http://tw.pycon.org/
2013 Taiwan
PYCON

PyCon Taiwan 2013 Tutorial

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Course Objectives

- Learning Python ecosystem
  - Languages, tools, libraries…
- Understanding core culture of Python communities
  - Coding styles, paradigms, documents, communities …
- Making a connection with PyConTW 2013
- **Be pythonic**

Instructor ?

Justin Lin

Technology Evangelist

Taiwan | Information Technology and Services

Current	**Technology Evangelist** at **Free lancer**
Past	Consultant at Sun Microsystems
	Technical Writer, Trainer, Consultant at Free Lancer
	Deputed Manager at Zong Chin Technology Corporation
Education	National Taiwan University
Connections	**59** connections
Websites	Personal Website

Justin Lin's Summary

- Technical writing since 1999.
- Java programming since 2002.
- Programming training since 2005.
- Research interests include programming languages, web-related open source framework.
- Online documentation covers areas about C/C++, Java, Scala, Ruby/Rails, Python, JavaScript, etc.

LinkedIn http://www.linkedin.com/in/caterpillar

Student ?

- Understanding cultures and ecosystem of a language takes me about three to six months. How about wrapping up what I have learned from Python ecosystem before mid-March and considering the agenda of PyConTW to build up a six-hour course?

PyCon Taiwan 2013 Tutorial Invitation 收件匣 x

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對我而言，要瞭解語言後的文化與生態系，約莫是三到六個月的時間，若以我至三月中前對 Python 生態系的瞭解過程與心得，配合 PyConTW 的議程，將之濃縮為六個小時的課程，你覺得如何？

. . .

Schedule

- The 1st class
  - **Preface (currently here)**
  - Picking and Installing an Interpreter
    - Implementations
    - Preparing Course Environment
    - Where're My Libraries?
    - What's the Relationship among Distutils, Distribute and Pip?
  - Hello! World!
    - Introduction to Unicode Support
    - Basic Input and Output
  - Integrated Development Environment
  - Reference

- The 2nd class
  - Learning Python language
  - Built-in Types
    - Numerical Types
    - String Type
    - List Type
    - Set Type
    - Dict Type
    - Tuple Type
  - `if`, `for`, `while` and `for` Comprehensions
    - `if..else`
    - `for` and `while`
    - `for` Comprehensions
  - Functions, Modules, Classes and Packages
    - Functions
    - Modules
    - Classes
    - Packages
  - References

- The 3rd class
  - The Community
  - Documentation
    - DocStrings
    - Official Documentation
    - PyDoc
    - EpyDoc
  - Data Management Functions
    - Built-in Functions
    - `reduce`
  - Persistence
    - `marshal`, `pickle`, `cPickle`
    - DBM
    - `shelve`
    - DB-API 2.0 (PEP 249)
  - References

- The 4th class
  - Libraries vs Frameworks
    - Inversion of Control
    - Do We Need a Framework?
  - Getting Started with Django
    - Creating a Project
    - Creating a Database and an App
    - Playing API with the Python shell
  - Writing Your First View
    - Controller? or Views?
    - URLconf
  - References

- The 5th class
  - Using the Template System
    - Writing Templates
    - Removing Hardcoded URLs in Templates
    - Namespacing URL Names
    - Writing a Simple Form
  - A Bit About CSRF
    - A Cross-Site Request Forgery Example
    - CSRF Countermeasures
  - Testing
    - `assert`
    - `doctest`
  - References

- The 6th class
  - `unittest` (Testing Continued)
    - Test Case
    - Test Fixture
    - Test Suite
    - Test Runner
  - Profiling
    - `timeit`
    - `cProfile` (`profile`)
  - PyCon Taiwan
    - PyCon Taiwan 2012
    - PyCon Taiwan 2013
  - References

Picking and Installing an Interpreter

- 2.x vs 3.x
  - Python 3.0 (a.k.a. "Python 3000" or "Py3k") final was released on **December 3rd, 2008**.
  - Python 3.3.0 was released on **September 29th, 2012**.
  - Python 2.7.3 was released on **April 9, 2012**.
  - **Python 2.7.x is highly recommended** unless you have a strong reason not to.
  - As more and more modules get ported over to Python3, the easier it will be for others to use it.

Implementations

- **CPython** (www.python.org)
  - Is written in **C**.
  - Compiles Python code to intermediate **bytecode**.
  - Provides **the highest level of compatibility** with Python packages and C extension modules.
- PyPy (pypy.org)
  - Features a **JIT** (just-in-time) compiler.
  - Aims for maximum compatibility with the reference CPython implementation while **improving performance**.

- Jython (www.jython.org)
  - An implementation of Python for the **JVM**.
  - Compiles Python code to **Java byte code.**
  - Can import and use any Java class the same as a Python module.
- IronPython (ironpython.net)
  - An open-source implementation of the Python programming language which is tightly integrated with the **.NET Framework**.
  - Can use the .NET Framework and Python libraries.
  - Other .NET languages can use Python code just as easily.

Preparing Course Environment

- Ubuntu 12.04 LTS
- The Slide and lab files.

```
sudo apt-get install git
git clone https://github.com/JustinSDK/PyConTW2013Tutorial.git
```

