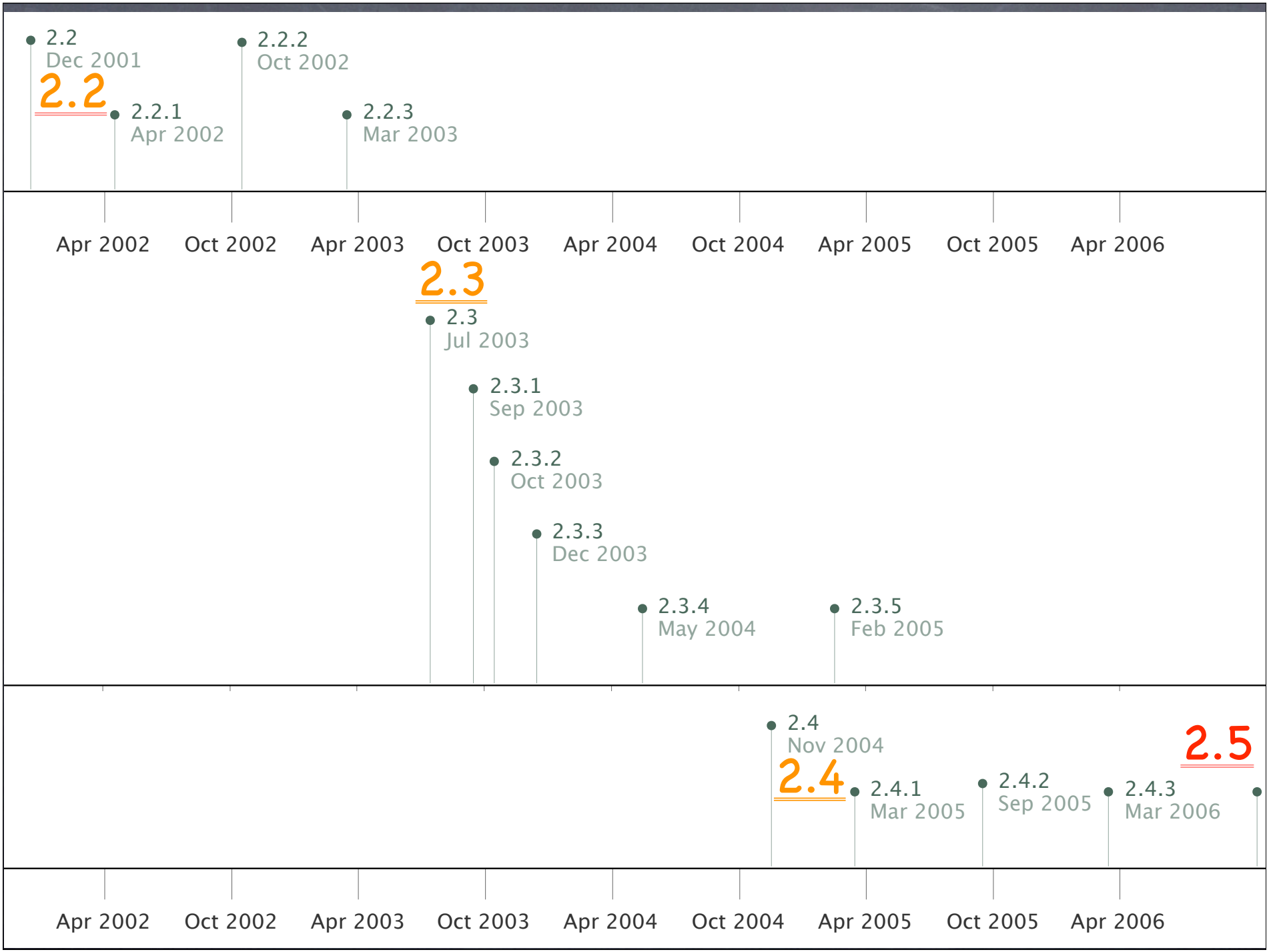
Better, faster, smarter

Python: yesterday, today... and tomorrow

1 lang, many versions

- Jython (pending 2.2/2.3 release)
- IronPython (1.0, 8/06, Microsoft ~ CPython 2.4)
- pypy (0.9, 6/06 ~ CPython 2.4, but "beta")
- CPython (Classic Python) timeline
  - 2.2: 12/01 (...2.2.3: 5/03) major new stuff
  - 2.3: 7/03 (...2.3.5: 2/05) ~30% faster
  - 2.4: 11/04 (...2.4.4: 9/06) ~5% faster yet
  - 2.5: 8/06 (...?) ~10% (?) faster yet


2.2
Dec 2001
2.2
2.2.1
Apr 2002
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Mar 2003
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Apr 2002
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Apr 2006

The 2.2 "revolution"

- 2.2 was a "backwards-compatible" revolution
  - new-style object model, descriptors, custom metaclasses...
  - iterators and generators
  - nested scopes
  - int/long merge, new division, bool
  - standard library: XML/RPC (clients and servers), IPv6 support, email, UCS-4, ...
- nothing THAT big since
- 2.N.*: NO extra features wrt 2.N

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2.2 highlights

```
class Newy(object): ...
__metaclass__ = ...

def funmaker(...):
  def madefun(...): ...
  return madefun

def gen1(item):
  yield item

for item in iter(f, sentinel): ...
```


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2.3: stable evolution

- no changes to the language "proper"
- many, MANY optimizations (and small fixes)
  - import-from-ZIP, ever-more-amazing sort, Karatsuba multiplication, pymalloc, interned strs gc'able ...
- builtins: sum, enumerate, extended slices, enhancements to str, dict, list, file, ...
- stdlib, many new modules: bz2, csv, datetime, heapq, itertools, logging, optparse, platform, sets, tarfile, textwrap, timeit
  - & many enhancements: socket timeouts, ...

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2.3 highlights

```
