Announcements

• Project 2 due Thursday 10/9 @ 11:59pm

• Homework 5 due Wednesday 10/15 @ 11:59pm

• Special event on Tuesday 10/14 @ 7pm, John interviews Dropbox CEO/founder Drew Houston
  
  ▪ No video, so come to Wheeler
  
  ▪ Suggest questions and vote for your favorites at http://goo.gl/HtkXFf or on Piazza
Object-Oriented Programming
Object-Oriented Programming

A method for organizing modular programs

- Data abstraction
- Bundling together information and related behavior

A metaphor for computation using distributed state

- Each object has its own local state
- Each object also knows how to manage its own local state, based on method calls
- Method calls are messages passed between objects
- Several objects may all be instances of a common type
- Different types may relate to each other

Specialized syntax & vocabulary to support this metaphor

- Withdraw $10
- Deposit $10
- Apply for a loan!
A class serves as a template for its instances.

**Idea:** All bank accounts have a balance and an account holder; the Account class should add those attributes to each newly created instance.

```python
>>> a = Account('Jim')
>>> a.holder
'Jim'
>>> a.balance
0
```

**Idea:** All bank accounts should have "withdraw" and "deposit" behaviors that all work in the same way.

```python
>>> a.deposit(15)
15
>>> a.withdraw(10)
5
```

**Better idea:** All bank accounts share a "withdraw" method and a "deposit" method.

```python
>>> a = Account('Jim')
>>> a.holder
'Jim'
>>> a.balance
0
```

```python
>>> a.deposit(15)
15
>>> a.withdraw(10)
5
>>> a.balance
5
>>> a.withdraw(10)
'Insufficient funds'
```
Class Statements
The Class Statement

A class statement creates a new class and binds that class to `<name>` in the first frame of the current environment.

Assignment & def statements in `<suite>` create attributes of the class (not names in frames)

```python
>>> class Clown:
...     nose = 'big and red'
...     def dance():
...         return 'No thanks'
...     
>>> Clown.nose
'big and red'
>>> Clown.dance()
'No thanks'
>>> Clown
<class '__main__.Clown'>
```
Object Construction

Idea: All bank accounts have a balance and an account holder; the Account class should add those attributes to each of its instances.

```python
>>> a = Account('Jim')
>>> a.holder
'Jim'
>>> a.balance
0
```

When a class is called:

1. A new instance of that class is created:

2. The `__init__` method of the class is called with the new object as its first argument (named `self`), along with any additional arguments provided in the call expression.

```python
class Account:
    def __init__(self, account_holder):
        self.balance = 0
        self.holder = account_holder
```

_balance: 0  _holder: 'Jim'

__init__ is called a constructor
Object Identity

Every object that is an instance of a user-defined class has a unique identity:

```python
>>> a = Account('Jim')
>>> b = Account('Jack')
>>> a.balance
0
>>> b.holder
'Jack'
```

Identity operators "is" and "is not" test if two expressions evaluate to the same object:

```python
>>> a is a
True
>>> a is not b
True
```

Binding an object to a new name using assignment does not create a new object:

```python
>>> c = a
>>> c is a
True
```
Methods
Methods

Methods are functions defined in the suite of a class statement.

class Account:
    def __init__(self, account_holder):
        self.balance = 0
        self.holder = account_holder

def deposit(self, amount):
    self.balance = self.balance + amount
    return self.balance

def withdraw(self, amount):
    if amount > self.balance:
        return 'Insufficient funds'
    self.balance = self.balance - amount
    return self.balance

These def statements create function objects as always, but their names are bound as attributes of the class.

self should always be bound to an instance of the Account class.
Invoking Methods

All invoked methods have access to the object via the self parameter, and so they can all access and manipulate the object's state.

```python
class Account:
    ...
    def deposit(self, amount):
        self.balance = self.balance + amount
        return self.balance
```

Dot notation automatically supplies the first argument to a method.

```python
>>> tom_account = Account('Tom')
>>> tom_account.deposit(100)
100
```
Dot Expressions

Objects receive messages via dot notation.

Dot notation accesses attributes of the instance or its class.

<expression> . <name>

The <expression> can be any valid Python expression.

The <name> must be a simple name.

Evaluates to the value of the attribute looked up by <name> in the object that is the value of the <expression>.

tom_account.deposit(10)
Attributes
Accessing Attributes

Using `getattr`, we can look up an attribute using a string

```python
>>> getattr(tom_account, 'balance')
10
>>> hasattr(tom_account, 'deposit')
True
```

global `getattr` and dot expressions look up a name in the same way

Looking up an attribute name in an object may return:

• One of its instance attributes, or

• One of the attributes of its class
Methods and Functions

Python distinguishes between:

• Functions, which we have been creating since the beginning of the course, and
• Bound methods, which couple together a function and the object on which that method will be invoked.

Object + Function = Bound Method

```python
>>> type(Account.deposit)
<class 'function'>
>>> type(tom_account.deposit)
<class 'method'>
```

Function: all arguments within parentheses
Method: One object before the dot and other arguments within parentheses

```python
>>> Account.deposit(tom_account, 1001)
1011
>>> tom_account.deposit(1003)
2014
```
Looking Up Attributes by Name

To evaluate a dot expression:

1. Evaluate the `<expression>` to the left of the dot, which yields the object of the dot expression.

2. `<name>` is matched against the instance attributes of that object; if an attribute with that name exists, its value is returned.

3. If not, `<name>` is looked up in the class, which yields a class attribute value.

4. That value is returned unless it is a function, in which case a bound method is returned instead.
Class Attributes

Class attributes are "shared" across all instances of a class because they are attributes of the class, not the instance.

class Account:
    interest = 0.02  # A class attribute
    def __init__(self, account_holder):
        self.balance = 0
        self.holder = account_holder
    # Additional methods would be defined here

>>> tom_account = Account('Tom')
>>> jim_account = Account('Jim')
>>> tom_account.interest
0.02
>>> jim_account.interest
0.02

The interest attribute is not part of the instance; it's part of the class!
Attribute Assignment
Assignment Statements and Attributes

Assignment statements with a dot expression on their left-hand side affect attributes for the object of that dot expression

- If the object is an instance, then assignment sets an instance attribute
- If the object is a class, then assignment sets a class attribute

```python
>>> jim_account = Account('Jim')
>>> tom_account = Account('Tom')
>>> tom_account.interest = 0.02
>>> jim_account.interest
0.02
>>> jim_account.interest = 0.08
>>> Account.interest = 0.04
>>> tom_account.interest
0.04
>>> jim_account.interest
0.08
```