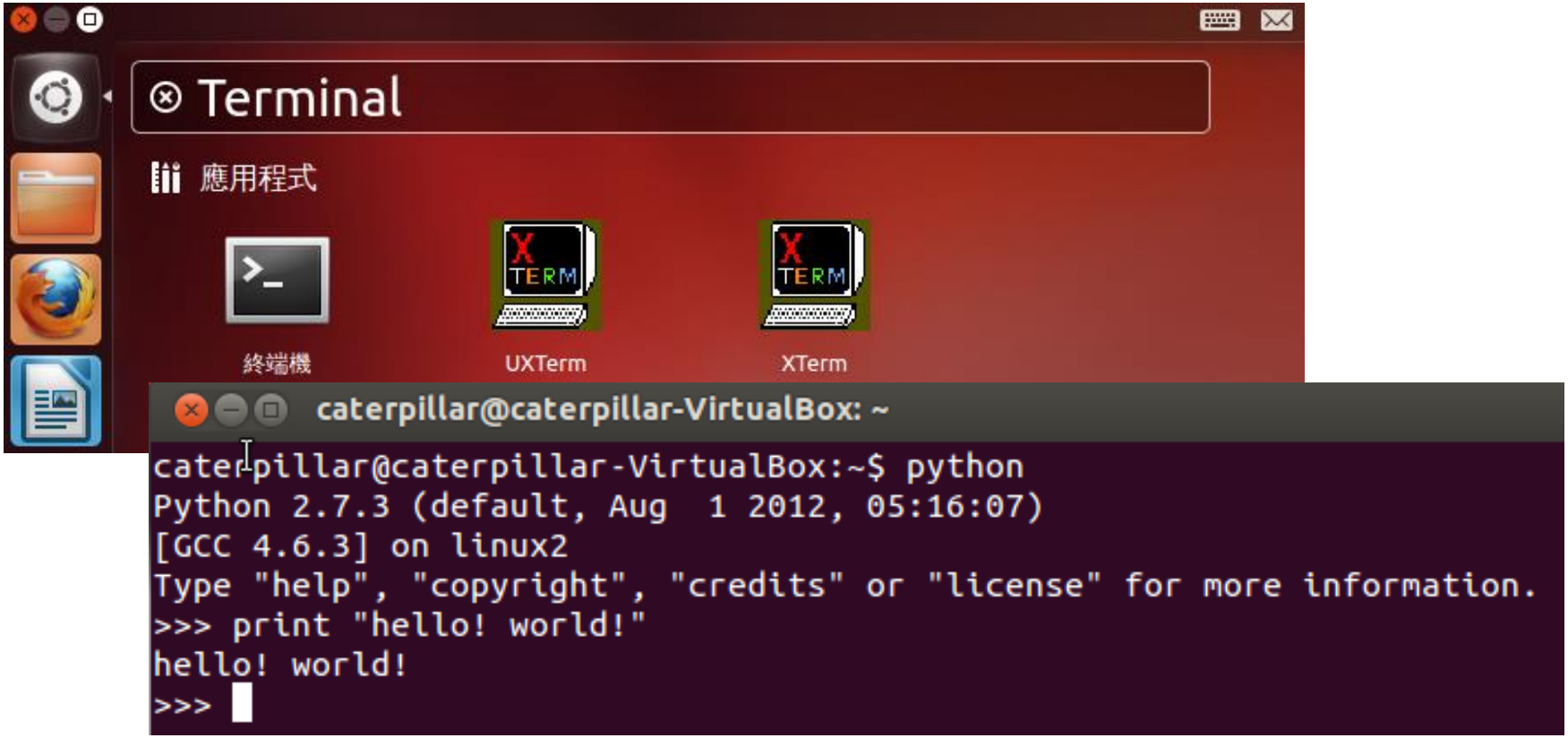
- Sublime Text 2.0.1

```
wget http://c758482.r82.cf2.rackcdn.com/Sublime%20Text%202.0.1.tar.bz2
tar -xf "Sublime Text 2.0.1.tar.bz2"
sudo mv "Sublime Text 2" /usr/lib
sudo ln -s "/usr/lib/Sublime Text 2/sublime_text" /usr/bin/st2
```

- **Python 2.7.3**
  - Distribute
  - Pip
  - Virtualenv

Exercise 0

- **Installing Python 2.7.3**
- Ubuntu 12.04 comes with Python 2.7.3 out of the box.
- All you have to do is to open a terminal and `python`!



Exercise 1

- **Installing Distribute, Pip and Virtualenv**
- **Distribute** extends the packaging and installation facilities provided by the **distutils** in the standard library.
  - Run the python script available below:
    http://python-distribute.org/distribute_setup.py

```
~$ mkdir scripts
~$ cd scripts
~/scripts$ wget http://python-distribute.org/distribute_setup.py
~/scripts$ sudo python distribute_setup.py
```

What You Should See

```
caterpillar@caterpillar-VirtualBox: ~/scripts
caterpillar@caterpillar-VirtualBox:~$ mkdir scripts
caterpillar@caterpillar-VirtualBox:~$ cd scripts
caterpillar@caterpillar-VirtualBox:~/scripts$ wget http://python-distribute.org/
distribute_setup.py
--2013-01-24 11:08:35--  http://python-distribute.org/distribute_setup.py
正在查找主機 python-distribute.org (python-distribute.org)... 88.191.140.69
正在連接 python-distribute.org (python-distribute.org)|88.191.140.69|:80... 連上
了。
已送出 HTTP 要求，正在等候回應... 200 OK
長度： 17319 (17K) [text/x-python]
Saving to: `distribute_setup.py'

100%[======================================>] 17,319      54.7K/s   in 0.3s

2013-01-24 11:08:37 (54.7 KB/s) - `distribute_setup.py' saved [17319/17319]

caterpillar@caterpillar-VirtualBox:~/scripts$ sudo python distribute_setup.py
[sudo] password for caterpillar:
```

~

```
Installed /usr/local/lib/python2.7/dist-packages/distribute-0.6.34-py2.7.egg
Processing dependencies for distribute==0.6.34
Finished processing dependencies for distribute==0.6.34
After install bootstrap.
Creating /usr/local/lib/python2.7/dist-packages/setuptools-0.6c11-py2.7.egg-info
Creating /usr/local/lib/python2.7/dist-packages/setuptools.pth
caterpillar@caterpillar-VirtualBox:~/scripts$
```

- The new``easy_install`` command you have available is considered by many to be deprecated, so we will install its replacement: **pip**.
- The **virtualenv** kit provides the ability to create virtual Python environments that do not interfere with either each other, or the main Python installation.

```
~/scripts$ sudo easy_install pip
~/scripts$ sudo pip install virtualenv
```

