Python Idioms
to help you write
good code

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Speaker Introduction

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- Python since 1993/1994
- Studied Mathematics
- eGenix.com GmbH
- Senior Software Architect
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Python Idioms for cooking better Code
Agenda

• Coding Conventions
• Common Patterns in Python
• Performance Idioms
• Coding Idioms
• Avoiding Gotchas
• Tools
• Questions
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Python Coding Conventions: The Basics
PEP 8 – Python Coding Conventions

• Document:
  http://www.python.org/dev/peps/pep-0008/

• Many useful tips on how to write readable Python code

• Guideline, not law :-) 

• Can be used as basis for a corporate Python style guide

• Tool: pep8 package for checking PEP 8 compliance
Generic Python module structure:

- Header
- Tools
- Body
Module Layout: Header Section

• **Module Doc String**

• **Imports**
  – Python ones first
  – 3\textsuperscript{rd} party modules
  – application modules

• **Constants**
  – usually simple types (strings, integers)

• **Globals**
  – often private to the module
  – used for e.g. caches, static mappings, etc.
Module Layout: Tools Section

• **Exceptions**
  - used in the module
  - derived from standard exceptions
  - allow easily tracking origin of exceptions
  - often part of the module API

• **Helper Functions**
  - usually private to the module
Module Layout: Body Section

• **Functions**
  – usually part of the module API

• **Classes**
  – usually part of the module API

• **Module execution** (usually for testing or scripting)
  – if `__name__` == '__main__':
    main()
Module Layout: Overview

• Doc String
• Imports
• Constants & Globals
• Exceptions
• Helper Functions
• Functions & Classes

• Module execution (usually for testing or scripting)
  – if __name__ == '__main__':
    main()
Module Guidelines

• Use descriptive names for modules
  – try to name after the most important class or function

• Try not to use executable code at the module top-level
  – put all such code into functions to make the module import side-effect free
  – this is especially true for package __init__.py modules

• Always use absolute imports
Python Idioms

We're now going to take a tour

from high level

to low level
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Common Patterns in Python

• **Duck Typing**
  - API interface counts, not type
  - “When I see a bird that walks like a duck and swims like a duck and quacks like a duck, I call that bird a duck.” – James W. Riley

• **Examples:**
  - Python sequence API, iterator API, index API, mapping API, file API
  - ElementTree API for XML, Python DB-API
  - collections module provides ABCs
Common Patterns in Python

• Facade / Adapter
  – Make an object API compatible with another object
  – Turn any bird into a duck
  – API based, not class based

• Examples:
  – StringIO module (turn strings into file-like objects)
  – DB-API compatible modules (adapt database C APIs to a standard Python API)
Common Patterns in Python

• Singletons
  – Objects that only exist once
  – usually not enforced in Python
    (e.g. True, False are not protected in Py2, None is protected, all in Py3)

• Examples:
  – True, False, None, NotImplemented
  – Small integers
Common Patterns in Python

• Factories
  – Build objects in multiple ways
  – Python only has one `__init__()` method per class
  – use *factory functions* returning instances, or *class methods* to the same effect

• Examples:
  – `mx.DateTime.DateTimeFrom()`
  – `datetime.fromtimestamp()`
Common Patterns in Python

• Wrappers / Proxies
  – hide / control APIs
  – add information / verification to APIs
  – decorators often create wrappers (try to avoid this)

• Examples:
  – decorators, functools.partial, weakref, mxProxy
Common Patterns in Python

• Callbacks
  – functions/methods called when an event triggers
  – usually methods on a processing object (handler) or on a subclass (handler method)
  – hooks to extend / customize APIs
  – very common: runtime introspection for finding handlers

• Examples:
  – SAX parser, HTML parser, urllib2, threading
  – command line option processing
  – asynchronous processing
There's also a typical code evolution pattern in Python ...
Code Evolution: From scripts to functions

• Typical situation:
  – Start with a script using top-level commands
  – Turn common script sections into functions
  – Pass around common parameters (e.g. context related variables)
  – Group functions
Code Evolution: Abstracting functions to classes

• Next level:
  – Refactor function sections into methods of classes
  – Instantiate classes to drive the application
  – Provide a user interface (e.g. command line, web or GUI)
  – Add more input/output channels
  – More user customization
Code Evolution: Abstracting classes into components

- **Evolution:**
  - Create subclasses to provide more features
  - Split code into modules to more clarity
  - Group modules in packages
  - **Build loosely coupled components based on classes**
  - Add packaging for better deployment
  - Add automated tests and builds
  - Enter build-test-release cycle
  - Enter the code refactor cycle
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Performance Idioms

... when performance matters
Looping over sequences

• Different methods possible:
  – for-loop, map(), list comprehensions, generator

• Fastest:

Use list comprehensions

[op(x) for x in seq]

when operating on sequences
Joining strings

• Using + (concat)
  – Good when concatenating a few strings
  – Copies strings together

• Using ''.join()
  – Great for concatenating many strings
  – Copies strings, but only once

• Using StringIO.write(), array.fromstring() or %-formatting
  – Much slower than the above two
Exceptions

• Expensive in Python (but cheap in Python's C API)

• Exceptions should only be used for exceptional cases …

    # Not a good idea:
    try:
        fails_often()
    except ValueError:
        runs_often()
More performance hints

• Python wiki page:
  – https://wiki.python.org/moin/PythonSpeed/PerformanceTips

• My talk “When performance matters...”

