



Modules & Objects

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Namespaces

As the Zen of Python says:

“Namespaces are one honking great idea—
let's do more of those!”

Namespaces

- * make code reuse possible
- * are a prerequisite for clean module system

The `import` statement brings in functionality from another module, usually in a new namespace

The `.` operator marks the symbol on the right to be from the namespace on the left: `owner.thing`

Modules

```
# helpers.py

def spam(x):
    return '{0}, {0}, {0}, {1} and {0}.'.format('spam', x)

N_A = 6.02214e+23
```

```
# work1.py

import helpers

print helpers.N_A
print helpers.spam('eggs')
```

```
# work2.py

import helpers as h

print h.N_A
print h.spam('eggs')
```

```
# work3.py

from helpers import *

print N_A
print spam('eggs')
```

```
# work4.py

from helpers import N_A as L, spam as foo

print L
print foo('eggs')
```

Modules

```
# helpers.py

def spam(x):
    return '{0}, {0}, {0}, {1} and {0}.'.format('spam', x)

N_A = 6.02214e+23
```

```
# work1.py

import helpers

print helpers.N_A
print helpers.spam
```

```
>>> import helpers
>>> dir(helpers)
[... , 'N_A', 'spam']
```

```
helpers as h
N_A
print h.spam('eggs')
```

```
# work3.py

from helpers import *

print N_A
print spam('eggs')
```

```
# work4.py

from helpers import N_A as L, spam as foo

print L
print foo('eggs')
```

Packages

Organize modules hierarchically:

```
sound/
  __init__.py
  formats/
    __init__.py
    wavread.py
    wavwrite.py
    aiffread.py
    aiffwrite.py
    auread.py
    auwrite.py
    ...
  effects/
    __init__.py
    echo.py
    surround.py
    reverse.py
    ...
  filters/
    __init__.py
    equalizer.py
    vocoder.py
    karaoke.py
    ...
```

Top-level package
Initialize the sound package
Subpackage for file format conversions

Subpackage for sound effects

Subpackage for filters

Packages

Organize modules hierarchically:

```
sound/  
  __init__.py  
  formats/  
    __init__.py  
    wavread.py  
    wavwrite.py  
    aiffread.py  
    aiffwrite.py  
    auread.py  
    auwrite.py  
    ...  
  effects/  
    __init__.py  
    echo.py  
    surround.py  
    reverse.py  
    ...  
  filters/  
    __init__.py  
    equalizer.py  
    vocoder.py  
    karaoke.py  
    ...
```

Top-level package
Initialize the sound package
Subpackage for file format conversions

```
import sound.effects as se  
  
from sound.effects import echo  
  
from sound.effects.echo import echofilter
```

Subpackage for filters

Module use

Flexible name remapping at import time allows this powerful idiom for optional libraries:

```
try:
    from fastlib import xyz as foo
except ImportError:
    from slowlib import abc as foo

foo('something', 3, 4)
```

different func names,
same argument order

```
try:
    from fastlib import xyz as foo
except ImportError:
    from slowlib import abc as _abc
    def foo(x,y,z): return _abc(z,x,y)

foo('something', 3, 4)
```

different func names,
different arg order



Classes

```
class TVseries(object):  
  
    def __init__(self, name, eps):  
        self.name = name  
        self.eps_per_s = eps  
  
    def status(self):  
        text = '{} has {} episodes per season.'  
        return text.format(self.name, self.eps_per_s)
```

```
bbt = TVseries('Big Bang Theory', 24)  
gf  = TVseries('Gravity Falls', 20)  
  
print bbt.name  
print bbt.status()  
print  
print gf.name  
print gf.status()  
  
print dir(bbt)
```



Classes

```
class TVseries(object):  
  
    def __init__(self, name, eps):           initialization (constructor)  
        self.name = name                   member variables (attributes)  
        self.eps_per_s = eps  
  
    def status(self):                       member function (method)  
        text = '{} has {} episodes per season.'  
        return text.format(self.name, self.eps_per_s)
```

```
bbt = TVseries('Big Bang Theory', 24)  
gf  = TVseries('Gravity Falls', 20)  
  
print bbt.name  
print bbt.status()  
print  
print gf.name  
print gf.status()  
  
print dir(bbt)
```



