Introduction to Python
More OO – Decorators and Generators

Christopher Barker

UW Continuing Education / Isilon

August 08, 2012

Table of Contents

Lightning Talks

Lightning Talks today:

Brett and Jeffery

Review of Previous Class

- Really Quick OO overview
- Built an html generator, using:
  - A base class with a couple methods
  - Subclasses overriding class attributes
  - Subclasses overriding a method
  - Subclasses overriding the `__init__`

Homework review

Homework notes

Did anyone make classes for a real project?

How many of you finished the html building code from last class?

multiple inheritance

Multiple inheritance:
Pulling from more than one class

```
class Combined(Super1, Super2, Super3):
    def __init__(self, something, something else):
        Super1.__init__(self, ......)
        Super2.__init__(self, ......)
        Super3.__init__(self, ......)
```

(calls to the super class `__init__` are optional – case dependent)

multiple inheritance

Attribute resolution – left to right

1. Is it an instance attribute ?
2. Is it a class attribute ?
3. Is it a superclass attribute ?
    1. is the it an attribute of the left-most superclass?
    2. is the it an attribute of the next superclass?
    3. ....
4. Is it a super-superclass attribute ?
5. ...also left to right...

mix-ins

Why would you want to do this?

Hierarchies are not always simple:

- Animal
  - Mammal
    - GiveBirth()
  - Bird
    - LayEggs()

Where do you put a Platypus or an Armadillo?

Real World Example: `FloatCanvas`

LAB

Last class: Step 6:

- Create an `A` class for an anchor (link) element. Its constructor should look like: `A(self, link, content)` – where link is the link, and content is what you see. It can be called like so: `A("http://google.com", "link")`
- You should be able to subclass from `Element`, and only override the `__init__`
  – Calling the `Element __init__` from the `A __init__`

You can now add a link to your web page.

LAB

Last class: Step 7:

- Create `Ul` class for an unordered list (really simple subclass of Element)
- Create `Li` class for an element in a list (also really simple)
- add a list to your web page.
- Create a Header class – this one should take an integer argument for the header level. i.e `<h1>`, `<h2>`, `<h3>`, called like:
- `H(2, "The text of the header")` for an `<h2>` header
- It can subclass from `OneLineTag` – overriding the `__init__`, then calling the superclass `__init__`

LAB

Last class Step 8:

- Update the Html element class to render the "`<!DOCTYPE html>`" tag at the head of the page, before the `html` element.
- You can do this by subclassing `Element`, overriding `render()`, but then calling `Element.render()` from `Html.render()`.
- Create a subclass of `SelfClosingTag` for `<meta charset="UTF-8" />` and add the meta element to the beginning of the head element to give your document an encoding.
- The doctype and encoding are HTML 5 and you can check this at: `validator.w3.org`.

You now have a pretty full-featured html renderer

Lightning Talk

Lightning Talk:

Brett

Accessing Attributes

One of the strengths of Python is lack of clutter

Simple attributes:

```
In [5]: class C(object):
            def __init__(self):
                self.x = 5
In [6]: c = C()
In [7]: c.x
Out[7]: 5
In [8]: c.x = 8
```

Getter and Setters?

What if you need to add behavior later?

- do some calculation
- check data validity
- keep things in sync

Getter and Setters?

```
class C(object):
    def get_x(self):
        return self.x
    def set_x(self, x):
        self.x = x
>>> c = C()
>>> c.get_x()
>>> 5
>>> c.set_x(8)
>>> c.get_x()
>>> 8
```

Ugly and verbose – Java?

http://dirtsimple.org/2004/12/python-is-not-java.html

properties

When (and if) you need them:

```
class C(object):
    def getx(self):
        return self._x
    def setx(self, value):
        self._x = value
    def delx(self):
        del self._x
    x = property(getx, setx, delx, "docstring")
```

Interface is still like simple attribute access
(`properties_sample.py`)

properties

When (and if) you need them:

```
class C(object):
    def getx(self):
        return self._x
    def setx(self, value):
        self._x = value
    def delx(self):
        del self._x
    x = property(getx, setx, delx, "docstring")
```

Interface is still like simple attribute access
(`properties_sample.py`)

staticmethod

A method that doesn't get self!

```
class C(object):
    def add(a, b):
        return a + b
    add = staticmethod(add)
>>> C.add(3,4)
7
>>> c = C()
>>> c.add(2, 2)
4
```

When you don't need self – can be used from either an instance or the class itself

see: `static_method.py`

classmethod

Method gets the class object, rather than an instance the first argument

```
class C(object):
    def __init__(self, x, y):
        self.x = x
        self.y = y
    def a_class_method(klass, y):
        print "in a_class_method", klass
        return klass( y, y**2 )
    a_class_method = classmethod(a_class_method)
```

When you need the class object rather than an instance – plays well with subclassing

see: `class_method.py`

dict.fromkeys()

`classmethod` often used for alternate constructors:

```
>>> d = dict([1,2,3])
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: cannot convert dictionary update
sequence element #0 to a sequence
>>> d = dict.fromkeys([1,2,3])
>>> d
{1: None, 2: None, 3: None}
```

dict.fromkeys()

```
class Dict: ...
    def fromkeys(klass, iterable, value=None):
        "Emulate dict_fromkeys() in dictobject.c"
        d = klass()
        for key in iterable:
            d[key] = value
        return d
    fromkeys = classmethod(fromkeys)
```

See also datetime.datetime.now(), etc....