• Examples:
  – localizing variables: \( x = \text{global}_x \)
  – localizing method lookups: \( m = \text{list.append} \)
  – \( \text{dict.setdefault()} \) and \( \text{collections.defaultdict} \)
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Deeply nested if statements in loops

• Typical situation:

```python
for x in items:
    if cond1(x):
        do_something()
    if cond2(x):
        do_something_else()
```
Deeply nested if statements in loops

- **Staircase Syndrom:**

```python
for x in items:
    if cond1(x):
        do_something()
    if cond2(x):
        do_something_else()
```
Better: Use `continue` to avoid nesting

```python
for x in items:
    if not cond1(x):
        continue
    do_something()
    if not cond2(x):
        continue
    do_something_else()
```
Avoiding Gotchas

... mutable or not, that is the question
(well, at least one of them)
Avoid **mutable state** in module globals

- **Typical situations** at module scope:
  
  ```python
  db = database.connect(…)
  settings = dict(Verbose=1, log=False)
  ```

- **Not thread safe**

  … and no, *thread locals* are not a good idea

- **Difficult to manage**
  (access, resources, validations)

- **Dangerous in larger projects**
Better: Place mutable state in context objects

• Keep state in context objects

• Pass context to methods and functions as first parameter

  def read_data(context, key): ...
  def get_config(context): ...

or refactor code to use instance attributes:

class Application:
  def __init__(self):
    self.context = ApplicationContext()
Function/method default parameters

- **Use only immutable types**

- **For mutable types:**
  - fallback to None or
  - immutable alternatives
  - Add mutable defaults at the top of the function/method:

```python
def func(x, a=None):
    if a is None:
        a = []
    return x(a)
```
Class default attributes

- **Only use immutable types**
  - unless you really know what you're doing

- **For mutable types:**
  - fallback to `None` or
  - immutable alternatives
  - *Add mutable type defaults in `__init__()`*

- **Document all attributes using comments:**
  
  # List of file names
  files = None
Avoiding Gotchas

... and finally, some very basic hints to write better code
Use the *in* operator in Python

- Interface to the `obj.__contains__() ` method

- `if x in some_list: ...`
  - better than using `some_list.index(x)` with try-except

- `if x in some_dict: ...`
  - better than using `some_dict.has_key(x)`

- `if x in some_set: ...`
  - better than `???` (only way to test membership :-))

- Function equivalent:
  
  ```python
  a in b = operator.contains(b, a)
  ```
Boolean testing in Python

- Boolean singletons:
  True (=integer 1), False (= integer 0)

- Use: if x: print(“x is true”)
  Not: if x == True: print(“x is true”)
  Not: if x is True: print(“x is true”)

- Use: if not x: print(“x is false”)
  Not: if x == False: print(“x is false”)
  Not: if x is False: print(“x is false”)

- Function equivalent: bool(x)
Container empty testing in Python

• **Empty containers** (sequences, mappings, sets) are considered false in Python

• Use: `if container: print("not empty")`

  Not: `if len(container): print("not empty")`

  Not: `if len(container) > 0: print("not empty")`
Commas in Python: 1-Tuples

• Nasty in 1-tuples:

  ```python
  x = (1,)
  x = 1,
  ← note the comma
  ```

• Weird errors when not intended…

  ```python
  >>> s = 'abc',
  >>> len(s)
  1
  >>> s[2]
  IndexError: tuple index out of range
  ```
Commas in Python: Listings

- Great in argument/parameter/item listings:

  Python allows trailing "," at end of listings...

  ```python
  d = {'a': 1,
       'b': 2,
       # insert something new here
       }
  even in functions/methods...
  f(x, y, z,
     a=1,
     # insert more keyword args here
     )
  ```
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Tools

• The Python community has created some really good tools to help with developing good code

Let's have a look at some …
Code Checking Tools

- **pylint**: [https://pypi.python.org/pypi/pylint/](https://pypi.python.org/pypi/pylint/)
  - style/typo checking
  - good documentation: [http://docs.pylint.org/](http://docs.pylint.org/)

- **pep8**: [https://pypi.python.org/pypi/pep8/](https://pypi.python.org/pypi/pep8/)
  - style checking

- **pyflakes**: [https://pypi.python.org/pypi/pyflakes/](https://pypi.python.org/pypi/pyflakes/)
  - logical checking
  - no documentation
Code Checking Tools

• **flake8:**
  - combines pep8, pyflakes and a complexity checker

• **pychecker:** [http://pychecker.sourceforge.net/](http://pychecker.sourceforge.net/)
  - note: imports modules
  - not maintained anymore (predates the other tools), but can still be useful
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Questions

```python
>>> raise Question()
```
Thank you for listening

Beautiful is better than ugly.
Photo References

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