DP and OOP in Python

Objects by Design

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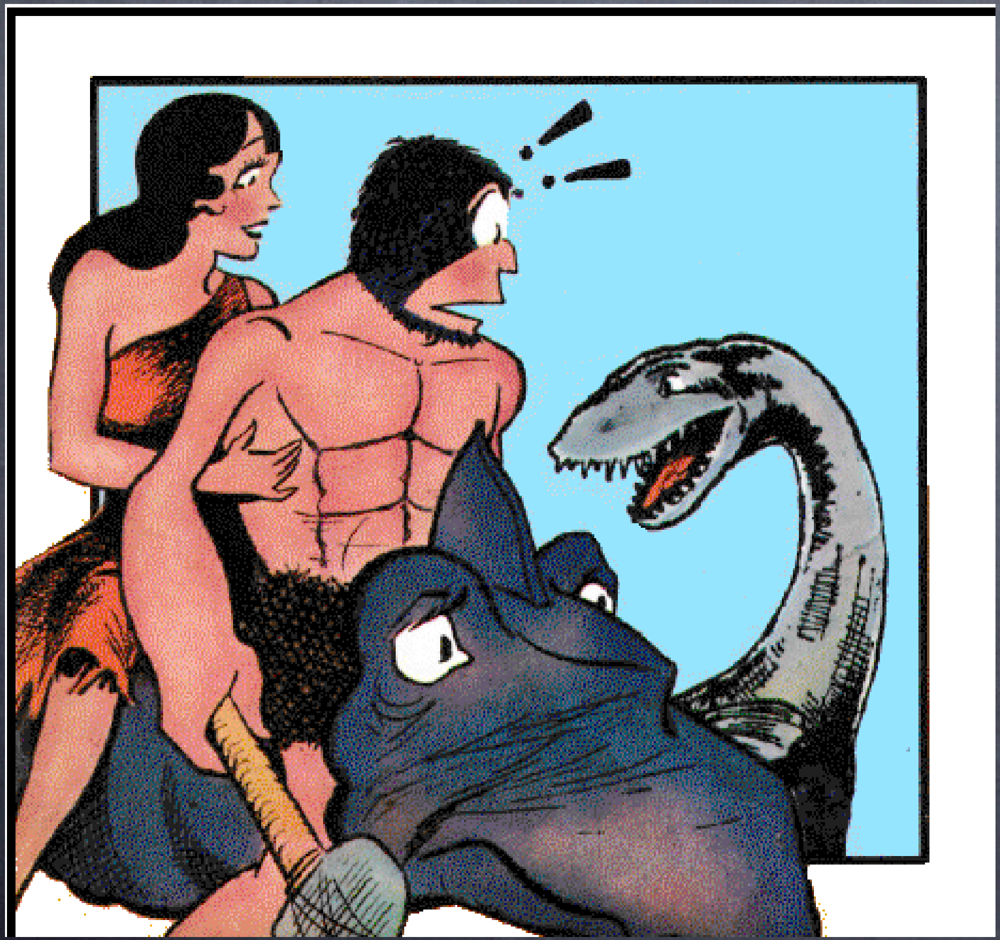
What's OOP?

I dunno -- what's OOP with you?



Alley Oop...?

OOP as delegation

- intrinsic/implicit:
  - instance -> class
  - class -> descriptors
  - class -> base classes
- overt/explicit:
  - containment and delegation (hold/wrap)
  - delegation to self
- inheritance: more rigid; IS-A...
- hold/wrap: more flexibile; USES-A...

Pydioms: hold vs wrap

- “Hold”: object O has subobject S as an attribute (maybe property) -- that’s all
  - use self.S.method or O.S.method
  - simple, direct, immediate, but coupling on the wrong axis
- “Wrap”: hold (often via private name) plus delegation (so you use O.method)
  - explicit (def method(self...)...self.S.method)
  - automatic (delegation in __getattr__)
  - gets coupling right (Law of Demeter)

Wrapping to restrict

```
class RestrictingWrapper(object):
  def __init__(self, w, block):
    self._w = w
    self._block = block
  def __getattr__(self, n):
    if n in self._block:
      raise AttributeError, n
    return getattr(self._w, n)
  ...
```

Inheritance cannot restrict!
However...: what about <u>special</u> methods?