For a low-level look:
http://docs.python.org/howto/descriptor.html

super

getting the superclass:

```
class SafeVehicle(Vehicle):
    """
    Safe Vehicle subclass of Vehicle base class...
    """
    def __init__(self, position=0, velocity=0, icon='S'):
        Vehicle.__init__(self, position, velocity, icon)
```

not DRY

also, what if we had a bunch of references to superclass?

super

getting the superclass:

```
class SafeVehicle(Vehicle):
    """
    Safe Vehicle subclass of Vehicle base class
    """
    def __init__(self, position=0, velocity=0, icon='S'):
        super(SafeVehicle, self).__init__(position, velocit
```

"super() considered super!" by Raymond Hettinger

http://rhettinger.wordpress.com/2011/05/26/super-considered-super/

special methods

Python's Duck typing:

Defining special (or magic) methods in your classes is how you make your class act like standard classes

special methods

We've seen at least one:

`__init__`

it's all in the double underscores...

Pronounced "dunder" (or "under-under")

try: `dir(2)` or `dir(list)`

special methods

Emulating Numeric types

```
object.__add__(self, other)
object.__sub__(self, other)
object.__mul__(self, other)
object.__floordiv__(self, other)
object.__mod__(self, other)
object.__divmod__(self, other)
object.__pow__(self, other[, modulo])
object.__lshift__(self, other)
object.__rshift__(self, other)
object.__and__(self, other)
object.__xor__(self, other)
object.__or__(self, other)
```

special methods

Emulating container types:

```
object.__len__(self)
object.__getitem__(self, key)
object.__setitem__(self, key, value)
object.__delitem__(self, key)
object.__iter__(self)
object.__reversed__(self)
object.__contains__(self, item)
object.__getslice__(self, i, j)
object.__setslice__(self, i, j, sequence)
object.__delslice__(self, i, j)
```

special methods

You get the idea...

You only need to define the ones that are going to get used

but you probably want to define at least these:

`object.__str__`: Called by the str() built-in function and by the print statement to compute the informal string representation of an object.

`object.__repr__`: Called by the repr() built-in function and by string conversions (reverse quotes) to compute the official string representation of an object.

special methods

When you want your class to act like a "standard" class in some way:

Look up the magic methods you need and define them

`http://docs.python.org/reference/datamodel.html#special-method-names`

`http://www.rafekettler.com/magicmethods.html`

LAB

Write a "Circle" class:

```
>> c = Circle(radius = 4)

>> c.radius = 3
>> c.diameter
6
>> c.diameter = 8
>> c.radius
4
>> c.area
50.26548245743669
```

Use properties so you can keep the radius and diameter in sync

Lightning Talk

Lightning Talk:

Jeffery

Iterators

Iterators are one of the main reasons Python code is so readable:

```
for x in just_about_anything:
    do_stuff(x)
```

you can loop through anything that satisfies the iterator protocol

`http://docs.python.org/library/stdtypes.html#iterator-types`

Iterator Protocol

An iterator must have the following methods:

`iterator.__iter__()`

Return the iterator object itself. This is required to allow both containers and iterators to be used with the for and in statements.

`iterator.next()`

Return the next item from the container. If there are no further items, raise the StopIteration exception.

Example Iterator

```
class IterateMe_1(object):
    def __init__(self, stop=5):
        self.current = 0
        self.stop = 5
    def __iter__(self):
        return self
    def next(self):
        if self.current < self.stop:
            self.current += 1
            return self.current
        else:
            raise StopIteration
```

This is a simple version of `xrange()`

itertools

`itertools` is a collection of utilities that make it easy to build an iterator that iterates over sequences in various common ways

`http://docs.python.org/library/itertools.html`

LAB

- Extend (`iterator_1.py`) to be more like `xrange()` – add three input parameters:
  `iterator_2(start, stop, step=1)`
- See what happens if you break out in the middle of the loop:

```
it = IterateMe_2(2, 20, 2)
for i in it:
    if i > 10:  break
    print i
```

  And then pick up again:

```
for i in it:
    print i
```

- Does `xrange()` behave the same?
  – make yours match `xrange()`.

generators

Generators give you the iterator immediately no access to the underlying data ... if it even exists

Conceptually:
iterators are about various ways to loop over data, generators generate the data on the fly

Practically:
You can use either either way (and a generator is one type of iterator)
Generators do some of the book-keeping for you.

yield

`yield` is a way to make a quickie generator with a function:

```
def a_generator_function(params):
    some_stuff
    yield(something)
```

Generator functions "yield" a value, rather than returning it

State is preserved in between yields

yield

A function with `yield` in it is a "factory" for a generator
Each time you call it, you get a new generator:

```
gen_a = a_generator()
gen_b = a_generator()
```

Each instance keeps its own state.

Really just a shorthand for an iterator class that does the book keeping for you.

yield

An example: like `xrange()`

```
def y_xrange(start, stop, step=1):
    i = start
    while i < stop:
        yield i
        i += step
```

Real World Example: `FloatCanvas`

yield

Note:

```
In [164]: gen = y_xrange(2,6)

In [165]: type(gen)
Out[165]: generator

In [166]: dir(gen)
Out[166]:
...
 '__iter__',
...
 'next',
```

So the generator **is** an iterator

yield

A generator function can also be a method in a class

More about iterators and generators:
`http://www.learningpython.com/2009/02/23/iterators-iterables-and-generators-oh-my/`

`yield_example.py`

generator comprehension

another way to make a generator:

```
>>> [x * 2 for x in [1, 2, 3]]
[2, 4, 6]
>>> (x * 2 for x in [1, 2, 3])
<generator object <genexpr> at 0x10911bf50>
>>> for n in (x * 2 for x in [1, 2, 3]):
...     print n
... 2 4 6
```

More interesting if [1, 2, 3] is also a generator

LAB

generator lab

Homework

Pickup from last week – For a portion of the system you're responsible for testing:

- Make a few classes to represent that portion. (No more than three or four classes)
- Try to make use or something from today:
  - mix-ins
  - properties
  - Magic methods
  - iterator or generator