Classes

```
class TVseries(object):  
  
    def __init__(self, name, eps):           initialization (constructor)  
        self.name = name                   member variables (attributes)  
        self.eps_per_s = eps  
  
    def status(self):                       member function (method)  
        text = '{} has {} episodes per season.'  
        return text.format(self.name, self.eps_per_s)
```

```
bbt = TVseries('Big Bang Theory', 24)  
gf  = TVseries('Gravity Falls', 20)  
  
print bbt.name  
print bbt.status()           parallel to module usage!  
print  
print gf.name  
print gf.status()  
  
print dir(bbt)
```



Methods

```
class TVseries(object):  
  
    def __init__(self, name, eps):  
        self.name = name  
        self.eps_per_s = eps  
        self.num_watched = 0  
  
    def seen(self, num=1):  
        self.num_watched += num  
  
    def status(self):  
        text = '{} has {} episodes per season. I saw {} of them.'  
        return text.format(self.name, self.eps_per_s, self.num_watched)
```

```
bbt = TVseries('Big Bang Theory', 24)  
gf  = TVseries('Gravity Falls', 20)  
  
print bbt.name  
bbt.seen(4)  
print bbt.status()  
print  
print gf.name  
gf.seen()  
print gf.status()  
  
print dir(bbt)
```



Built-in methods

```
class TVseries(object):  
  
    def __init__(self, name, eps):  
        self.name = name  
        self.eps_per_s = eps  
        self.num_watched = 0  
  
    def seen(self, num=1):  
        self.num_watched += num  
  
    def __str__(self):  
        text = '{} has {} episodes per season. I saw {} of them.'  
        return text.format(self.name, self.eps_per_s, self.num_watched)
```

```
bbt = TVseries('Big Bang Theory', 24)  
gf  = TVseries('Gravity Falls', 20)  
  
print bbt.name  
bbt.seen(4)  
print bbt  
print  
print gf.name  
got.seen()  
print gf  
  
print dir(bbt)
```



Inheritance

```
class Foo(object):
    def hello(self):
        print "Hello! Foo here."

    def bye(self):
        print "Bye bye from Foo!"

class Bar(Foo):
    def hello(self):
        print "Hello! Bar here."
```

```
>>> f = Foo()
>>> f.hello()
Hello! Foo here.
>>> f.bye()
Bye bye from Foo!
>>>
>>> b = Bar()
>>> b.hello()
Hello! Bar here.
>>> b.bye()
Bye bye from Foo!
```

Accessor methods

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y
```

```
>>> p = Point(2,2)  
>>> p.x, p.y  
(2, 2)  
>>> p.x = 5  
>>> p.x, p.y  
(5, 2)
```

Would like polar coordinates, too.

Accessor methods

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y
```

```
>>> p = Point(2,2)  
>>> p.x, p.y  
(2, 2)  
>>> p.x = 5  
>>> p.x, p.y  
(5, 2)
```

Would like polar coordinates, too.

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y  
        self.r = sqrt(x**2 + y**2)  
        self.phi = atan2(y,x)
```

```
>>> p = Point(3,4)  
>>> p.x, p.y  
(3, 4)  
>>> p.r, p.phi  
(5.0, 0.9272952)
```


Accessor methods

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y
```

```
>>> p = Point(2,2)  
>>> p.x, p.y  
(2, 2)  
>>> p.x = 5  
>>> p.x, p.y  
(5, 2)
```

Would like polar coordinates, too.

```
from math import sqrt, atan2
```

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y  
        self.r = sqrt(x**2 + y**2)  
        self.phi = atan2(y,x)
```

```
>>> p = Point(3,4)  
>>> p.x, p.y  
(3, 4)  
>>> p.r, p.phi  
(5.0, 0.9272952)
```

Accessor methods

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y
```

```
>>> p = Point(2,2)
>>> p.x, p.y
(2, 2)
>>> p.x = 5
>>> p.x, p.y
(5, 2)
```

Would like polar coordinates, too.

```
from math import sqrt, atan2
```

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y
        self.r = sqrt(x**2 + y**2)
        self.phi = atan2(y,x)
```

```
>>> p = Point(3,4)
>>> p.x, p.y
(3, 4)
>>> p.r, p.phi
(5.0, 0.9272952)
```

But need to avoid inconsistent state!