Self-delegation == TMDP

- Template Method design pattern
- great pattern, lousy name
  - way overloaded
- classic version:
  - abstract base's organizing method...
  - ...calls hook methods of subclasses
  - client code calls OM on instances
- mixin version:
  - mixin base's OM, concrete classes' hooks

TMDP in Queue.Queue

```
class Queue:
  ...
  def put(self, item):
    self.not_full.acquire()
    try:
      while self._full():
        self.not_full.wait()
      self._put(item)
      self.not_empty.notify()
    finally:
      self.not_full.release()
  def _put(self, item):
    self.queue.append(item)
  ...
```

Queue's TMDP

- Not abstract, often used as-is
  - so, must implement all hook-methods
- subclass can customize queueing discipline
  - with no worry about locking, timing, ...
  - default discipline is simple, useful FIFO
  - could override hook methods (_init, _qsize, _empty, _full, _put, _get) AND...
  - ...data (maxsize, queue), a Python special

Customizing Queue

```
class LifoQueueA(Queue):
  def _put(self, item):
    self.queue.appendleft(item)

class LifoQueueB(Queue):
  def _init(self, maxsize):
    self.maxsize = maxsize
    self.queue = list()
  def _get(self):
    return self.queue.pop()
```

DictMixin's TMDP

- Abstract, meant to multiply-inherit from
  - does not implement hook-methods
- subclass must supply needed hook-methods
  - at least __getitem__, keys
  - if R/W, also __setitem__, __delitem__
  - normally __init__, copy
  - may override more (for performance)

Exploiting DictMixin

```
class Chainmap(UserDict.DictMixin):
  def __init__(self, mappings):
    self._maps = mappings
  def __getitem__(self, key):
    for m in self._maps:
      try: return m[key]
      except KeyError: pass
    raise KeyError, key
  def keys(self):
    keys = set()
    for m in self._maps:
      keys.update(m)
    return list(keys)
```

State and Strategy DPs

- Not unlike a "Factored-out" TMDP
  - OM in one class, hooks in others
  - OM calls self.somedelegate.dosomehook()
- classic vision:
  - Strategy: 1 abstract class per decision, factors out object behavior
  - State: fully encapsulated, strongly coupled to Context, self-modifying
- Python: can switch __class__, methods

Strategy DP

```
class Calculator(object):
  def __init__(self):
    self.strat=Show()
  def compute(self, expr):
    res = eval(expr)
    self.strat.show('%r=%r'% (expr, res))
  def setVerb(self, quiet=False):
    if quiet: self.strat = Quiet()
    else: self.strat = Show()
class Show(object):
  def show(self, s): print s
class Quiet(Show):
  def show(self, s): pass
```

State DP

```
class Calculator(object):
  def __init__(self): self.state=Show()
  def compute(self, expr):
    res = eval(expr)
    self.state.show('%r=%r'% (expr, res))
  def setVerb(self, quiet=False):
    self.state.setVerb(self, quiet)
class Show(object):
  def show(self, s): print s
  def setVerb(self, obj, quiet):
    if quiet: obj.state = Quiet()
    else: obj.state = Show()
class Quiet(Show):
  def show(self, s): pass
```

Switching __class__

```
class RingBuffer(object):
  class _Full(object):
    def append(self, item):
      self.d[self.c] = item
      self.c = (1+self.c) % MAX
    def tolist(slf):
      return slf.d[slf.c:]+slf.d[:slf.c]
  def __init__(self): self.d = []
  def append(self, item):
    self.d.append(item)
    if len(self.d) == MAX:
      self.c = 0
      self.__class__ = self._Full
  def tolist(self): return list(self.d)
```

Switching a method

```
class RingBuffer(object):
  def __init__(self): self.d = []
  def append_full(self, item):
    self.d.append(item)
    self.d.pop()
  def append(self, item):
    self.d.append(item)
    if len(self.d) == MAX:
      self.c = 0
      self.__class__ = self._Full
  def tolist(self): return list(self.d)
```

OOP for polymorphism

- intrinsic/implicit/classic:
  - inheritance (single/multiple)
- overt/explicit/pythonic:
  - adaptation and masquerading DPs
  - special-method overloading
  - advanced control of attribute access
  - custom descriptors and metaclasses

Python's polymorphism

- ...is notoriously based on duck typing...:

"Dear Farmer Brown,
The pond is quite boring.
We'd like a diving board.

Sincerely,
The Ducks."

Click, clack, quack. Click, clack, quack.
Clickety, clack, quack.

(why a duck?)

