But in actual practice, we use a different way to construct new types—syntax that leads to clearer programs that are more convenient to read and maintain.
- The Python class statement defines new classes or types, creating new, vaguely dictionary-like varieties of object.

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Simple Classes: Bank Account

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```
class Account: # Type name
                                                    >>> mine = Account(1000)
    # constructor method
                                                    >>> mine.deposit(100)
   def __init__(self, initial_balance):
                                                    >>> mine.balance()
       self._balance = initial_balance
                                                    1100
                                                    >>> mine.withdraw(200)
   def balance(self): # instance method
                                                    >>> mine.balance()
        return self._balance # instance variable
                                                    900
   def deposit(self, amount):
       if amount < 0:
           raise ValueError("negative deposit")
       self._balance += amount.
   def withdraw(self, amount):
       if 0 <= amount <= self.__balance:</pre>
           self._balance -= amount
        else: raise ValueError("bad withdrawal")
```

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Class Concepts

- Classes beget instances, created by "calling" the class: Account(1000).
- Each such Account object (instance) contains *attributes*, accessed using object.attribute notation.
- The defs inside classes define function-valued attributes called *methods* (full names: Account.balance, etc.) Each object has a copy.
- A call mine.deposit(100) is essentially Account.deposit(mine, 100).
- By convention, we therefore call the first argument of a method something like "self" to indicate that it is the object from which we got the method.
- When an object is created, the special <u>_init_</u> method is called first.
- Each Account object has other attributes (_balance), which we create by assignment, again using dot notation.

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Philosophy

- Just as def defines functions and allows us to extend Python with new operations, class defines types and allows us to extend Python with new kinds of data.
- What do we want out of a class?
 - A way of defining named new types of data.
 - A means of defining and accessing state for these objects.
 - A means of defining and using operations specific to these objects.
 - In particular, an operation for initializing the state of an object.
 - A means of creating new objects.

Applied Philosophy

• The Account type illustrates how we do each of these

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Class Attributes

- Things like _balance, _init__, and deposit are attributes of instances of classes.
- Sometimes, a quantity applies to a class type as a whole, not a specific instance.
- For example, with Accounts, you might want to keep track of the total amount deposited from all Accounts.
- This is an example of a class attribute.

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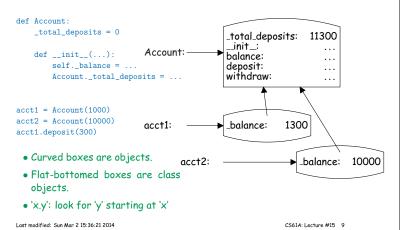
Class Attributes in Python

```
class Account:
                           # Define/initialize a class attribute
    _total_deposits = 0
    def __init__(self, initial_balance):
       self._balance = initial_balance
        Account._total_deposits += initial_balance # Use the class name
    def deposit(self, amount):
       self._balance += amount
       Account._total_deposits += amount
    @staticmethod
    def total_deposits():  # Define a class method.
       return Account._total_deposits
>>> acct1 = Account(1000)
>>> acct2 = Account(10000)
>>> acct1.deposit(300)
>>> Account.total_deposits()
11300
>>> acct1.total_deposits()
11300
```

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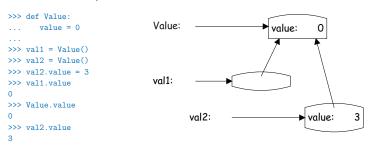
Modeling Attributes in Python

- Unlike C++ or Java, Python takes a very dynamic approach.
- Classes and class instances behave rather like environment frames.



Assigning to Attributes

Assigning to an attribute of an object (including a class) is like assigning to a local variable: it creates a new binding for that attribute in the object selected from (i.e., referenced by the expression on the left of the dot).



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Methods

• Consider

```
>>> def Foo:
...    def set(self, x):
...         self.value = x
>>> aFoo = Foo()
>>> aFoo.set(13)  # The first parameter of set is aFoo.
>>> aFoo.value
13
>>> aFoo.set
<bound method Foo.set of ...>
```

- Selection of attributes from objects (other than classes) that were defined as functions in the class does something to those attributes so that they take one fewer parameters: first parameter is bound to the selected-from object.
- Effect of selecting aFoo.set is like calling partial_bind(aFoo, Foo.set), where