What You Should See

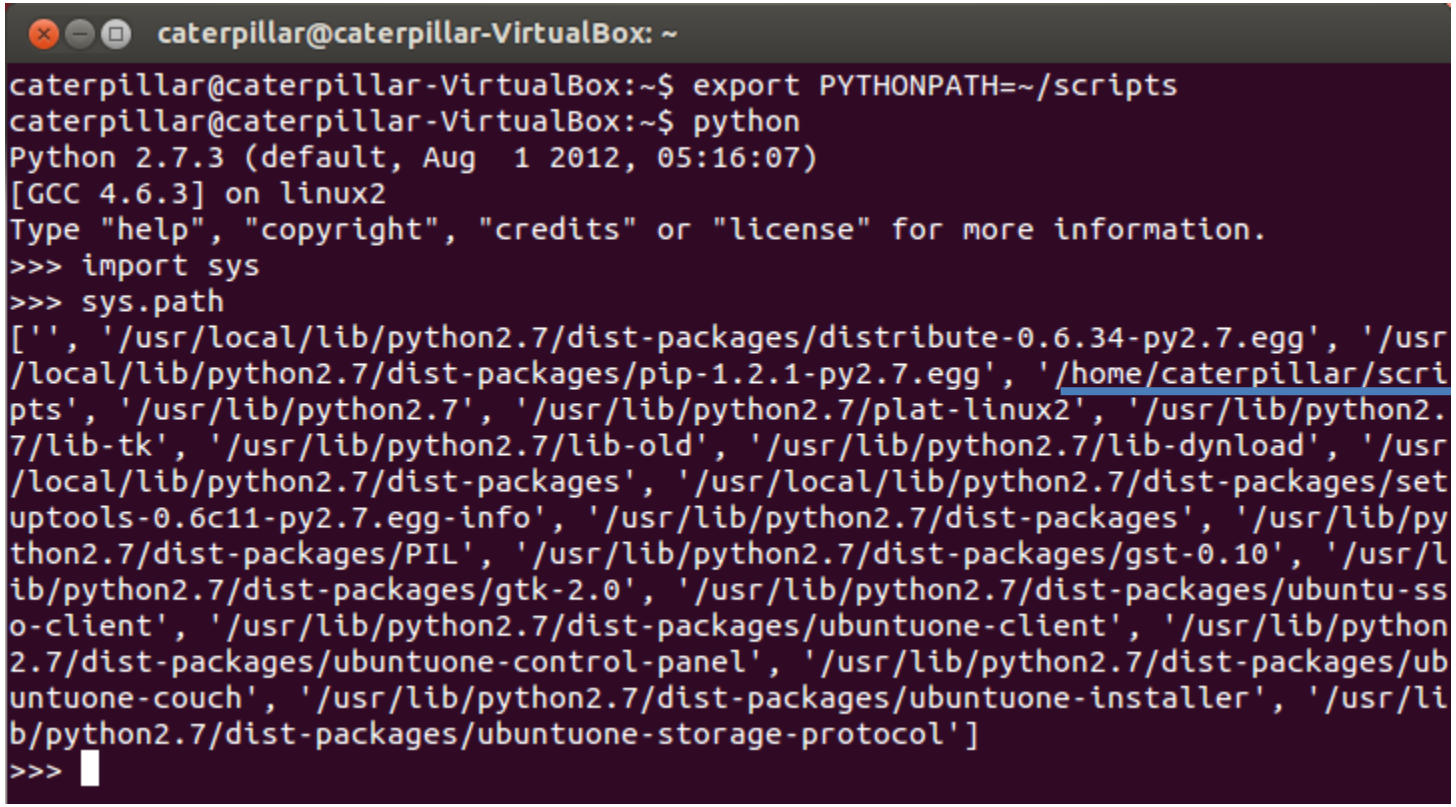
```
caterpillar@caterpillar-VirtualBox: ~/scripts
caterpillar@caterpillar-VirtualBox:~/scripts$ sudo easy_install pip
[sudo] password for caterpillar:
Searching for pip
Reading http://pypi.python.org/simple/pip/
Reading http://www.pip-installer.org
```

~

```
Finished processing dependencies for pip
caterpillar@caterpillar-VirtualBox:~/scripts$ sudo pip install virtualenv
Downloading/unpacking virtualenv
  Downloading virtualenv-1.8.4.tar.gz (1.9MB): 1.9MB downloaded
  Running setup.py egg_info for package virtualenv

    warning: no previously-included files matching '*' found under directory 'do
cs/_templates'
    warning: no previously-included files matching '*' found under directory 'do
cs/_build'
Installing collected packages: virtualenv
  Running setup.py install for virtualenv

    warning: no previously-included files matching '*' found under directory 'do
cs/_templates'
    warning: no previously-included files matching '*' found under directory 'do
cs/_build'
    Installing virtualenv script to /usr/local/bin
    Installing virtualenv-2.7 script to /usr/local/bin
Successfully installed virtualenv
Cleaning up...
caterpillar@caterpillar-VirtualBox:~/scripts$
```

Where’re My Libraries?

- The **`sys.path`** is a list of strings that specifies the search path for modules.
- Use the environment variable **`PYTHONPATH`** to augment the default search path for module files.



What's the Relationship among Distutils, Setuptools, Distribute and Pip?

- Distutils
  - The Python standard library for building and installing additional modules.
  - For simple installation scenarios.
  - Basic steps:
    - Untar the downloaded file (e.g. tar xzvf Django-X.Y.tar.gz)
    - Change into the directory. Basically, all you need is **setup.py**.
    - `sudo python setup.py install`
- Setuptools
  - Extends distutils.
  - Is de facto standard of Python community.
  - Has problems of slow development, messy code…

- Distribute
  - Extends distutils.
  - Is intended to **replace Setuptools** as the standard method for working with Python module distributions.
  - Provides **a backward compatible** version to replace Setuptools and makes all distributions that depend on Setuptools work as before.
  - So, once setuptools or distribute is installed, `easy_install` is prepared.
  - The `easy_install` command is considered by many to be deprecated due to lack of unstallation command, svn-only support…
- Pip
  - **An `easy_install` replacement.**
  - Allows for uninstallation of packages, and is actively maintained, unlike `easy_install`.
  - Virtualenv is its good partner.
  - Basic commands:
    - `pip install [PACKAGE_NAME]`
    - `pip unstall [PACKAGE_NAME]`

Hello! World!