sys.path.append('some.zip')

sum([x**2 for x in xs if x%2])

for i, x in enumerate(xs): ...

print 'ciao'[::-1]

for line in open(fn, 'U'): ...
```

...and MANY new stdlib modules...!

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2.4: mostly evolution

- "small" new language features:
  - genexps, decorators
  - many "peephole-level" optimizations
- builtins: sorted, reversed; enhancements to sort, str; set becomes built-in
- stdlib, new modules: collections, cookielib, decimal, subprocess
  - string.Template, faster bisect & heapq, operator itemgetter & attrgetter, os.urandom, threading.local, ...

2.4 language changes

```
sum(x**2 for x in xs if x%2)
```

like `sum([x**2 for x in xs if x%2])`
(without actually building the list!)

```
class Foo(object):
  @classmethod
  def bar(cls): return cls.__name__
print Foo().bar(), Foo.bar()
```

emits: `Foo Foo`

2.4 new built-ins

`for item in sorted(sequence): ...`
(does not alter `sequence` in-place!)

`for item in reversed(sequence): ...`
(does not alter `sequence` in-place; like...
`for item in sequence[::-1]: ...`
...but more readable!)

`set` and `frozenset` become built-in types

2.4 built-ins additions

```
print 'foo'.center(7, '+')
```
emits: ++foo++

```
print 'foo+bar+baz'.rsplit('+',1)[-1]
```
emits: baz

```
print 'abc d ef g'.split().sort(key=len)
```
emits: ['d', 'g', 'ef', 'abc']

2.4 new stdlib modules

collections.deque

double-ended queue -- methods: append, appendleft, extend, extendleft, pop, popleft, rotate

decimal.Decimal

specified-precision decimal floating point number, IEEE-754 compliant

subprocess.Popen

spawn and control a sub-process

2.4 stdlib additions

```
list2d.sort(key=operator.itemgetter(1))
```

```
os.urandom(n) -> n crypto-strong byte str
```

```
threading.local() -> TLS (attrs bundle)
```

```
heapq.nlargest(n, sequence)
```

also .nsmallest (and much faster)

2.5: evolution... plus!

