Python Classes & Objects
Object Oriented

• A program is made up of many cooperating objects

• Instead of being the “whole program” - each object is a little “island” within the program and cooperatively working with other objects.

• A program is made up of one or more objects working together - objects make use of each other’s capabilities
movies = list()
movie1 = dict()
movie1['Director'] = 'James Cameron'
movie1['Title'] = 'Avatar'
movie1['Release Date'] = '18 December 2009'
movie1['Running Time'] = '162 minutes'
movie1['Rating'] = 'PG-13'
movies.append(movie1)
movie2 = dict()
movie2['Director'] = 'David Fincher'
movie2['Title'] = 'The Social Network'
movie2['Release Date'] = '01 October 2010'
movie2['Running Time'] = '120 min'
movie2['Rating'] = 'PG-13'
movies.append(movie2)
keys = ['Title', 'Director', 'Rating', 'Running Time']

print '-----------'
print movies
print '-----------'
print keys

for item in movies:
    print '-----------'
    for key in keys:
        print key, ': ', item[key]

print '-----------'
Input

Objects get created and used

Output

Objects: create and use

Dictionary

String

Object

Object

Diagram: Input - Objects - Dictionary - String - Output

Diagram notes: 740.png
Input

Objects are bits of code and data

Output
Objects hide detail - they allow us to ignore the detail of the “rest of the program”.

Input

Code/Data

Code/Data

Code/Data

Output
Object

- An Object is a bit of self-contained Code and Data
- A key aspect of the Object approach is to break the problem into smaller understandable parts (divide and conquer)
- Objects have boundaries that allow us to ignore unnecessary detail
- We have been using objects all along: String Objects, Integer Objects, Dictionary Objects, List Objects...
Definitions

- **Class** - a template - Dog
- **Method or Message** - A defined capability of a class - bark()
- **Field or attribute** - A bit of data in a class - length
- **Object or Instance** - A particular instance of a class - Lassie
Terminology: Class

Defines the abstract characteristics of a thing (object), including the thing's characteristics (its attributes, fields or properties) and the thing's behaviors (the things it can do, or methods, operations or features). One might say that a class is a blueprint or factory that describes the nature of something. For example, the class Dog would consist of traits shared by all dogs, such as breed and fur color (characteristics), and the ability to bark and sit (behaviors).

Terminology: **Class**

A pattern (exemplar) of a **class**. The **class** of Dog defines all possible dogs by listing the characteristics and behaviors they can have; the object Lassie is one particular dog, with particular versions of the characteristics. A Dog has fur; Lassie has brown-and-white fur.

One can have an instance of a class or a particular object. The instance is the actual object created at runtime. In programmer jargon, the Lassie object is an instance of the Dog class. The set of values of the attributes of a particular object is called its state. The object consists of state and the behavior that's defined in the object's class.

Object and Instance are often used interchangeably.

An object's abilities. In language, methods are verbs. Lassie, being a Dog, has the ability to bark. So bark() is one of Lassie's methods. She may have other methods as well, for example sit() or eat() or walk() or save_timmy(). Within the program, using a method usually affects only one particular object; all Dogs can bark, but you need only one particular dog to do the barking.

Method and Message are often used interchangeably.

A Sample Class
class is a reserved word.

Each PartyAnimal object has a bit of code.

Tell the object to run the party() code.

This is the template for making PartyAnimal objects.

Each PartyAnimal object has a bit of data.

Create a PartyAnimal object.

PartyAnimal.party(an)

run party() *within* the object an

class PartyAnimal:
    x = 0

    def party(self):
        self.x = self.x + 1
        print "So far", self.x

an = PartyAnimal()

an.party()
an.party()
an.party()
```
class PartyAnimal:
    x = 0
    def party(self):
        self.x = self.x + 1
        print "So far", self.x

an = PartyAnimal()
an.party()
an.party()
an.party()
```

"self" is a formal argument that refers to the object itself.

self.x is saying "x within self"