- The **virtualenv** kit provides the ability to create virtual Python environments that do not interfere with either each other, or the main Python installation.
- Create a virtual Python environment:
  - `virtualenv --distribute venv`
- Activate the environment:
  - `source bin/activate`
- Deactivate the environment:
  - `deactivate`

Exercise 2

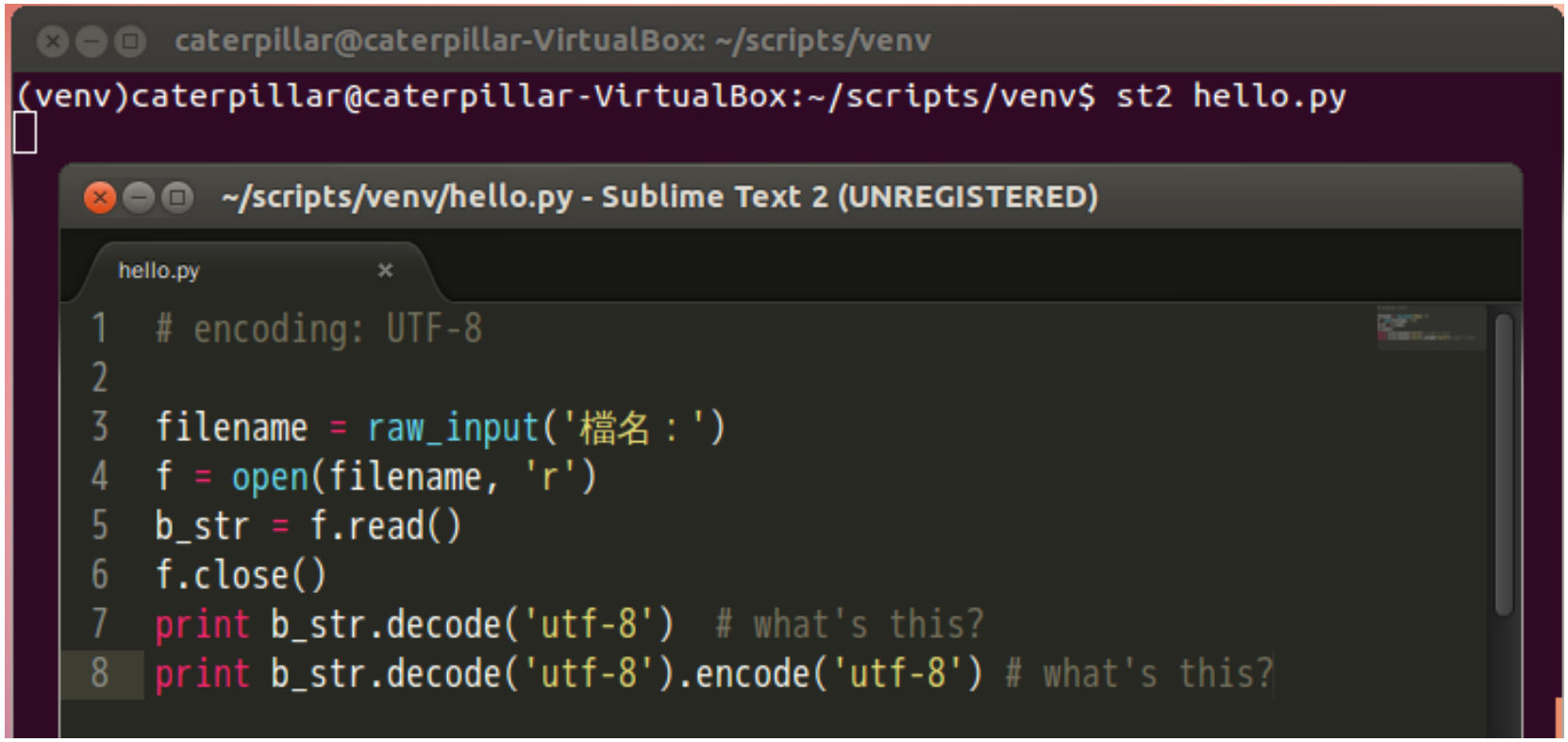
- **Create and activate a virtual Python environment.**
- **Prompt a use to provide a filename, read the file and print the content in the terminal. Consider the character encoding problems.**

```
~/scripts$ virtualenv --distribute venv
~/scripts$ cd venv
~/scripts/venv$ source bin/activate
```

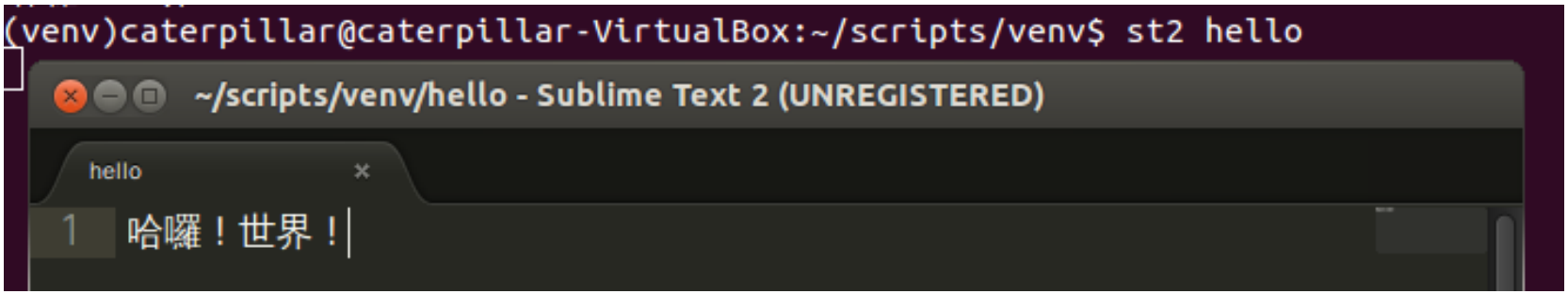
What You Should See

```
caterpillar@caterpillar-VirtualBox:~/scripts$ virtualenv --distribute venv
New python executable in venv/bin/python
Installing distribute.....................................................
.....................................................................
.....................................................................
done.
Installing pip.................done.
caterpillar@caterpillar-VirtualBox:~/scripts$ cd venv
caterpillar@caterpillar-VirtualBox:~/scripts/venv$ source bin/activate
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$
```