- several language changes:
  - full support for "RAII"-style programming
    - a new "with" statement, new contextlib module, generator enhancements...
  - absolute and relative imports, unified "try/except/finally" statement, new "if/else" ternary operator, exceptions are new-style classes
- new builtins: any/all, dict.__missing__
- MANY new stdlib modules: functools, ctypes, xml.etree, hashlib, sqlite3, wsgiref...

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Resource Allocation Is Initialization

```
# in 2.4 and earlier, Java-like...:
resource = ...allocate it...
try:
  ...use the resource...
finally:
  ...free the resource...

# in 2.5, much "slimmer"...:
with ...allocate it... as resource:
  ...use the resource...
```

with automatic "freeing" at block exit!

Many "with"-ready types

```
with open(filename) as f:
    ...work with file f...
# auto f.close() on block exit

somelock = threading.Lock()

with somelock:
   # auto somelock.acquire() on block entry
   ...work guarded by somelock...
# auto somelock.release() on block exit
```

The "with" statement

```
from __future__ import with_statement
with <expr> as var: <with-block>

# makes and uses a *context manager*
_context = <expr>
var = _context.__enter__()
try: <with-block>
except: _context.__exit__(*sys.exc_info())
else: _context.__exit__(None, None, None)
```

Better than C++: can distinguish exception exits from normal ones!

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Your own context mgrs

- roll-your-own: write a wrapper class
  - usually __init__ for initialization
  - __enter__(self) returns useful "var"
  - __exit__(self, ext, exv, tbv) performs the needed termination operations (exit is "normal" iff args are all None)
- extremely general
- somewhat clunky/boilerplatey

"with" for transactions

```
class Transaction(object):
 def __init__(self, c): self.c = c
 def __enter__(self): return self.c.cursor()
 def __exit__(self, ext, exv, tbv):
   if ext is None: self.c.commit()
   else: self.c.rollback()

with Transaction(connection) as cursor:
   cursor.execute(...)
   ...and more processing as needed...
```


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Your own context mgrs

- contextlib module can help in many ways
- decorator contextlib.contextmanager lets you write a context mgr as a generator
  - yield the desired result of __enter__
  - within a try/finally or try/except/else
  - re-raise exception in try/except case
- function contextlib.nested "nests" context managers without needing special syntax
- function contextlib.closing(x) just returns x and calls x.close() at block exit

Transaction w/contextlib

```
import contextlib

@contextlib.contextmanager
def Transaction(c):
  cursor = c.cursor()
  try: yield cursor
  except:
    c.rollback()
    raise
  else:
    c.commit()
```


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Other uses of contextlib

```
# syntax-free “nesting”
# e.g., a locked transaction:
with contextlib.nested(thelock,
  Transaction(c)) as (locked, cursor): ...
# auto commit or rollback, AND auto
# thelock.release, on block exit

# when all you need is closing, e.g:
with contextlib.closing(
  urllib.urlopen(...)) as f:
  ...work with pseudo-file object f...
# auto f.close() on block exit
```

Generator enhancements

- yield can be inside a try-clause
- yield is now an expression
  - x = g.send(value) gives yield's value
  - x = g.next() is like x = g.send(None)
  - preferred syntax: value = (yield result)
- g.throw(type [,value [,traceback]])
  - g.close() == g.throw(GeneratorExit)
- automatic g.close() when g is garbage-collected
  - this is what ensures try/finally works!

