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
- 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/](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.
Simple Classes: Bank Account

class Account:  # Type name
    # constructor method
    def __init__(self, initial_balance):
        self._balance = initial_balance

    def balance(self):  # instance method
        return self._balance  # instance variable

    def deposit(self, amount):
        if amount < 0:
            raise ValueError("negative deposit")
        self._balance += amount

    def withdraw(self, amount):
        if 0 <= amount <= self._balance:
            self._balance -= amount
        else: raise ValueError("bad withdrawal")

>>> mine = Account(1000)
>>> mine.deposit(100)
>>> mine.balance() 1100
>>> mine.withdraw(200)
>>> mine.balance() 900
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 **`__init__`** method is called first.
- Each `Account` object has other attributes `(_balance)`, which we create by assignment, again using dot notation.
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

```python
class Account:
    Define named new type

    def __init__(self, initial_balance):
        How to initialize
        self._balance = initial_balance
        Create/modify state

    def balance(self):
        Define new operation on Accounts
        return self._balance
        Access state of an Account

...

myAccount = Account(1000)
Create a new Account object,
print(myAccount.balance())
Operate on an Account object.
```
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.
class Account:
    _total_deposits = 0  # Define/initialize a class attribute
    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
Modeling Attributes in Python

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

```python
def Account:
    _total_deposits = 0

def __init__(...):
    self._balance = ...
    Account._total_deposits = ...

acct1 = Account(1000)
acct2 = Account(10000)
acct1.deposit(300)
```

• Curved boxes are objects.
• Flat-bottomed boxes are class objects.
• ‘x.y’: look for ‘y’ starting at ‘x’
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).

```python
>>> def Value:
...     value = 0
... 
... val1 = Value()
>>> val2 = Value()
>>> val2.value = 3
>>> val1.value
0
>>> Value.value
0
>>> val2.value
3
```
Methods

• Consider

```python
>>> 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

```python
def partial_bind(obj, func): return lambda x: func(obj, x)
```