~/scripts/venv$ **st2 hello.py**



~/scripts/venv$ **st2 hello**



What You Should See

```
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$ python hello.py
檔名：hello
哈囉！世界！
哈囉！世界！
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$
```

Introduction to Unicode Support

- **Default encoding of Ubuntu: UTF-8.**
- Python 2:
  - Strings are actual **byte sequence** representing the data.

```
# coding=UTF-8
text = '測試'
print len(text) # print "6"
```

Encoding declaration

  - Unicode literals are written as strings prefixed with the `'u'` or `'U'` character

```
# coding=UTF-8
text = u'測試'
print type(text) # print "<type 'unicode'>"
print len(text)  # print "2"
```

- Python 2:
  - `decode` interprets the string using the given encoding and returns a `unicode` instance.
  - `encode` returns an 8-bit string version of the Unicode string.
- Python 3: **Unicode by default**.
  - `encode` returns a `bytes` instance representing byte sequence.
  - `decode` returns a `str` instance representing the Unicode string.

```
>>> '元'.encode('big5')
b'\xa4\xb8'
>>> '元'.encode('utf-8')
b'\xe5\x85\x83'
>>> '元'.encode('big5').decode('big5')
'元'
>>>
```

Python 3 interactive shell

Basic Input and Output

- Read a file:

```
import sys
file = open(sys.argv[1], 'r')
content = file.read()
print content
file.close()
```

Import a module

Command line arguments. `sys.argv[0]` is the python source file.

- Write a file:

```
import sys
file = open(sys.argv[1], 'w')
file.write('test')
file.close()
```

- Three ways for reading all content in a file:

```
import sys
file = open(sys.argv[1], 'r')
while True:
    line = file.readline()
    if not line: break
    print line
file.close()
```

```
import sys
file = open(sys.argv[1], 'r')
for line in file.readlines():
    print line
file.close()
```

```
import sys
for line in open(sys.argv[1], 'r'):
    print line
```

The best way to read a file is never `read`.

Integrated Development Environment

- Sometimes, it‘s just the flavor problem.
  - PyCharm / IntelliJ IDEA
    - http://www.jetbrains.com/pycharm/
  - PyDev / Eclipse plugin
    - http://pydev.org/
  - Komodo IDE
    - http://www.activestate.com/komodo-ide
  - Spyder
    - http://code.google.com/p/spyderlib/
  - WingIDE
    - http://wingware.com/
  - NINJA-IDE
    - http://www.ninja-ide.org/
  - Python Tools for Visual Studio
    - http://pytools.codeplex.com/

References

- Implementations
  - http://www.python.org/download/releases/3.0/
  - http://www.python.org/download/releases/2.7.3/
  - http://docs.python-guide.org/en/latest/starting/which-python/
- Preparing course environment
  - http://docs.python-guide.org/en/latest/starting/install/linux/
- Where’re my libraries?
  - http://docs.python.org/2/using/cmdline.html
- What’s the relationship among distutils, Distribute and Pip?
  - http://docs.python.org/2/library/distutils.html
  - http://pypi.python.org/pypi/distribute
  - http://pypi.python.org/pypi/pip
  - http://blog.yangyubo.com/2012/07/27/python-packaging/
  - http://www.openfoundry.org/tw/tech-column/8536-introduction-of-python-extension-management-tools
- Hello! World!
  - http://openhome.cc/Gossip/Python/IOABC.html
  - http://openhome.cc/Gossip/Encoding/
  - http://openhome.cc/Gossip/Encoding/Python.html

Learning Python Language

- What’re the essential elements of a language?

> ***Algorithms + Data Structures = Programs***
>
> *-- Niklaus E. Wirth -- The chief designer of Pascal*

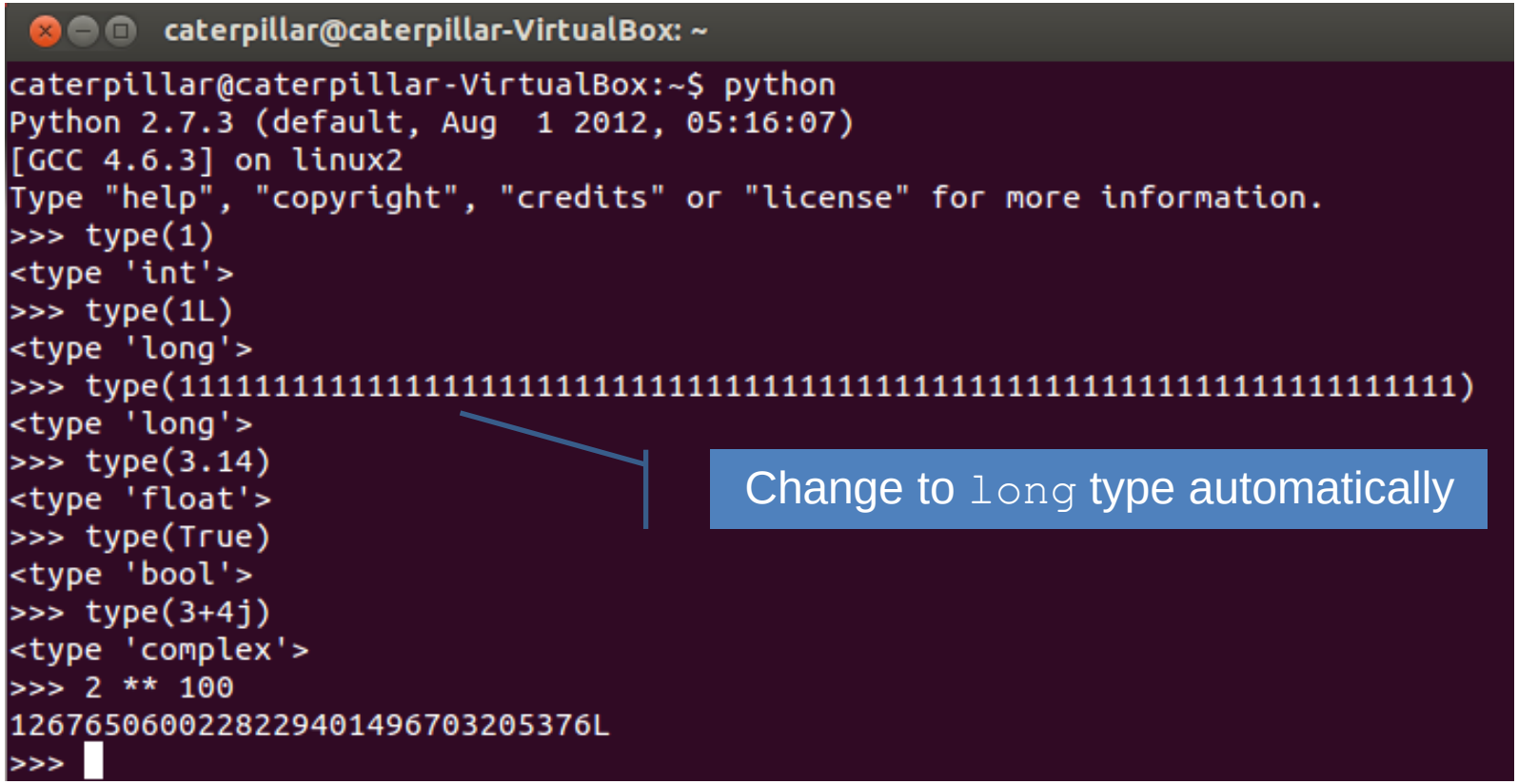
- How to encapsulate your code?
- Focus on the essence of Python, not nuts and bolts.
  - Built-in types, variables and operators
  - Functions, classes and modules