Absolute/relative imports

- `from __future__ import absolute_import`
  - means: `import X` finds X in sys.path
  - you can `import .X` to find X in the current package
  - also `import ..X` to find X in the package containing the current one, etc
- important "future" simplification of imports

try/except/finally

```
try: <body>
except <spec>: <handler>
else: <ebody>  # else-clause is optional
finally: <finalizer>
```

becomes equivalent to:

```
try:
  try: <body>
  except <spec>: <handler>
  else: <ebody>
finally: <finalizer>
```

if/else ternary operator

```
result = (whentrue if cond else whenfalse)
```

becomes equivalent to:

```
if cond:
  result = whentrue
else:
  result = whenfalse
```

- the parentheses are technically optional (!)
- meant to help with lambda & the like
- rather-controversial syntax...:-)

Exceptions are new-style

```
object
  Exception
    GeneratorExit
    StandardError
      # all “real error” classes go here,
      # directly or under 3 abstract ones:
      ArithmeticError
      EnvironmentError
      LookupError
    StopIteration
    SystemExit
    Warning
```

any and all

```
def any(seq):
  for item in seq:
    if item: return True
  return False

def all(seq):
  for item in seq:
    if not item: return False
  return True
```

note behavior for empty seq argument...

dict.__missing__

- hook method called by __getitem__ for a missing key
- default implementation in dict itself:

```
def __missing__(self, key):
    raise KeyError(key)
```

- meant to be overridden by subclasses
- collections.defaultdict subclasses dict:

```
def __missing__(self, key):
    return self.default_factory()
```

  - default_factory optionally set at __init__ (default None == like dict)

functools

- partial: partial-application of functions
- wraps, update_wrapper: copies name, doc, &c from wrapped to wrapping function

```
t=functools.partial(pow,2)
print t(3), t(5), t(7) # 8 32 128

def f(): pass
@functools.wraps(f)
def g(): pass
print g # <function f at 0x67e70>
```

ctypes

- general-purpose Python FFI
- load any shared library / DLL with ctypes.CDLL(<complete name of library>)
- call any function as a method of the CDLL
- automatically converts to/from int, char*, wchar_t* (to/from: int/long, str, Unicode)
  - can convert explicitly with c_int, c_float, create_string_buffer, ...
- dangerous: any programer mistake or oversight can easily crash Python!

ctypes “hello world”

```
import ctypes
libc = ctypes.CDLL("libc.so.6")
# or, “libc.dylib” in Darwin/MacOSX, &c
# or, ctypes.cdll.msvcrt in Windows
result = libc.printf("hello world\n")
# emits: hello world
print result            # emits: 12
```

Element-Tree

- new package xml.etree with modules ElementTree, ElementPath, ElementInclude
- highly Pythonic in-memory representation of XML document as tree, much slimmer (and faster!) than the DOM
- each XML element is a bit like a list of its children merged with a dict of its attrs
- scalable to large documents with included C accelerators and .iterparse incremental parsing (a bit like pulldom, but simpler, and keeps subtrees by default)

etree example

```
from xml.etree import ElementTree as E
t=E.fromstring('''<x y="z">foo<a>bar</a>
                  baz<b>bat</b>boo</x>''')
for x in t.getiterator():
  print x.tag, x.text, x.tail.strip()

# emits:
x foo None
a bar baz
b bat boo
```

hashlib

- replaces md5 and sha modules (which become wrappers to it!)
- adds SHA-224, SHA-256, SHA-384, SHA-512
- optionally uses OpenSSL as accelerator (but can be pure-Python if necessary!)

wsgiref

- Web Server Gateway Interface
- standard "middleware" interface between HTTP servers and Python web frameworks
  - goal: any framework, any server
  - non-goal: direct use by web applications!
  - already widely supported by frameworks
- stdlib now includes a "reference implementation" of WSGI (wsgiref)
  - includes basic HTTP server for debugging WSGI applications and interfaces

sqlite3

- wrapper for the SQLite embedded DB
- DB-API-2 compliant interface
  - except that SQLite is "typeless" (!)
  - some extensions: optional timeout on connect, isolation level, detect_type and type converters, executemany on iterators, executescript method, ...
- great way to "get started" on small app, can later migrate to PostgreSQL or other relational DB (mysql, Oracle, whatever)