Restricting attributes

```
class Rats(object):
  def __setattr__(self, n, v):
    if not hasattr(self, n):
      raise AttributeError, n
    super(Rats, self).__setattr__(n, v)
```

affords uses such as:

```
class Foo(Rats):
  bar, baz = 1, 2
```

so no new attributes can later be bound.
None of __slots__'s issues (inheritance &c)!

So, __slots__ or Rats?

- `__slots__` strictly, only to save memory
  - classes with LOTS of tiny instances
- Rats (& the like) for everything else
  - (if needed at all... remember *AGNI*!)

class instance as module

```
class _const(object):
  class ConstError(TypeError): pass
  def __setattr__(self, n, v):
    if n in self.__dict__:
      raise self.ConstError, n
    super(_const, self).__setattr__(n, v)
import sys
sys.module[__name__] = _const()
```

specials come from class

```
def restrictingWrapper(w, block):
  class c(RestrictingWrapper): pass
  for n, v in get_ok_specials(w, block):
    def mm(n, v):
      def m(self, *a, **k):
        return v(self._w, *a, **k)
      return m
    setattr(c, n, mm(n, v))
  return c(w, block)
def get_ok_specials(w, block):
  'use inspect's getmembers and
  ismethoddescriptor, skip nonspecial
  names, ones in block, ones already in
  RestrictingWrapper, __getattribute__'
```

get_ok_specials details

```
import inspect as i
def get_ok_specials(w, block):
  for n, v in i.getmembers(
      w.__class__, i.ismethoddescriptor):
    if (n[:2] != '__' or n[-2:] != '__'
       or n in block or
       n == '__getattribute__' or
       n in RestrictingWrapper.__dict__):
      continue
    yield n, v
```

Null Object DP

- instead of None, an object "innocuously polymorphic" with any expected objects
- "implement every method" to accept arbitrary arguments and return self
- special methods need special care
- advantage: avoid many "if x is None:" tests
  - or other similar guards

A general Null class

```
class Null(object):
  def __init__(self, *a, **k): pass
  def __call__(self, *a, **k):
    return self
  def __repr__(self): return 'Null()'
  def __len__(self): return 0
  def __iter__(self): return iter(())
  __getattr__ = __call__
  __setattr__ = __call__
  __delattr__ = __call__
  __getitem__ = __call__
  __setitem__ = __call__
  __delitem__ = __call__
```

A specialized Null class

```
class NoLog(object):
  def write(self, data): pass
  def writelines(self, data): pass
  def flush(self): pass
  def close(self): pass
```

either class allows:

```
if mustlog: logfile = file(...)
else: logfile = Null() # or NoLog()
```

then throughout the code, just

```
logfile.write(xx) # no guard 'if logfile'
```

specialized version may detect more errors

OOP for instantiation

- one class -> many instances
  - same behavior, but distinct state
  - per-class behavior, per-instance state
- ...but sometimes we don't want that...
  - while still requiring other OOP thingies
  - thus: Singleton (forbid "many instances")
  - or: Monostate (remove "distinct state")

Singleton ("Highlander")

```
class Singleton(object):
  def __new__(cls, *a, **k):
    if not hasattr(cls, '_inst'):
      cls._inst = super(Singleton, cls
                  ).__new__(cls, *a, **k)
    return cls._inst
```

subclassing is a problem, though:

```
class Foo(Singleton): pass
class Bar(Foo): pass
f = Foo(); b = Bar(); # ...???...
```

problem is intrinsic to Singleton

Class or closure?

```
class Callable(object):
  def __init__(self, init args):
    set instance data from init args
  def __call__(self, more args):
    use instance data and more args

def outer(init args):
  set local vars from init args
  def inner(more args):
    use outer vars and more args
  return inner
```

"closure factory" is simpler!

Closure or class?

```
class CallableSubclassable(object):
  def __init__(self, init args):
    set instance data from init args
  def do_hook1(self, …): ...
  def do_hook2(self, …): ...
  def __call__(self, more args):
    use instance data and more args
    and call hook methods as needed
```

class is more powerful and flexible, as subclasses may easily customize

use only the power you need!

Monostate ("Borg")

```
class Borg(object):
  _shared_state = {}
  def __new__(cls, *a, **k):
    obj = super(Borg, cls
             ).__new__(cls, *a, **k)
    obj.__dict__ = cls._shared_state
    return obj
```

subclassing is no problem, just:

```
class Foo(Borg): pass
class Bar(Foo): pass
class Baz(Foo): _shared_state = {}
```

data overriding to the rescue!