Built-in Types

- **Every thing is an object.**
  - Python, however, does not impose object-oriented programming as the main programming paradigm.
- Numerical types
  - `int, long, float, bool, complex`
- String type
- Container types
  - `list`, `set`, `dict`, `tuple`

Numerical Types

- `int, long, float, bool, complex`
- The `type` function returns the type of any object.



What You Should Know

- Python float division:

Different results in different versions

```
>>> 10 / 3
3
>>> 10 // 3
3
>>> 10 / 3.0
3.3333333333333335
>>> 10 // 3.0
3.0
>>>
```

- Float decision, `repr` and `str`:

```
>>> 1.0 - 0.8
0.19999999999999996
>>> print(1.0 - 0.8)
0.2
>>> repr(1.0 - 0.8)
'0.19999999999999996'
>>> str(1.0 - 0.8)
'0.2'
>>> import decimal
>>> a = decimal.Decimal('1.0')
>>> b = decimal.Decimal('0.8')
>>> a - b
Decimal('0.2')
>>>
```

Call `__repr__` function of an object

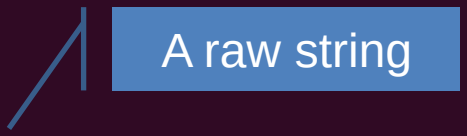
Call `__str__` function of an object

- **`__repr__`** computes the **“official”** string representation of an object.
- **`__str__`** compute the **“informal”** string representation of an object.
- **`__repr__` is to be unambigous and `__str__` is to be readable.**
- The `decimal` module provides support for decimal floating point arithmetic.

String Type

- `''` and `""` are the same in Python and replaceable.
- Use a raw string if you want to represent `'\'` itself.

```
>>> "Just'in"
"Just'in"
>>> 'Just"in'
'Just"in'
>>> 'c:\workspace'
'c:\\workspace'
>>> r'c:\workspace'
'c:\\workspace'
>>> 'c:\todo'
'c:\todo'
>>> r'c:\todo'
'c:\\todo'
>>> print 'c:\todo'
c:      odo
>>> print r'c:\todo'
c:\todo
>>>
```