self is "global within this object"
Playing with `dir()` and `type()`

A Nerdy Way to Find Capabilities

- The `dir()` command lists capabilities
- Ignore the ones with underscores - these are used by Python itself
- The rest are real operations that the object can perform
- It is like `type()` - it tells us something *about* a variable

```python
>>> x = list()
>>> type(x)
<type 'list'>
>>> dir(x)
['__add__', '__class__', '__contains__', '__delattr__', '__delitem__', '__delslice__', '__doc__', '__eq__', '__getattribute__', '__getitem__', '__getslice__', '__gt__', '__hash__', '__init__', '__init_subclass__', '__iter__', '__le__', '__len__', '__lt__', '__add__', 'append', 'count', 'extend', 'index', 'insert', 'pop', 'remove', 'reverse', 'sort']
```

```python
```
Try dir() with a String

```python
>>> y = "Hello there"
>>> dir(y)
['__add__', '__class__', '__contains__', '__delattr__', '__doc__',
 '__eq__', '__ge__', '__getattribute__', '__getitem__',
 '__getnewargs__', '__getslice__', '__gt__', '__hash__', '__init__',
 '__le__', '__len__', '__lt__', '__repr__', '__rmod__', '__rmul__',
 '__setattr__', '__str__', 'capitalize', 'center', 'count', 'decode',
 'encode', 'endswith', 'expandtabs', 'find', 'index', 'isalnum',
 'isalpha', 'isdigit', 'islower', 'isspace', 'istitle', 'isupper',
 'join', 'ljust', 'lower', 'lstrip', 'partition', 'replace', 'rfind',
 'rindex', 'rjust', 'rpartition', 'rsplit', 'rstrip', 'split',
 'splitlines', 'startswith', 'strip', 'swapcase', 'title',
 'translate', 'upper', 'zfill']
```
class PartyAnimal:
    x = 0

    def party(self):
        self.x = self.x + 1
        print "So far", self.x

an = PartyAnimal()

print "Type", type(an)
print "Dir ", dir(an)

$ python party2.py
Type <type 'instance'>
Dir ['__doc__', '__module__', 'party', 'x']
What Are Classes Useful For?

• Recall the midterm problem asking for a data structure for a person with: ID, first & last name, and salary?

• How could we use a Python class for this?
Object Lifecycle

- Objects are created, used and discarded
- We have special blocks of code (methods) that get called
  - At the moment of creation (constructor)
  - At the moment of destruction (destructor)
- Constructors are used a lot
- Destructors are seldom used
The primary purpose of the constructor is to set up some instance variables to have the proper initial values when the object is created.
class PartyAnimal:
    x = 0

    def __init__(self):
        print "I am constructed"
    
    def party(self):
        self.x = self.x + 1
        print "So far", self.x

    def __del__(self):
        print "I am destructed", self.x

an = PartyAnimal()
an.party()
an.party()
an.party()
an.party()
In object oriented programming, a constructor in a class is a special block of statements called when an object is created.

http://en.wikipedia.org/wiki/Constructor_(computer_science)
Many Instances

- We can create lots of objects - the class is the template for the object
- We can store each distinct object in its own variable
- We call this having multiple instances of the same class
- Each instance has its own copy of the instance variables
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
        self.name = nam
        print self.name, "constructed"
    def party(self):
        self.x = self.x + 1
        print self.name, "party count", self.x

s = PartyAnimal("Sally")
s.party()

j = PartyAnimal("Jim")
j.party()
s.party()

Constructors can have additional parameters. These can be used to set up instance variables for the particular instance of the class (i.e., for the particular object).

Let’s See What Happens When These Are Evaluated
Definitions

- **Class** - a template - Dog
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- **Object or Instance** - A particular instance of a class - Lassie
- **Constructor** - A method which is called when the instance / object is created
Inheritance

- When we make a new class - we can reuse an existing class and **inherit** all the capabilities of an existing class and then add our own little bit to make our new class
- Another form of store and reuse
- Write once - reuse many times
- The new class (child) has all the capabilities of the old class (parent) - and then some more
Terminology: Inheritance

‘Subclasses’ are more specialized versions of a class, which inherit attributes and behaviors from their parent classes, and can introduce their own.

class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
        self.name = nam
        print self.name, "constructed"

    def party(self):
        self.x = self.x + 1
        print self.name, "party count", self.x

class FootballFan(PartyAnimal):
    points = 0
    def touchdown(self):
        self.points = self.points + 7
        self.party()
        print self.name, "points", self.points

s = PartyAnimal("Sally")
s.party()

j = FootballFan("Jim")
j.party()
j.touchdown()
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
        self.name = nam
        print self.name,"constructed"

    def party(self):
        self.x = self.x + 1
        print self.name,"party count",self.x

class FootballFan(PartyAnimal):
    points = 0
    def touchdown(self):
        self.points = self.points + 7
        self.party()
        print self.name,"points",self.points

s = PartyAnimal("Sally")
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class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
        self.name = nam
        print self.name,"constructed"

    def party(self):
        self.x = self.x + 1
        print self.name,"party count",self.x

class FootballFan(PartyAnimal):
    points = 0
    def touchdown(self):
        self.points = self.points + 7
        self.party()
        print self.name,"points",self.points

s = PartyAnimal("Sally")
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j.party()
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Definitions

- **Class** - a template - Dog
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- **Constructor** - A method which is called when the instance / object is created
- **Inheritance** - the ability to take a class and extend it to make a new class.
Summary

• Object Oriented programming is a very structured approach to code reuse.
• We can group data and functionality together and create many independent instances of a class