```
>>> p.r = 10 # Noooo!
```

Accessor methods

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y
```

```
>>> p = Point(2,2)  
>>> p.x, p.y  
(2, 2)  
>>> p.x = 5  
>>> p.x, p.y  
(5, 2)
```

Try again:

```
class Point(object):  
    def __init__(self, x=0, y=0):  
        self.x = x  
        self.y = y  
  
    def r(self):  
        return sqrt(self.x**2 + self.y**2)  
  
    def phi(self):  
        return atan2(self.y, self.x)
```

Accessor methods

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y
```

```
>>> p = Point(2,2)
>>> p.x, p.y
(2, 2)
>>> p.x = 5
>>> p.x, p.y
(5, 2)
```

Try again:

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y

    def r(self):
        return sqrt(self.x**2 + self.y**2)

    def phi(self):
        return atan2(self.y, self.x)
```

```
>>> p = Point(3,4)
>>> p.x, p.y
(3, 4)
>>> p.r(), p.phi()
(5.0, 0.9272952)
```

Safe, but asymmetric:



Accessor methods

Solution: property decorators

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y

    @property
    def r(self):
        return sqrt(self.x**2 + self.y**2)

    @property
    def phi(self):
        return atan2(self.y, self.x)
```

```
>>> p = Point(3,4)
>>> p.x, p.y
(3, 4)
>>> p.r, p.phi
(5.0, 0.9272952)
```



Accessor methods

Solution: property decorators

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y

    @property
    def r(self):
        return sqrt(self.x**2 + self.y**2)

    @property
    def phi(self):
        return atan2(self.y, self.x)
```

```
>>> p = Point(3,4)
>>> p.x, p.y
(3, 4)
>>> p.r, p.phi
(5.0, 0.9272952)
```

Not quite symmetric.
Assignment still missing!

```
>>> p.r = 10
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: can't set attribute
```

Accessor methods

Property decorators with assignment

```
class Point(object):
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y

    @property
    def r(self):
        return sqrt(self.x**2 + self.y**2)

    @r.setter
    def r(self, r_new):
        r_old = self.r
        scale = r_new / r_old
        self.x *= scale
        self.y *= scale

    @property
    def phi(self):
        return atan2(self.y, self.x)
```

```
>>> p = Point(3,4)
>>> p.x,p.y
(3, 4)
>>> p.r,p.phi
(5.0, 0.9272952)
>>> p.r = 10
>>> p.r,p.phi
(10.0, 0.9272952)
>>> p.x,p.y
(6.0, 8.0)
```



Copying behaviour

```
class Test(object):
    def __init__(self):
        self.val = 5          # immutable
        self.list = [5,6,7] # mutable
```

```
>>> a = Test()
>>> b = a

>>> a.val, b.val
(5, 5)

>>> a.val = 7
>>> a.val, b.val
(7, 7)

>>> a.list, b.list
([5, 6, 7], [5, 6, 7])

>>> a.list.append(999)
>>> a.list, b.list
([5, 6, 7, 999], [5, 6, 7, 999])

>>> a.list = 'Hello'
>>> a.list, b.list
('Hello', 'Hello')
```


Copying behaviour

```
>>> from copy import copy, deepcopy

>>> a = Test()
>>> b = a
>>> c = copy(a)
>>> d = deepcopy(a)

>>> a.val, b.val, c.val, d.val
(5,          5,          5,          5)

>>> a.val = 7
>>> a.val, b.val, c.val, d.val
(7,          7,          5,          5)

>>> a.list, b.list, c.list, d.list
([5, 6, 7],  [5, 6, 7],  [5, 6, 7],  [5, 6, 7])

>>> a.list.append(999)
>>> a.list[0] = 0
>>> a.list, b.list, c.list, d.list
([0, 6, 7, 999], [0, 6, 7, 999], [0, 6, 7, 999], [5, 6, 7])

>>> a.list = 'Hello'
>>> a.list, b.list, c.list, d.list
('Hello',      'Hello',      [0, 6, 7, 999], [5, 6, 7])
```