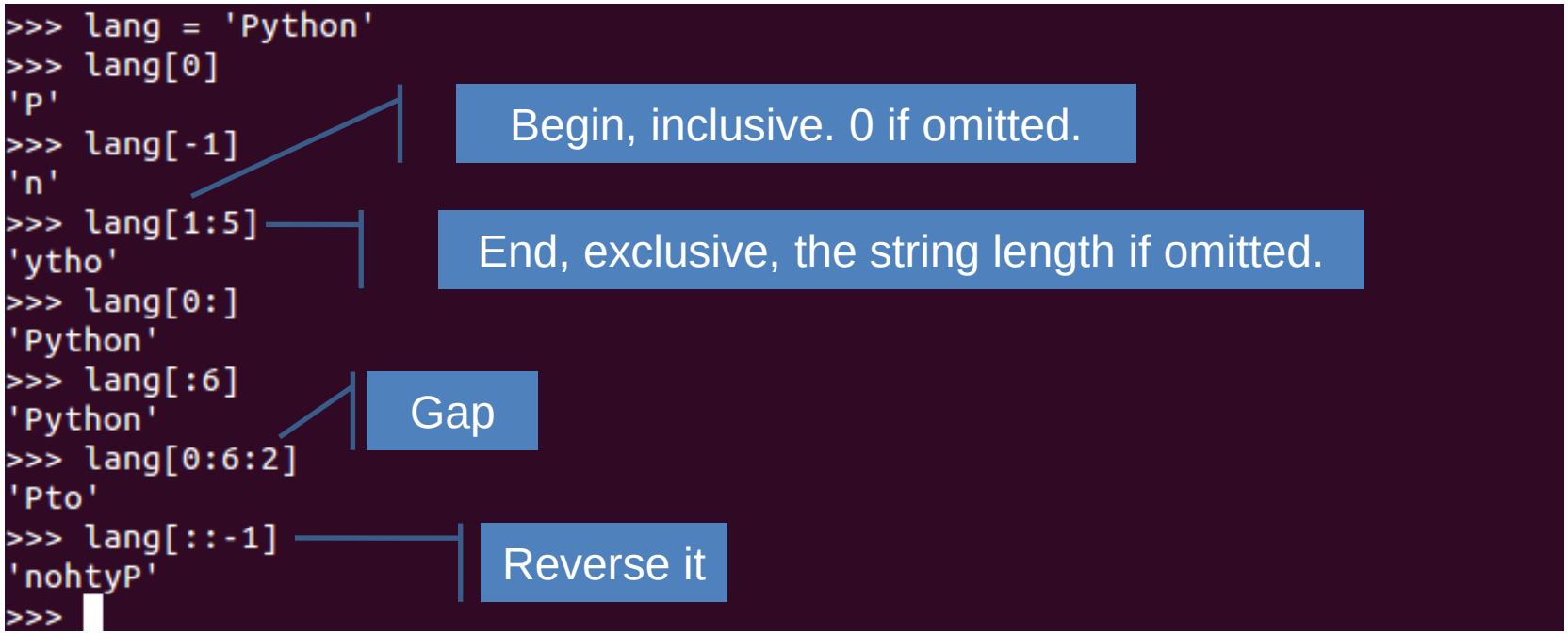


- A string is **immutable**.
- `len` returns the string length. Use `for` to iterate a string. `in` tests if a string contains a substring. `+` is for concatenating two strings. `*` replicates a string.

```
>>> name = 'Justin'
>>> len(name)
6
>>> for c in name:
...     print c
...
J
u
s
t
i
n
>>> 'Just' in name
True
>>> name + name
'JustinJustin'
>>> name * 3
'JustinJustinJustin'
>>>
```

String Slicing

- `[]` can be specified an index to get a character from a string. A negative index is counted from the last element.
- **The most useful power of `[]` is slicing.**



String Formatting

- Old string formatting operations

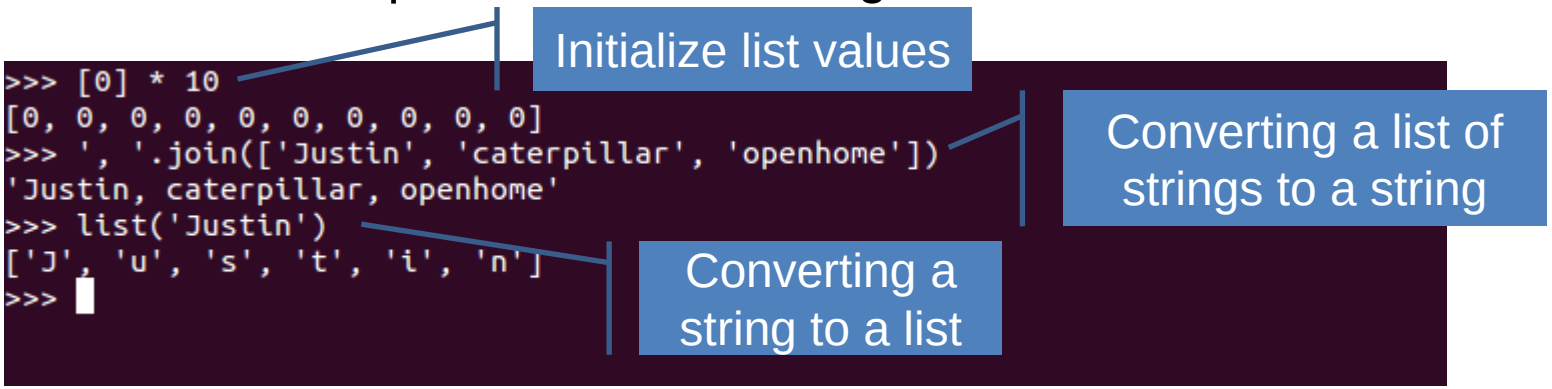
```
>>> '%d %.2f %s' % (1, 99.3, 'Justin')
'1 99.30 Justin'
>>> '%(real)s is %(nick)s!!' % {'real' : 'Justin', 'nick' : 'caterpillar'}
'Justin is caterpillar!!'
>>>
```

- New string formatting operations (after Python 2.6)

```
>>> '{0} is {1}!!'.format('Justin', 'caterpillar')
'Justin is caterpillar!!'
>>> '{real} is {nick}!!'.format(nick = 'caterpillar', real = 'Justin')
'Justin is caterpillar!!'
>>> '{0} is {nick}!!'.format('Justin', nick = 'caterpillar')
'Justin is caterpillar!!'
>>> import sys
>>> 'My platform is {pc.platform}'.format(pc = sys)
'My platform is linux2'
>>>
```

List Type

- An ordered and **mutable** collection.
  - `[1, 2, 3]` creates a list with elements `1`, `2`, and `3` in the index `0`, `1` and `2`.
- Shares common operations with strings.
  - `len` returns the list length. Use `for` to iterate a list. `in` tests if a list contains an element. `+` is for concatenating two lists. `*` replicates a list.
  - `[]` can be specified an index to get a character from a list. A negative index is counted from the last element.
  - The most useful power of `[]` is slicing.



Set Type

- A unordered collection. Contains no duplicate elements.
- Elements should be **hashable**.

```
>>> admins = {'Justin', 'caterpillar'}
>>> users = {'momor', 'hamini', 'Justin'}
>>> 'Justin' in admins
True
>>> admins & users
set(['Justin'])
>>> admins | users
set(['hamini', 'caterpillar', 'Justin', 'momor'])
>>> admins - users
set(['caterpillar'])
>>> admins ^ users
set(['hamini', 'caterpillar', 'momor'])
>>> admins > users
False
>>> admins < users
False
>>>
```

Exclusive or

∈

Dict Type

- An object that maps keys to values.

```
>>> passwords = {'Justin' : 123456, 'caterpillar' : 933933}
>>> passwords['Justin']
123456
>>> passwords['Hamimi'] = 970221
>>> passwords
{'caterpillar': 933933, 'Hamimi': 970221, 'Justin': 123456}
>>> del passwords['caterpillar']
>>> passwords
{'Hamimi': 970221, 'Justin': 123456}
>>> passwords.items()
[('Hamimi', 970221), ('Justin', 123456)]
>>> passwords.keys()
['Hamimi', 'Justin']
>>> passwords.values()
[970221, 123456]
>>> passwords.get('openhome', '000000')
'000000'
>>> passwords['openhome']
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 'openhome'
>>>
```

A tuple

```
if 'openhome' in passwords:
    return passwords['openhome']
else:
    return '000000'
```

Tuple Type

- A tuple is like a list, yet it's **immutable**.
- Shares common operations with lists.
  - In fact, sequences in Python (e.g. strings, lists, tuples, etc.) shares several features.
- Mutable or immutable? We'll talk about it soon…
- (In Haskell - a statically-typed language - the types of elements in a tuple composes an unnamed type.)

Exercise 3

- Open a terminal and type `python`. What will you see in **the interactive shell** if you type the following commands?
  - `1 + 2`
  - `_`
  - `_ + 3`
  - `help()`
  - `len`
  - `keywords`
  - `quit`(or simply `q`)
  - `help(len)`
  - Ctrl + D

- After exiting the interactive shell, what will you see in the terminal if you type the following commands?
  - `python -h`
  - `python -c 'print "Hello! Python!"'`
  - `python -c 'help(len)'`
  - **`python -c 'import this'`**
- (Try anything you see from the previous slides about built-in types.)

`if`, `for`, `while` and `for` comprehensions

- `if..else` block

```
from sys import argv
if len(argv) > 1:
    print 'Hello, ' + argv[1]
else:
    print 'Hello, Guest'
```

Below is a block

Indentation is important.

- `if..else` expression, something like the ternary operator `?:` in C or Java.

```
from sys import argv
print 'Hello, ' + (argv[1] if len(argv) > 1 else 'Guest')
```

`for` and `while`

- Use `for in` to iterate a sequence.

```
numbers = [10, 20, 30]
squares = []
for number in numbers:
    squares.append(number ** 2)
print squares
```

- Use `while` for undetermined conditions.

```
print 'Enter two numbers...'
m = int(raw_input('Number 1: '))
n = int(raw_input('Number 2: '))
while n != 0:
   r = m % n
   m = n
   n = r
print 'GCD: {0}'.format(m)
```

`for` comprehensions

- With a list comprehension we can turn this:

```
numbers = [10, 20, 30]
squares = []
for number in numbers:
    squares.append(number ** 2)
print squares
```

- Into this:

```
numbers = [10, 20, 30]
print [number ** 2 for number in numbers]
```

- With a list comprehension we can turn this:

```
numbers = [11, 2, 45, 1, 6, 3, 7, 8, 9]
odd_numbers = []
for number in numbers:
    if number % 2 != 0:
        odd_numbers.append(number)
print odd_numbers
```

- Into this:

```
numbers = [11, 2, 45, 1, 6, 3, 7, 8, 9]
print [number for number in numbers if number % 2 != 0]
```

- Flatten a list of lists.

```
lts = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
print [ele for lt in lts for ele in lt]
```

- A set comprehension

```
>>> {name for name in ["caterpillar", "Justin", "caterpillar", "openhome"]}
set(['caterpillar', 'Justin', 'openhome'])
>>>
```

- A dict comprehension

```
>>> names = {'caterpillar', 'Justin', 'openhome'}
>>> passwds = {123456, 987654, 13579}
>>> {name: passwd for name, passwd in zip(names, passwds)}
{'caterpillar': 123456, 'openhome': 13579, 'Justin': 987654}
>>>
```

- (In Haskell, a set comprehension $S = \{ 2 \cdot x \mid x \in \mathbb{N},\ x \leq 10 \}$ in mathematics can be written as [2 * x | x <- N, x <= 10] which looks similar to the set comprehension.)

Exercise 4

- Turn the following code into a single statement.

```
numbers = []
for number in range(20):
    numbers.append(str(number))
print ", ".join(numbers)
```

- (Here's a problem that combines tuple and list comprehensions: which right triangle that has integers for all sides and all sides equal to or smaller than 10 has a perimeter of 24?)

Functions, Modules, Classes and Packages

- In Python, everything is an object.
  - ***Does Python impose object-oriented programming as the main programming paradigm?***
- **Points about structuring your program.**
  - **Encapsulation and separation of abstraction layers.**
  - **State of an object.**
  - **Namespace**
  - **Physical structures of your resources, such as source files, packages, etc.**

Functions

xmath.py

```
1  def max(a, b):
2      return a if a > b else b
3
4  min = lambda a, b: a if a < b else b
5
6  def sum(*numbers):
7      total = 0
8      for number in numbers:
9          total += number
10     return total
11
12 maximum = max
13 minimum = min
14
15 pi = 3.141592653589793
16 e = 2.718281828459045
```

λ function
Anonymous function

Variable arguments

Functions are first-class values.

Modules

- What's the best way to organize functions in the previous slide?
- Modules are one of the main abstraction layers available and probably the most natural one.
  - A file named modu.py creates a module `modu`.
  - The `import modu` statement will look for *modu.py* in the same. If it isn't found, the Python interpreter will search for modu.py in the `sys.path` recursively; or raise an `ImportError` exception if it isn't found.

- **A module provides a namespace.** The module's variables, functions, and classes will be available to the caller through the module's namespace
- `import`, `import as`, `from import` are statements.

main.py

```
1  import xmath
2  print '# import xmath'
3  print xmath.pi
4  print xmath.max(10, 5)
5  print xmath.sum(1, 2, 3, 4, 5)
6
7  print '# import xmath as math'
8  import xmath as math
9  print math.e
10
11 print '# from xmath import min'
12 from xmath import min
13 print min(10, 5)
```

Create an alias

Copy it into the current module.
`from modu import *` is not recommended.

```
# import math
3.14159265359
10
15
# import xmath as math
2.71828182846
# from xmath import min
5
```

Classes

- Well, where's the playground for classes?
  - When we want to glue together some **state** and some functionality.

bank.py

```
1  def account(name, number, balance):
2      return {'name': name, 'number': number, 'balance': balance}
3
4  def deposit(acct, amount):
5      if amount <= 0:
6          raise ValueError('amount must be positive')
7      acct['balance'] += amount
8
9  def withdraw(acct, amount):
10     if amount > acct['balance']:
11         raise RuntimeError('balance not enough')
12     acct['balance'] -= amount
13
14 def to_str(acct):
15     return 'Account:' + str(acct)
```

main.py

```
1  import bank
2  acct = bank.account('Justin', '123-4567', 1000)
3  bank.deposit(acct, 500)
4  bank.withdraw(acct, 200)
5  print bank.to_str(acct)
```

- **OOP is considering usability more than reusability.**

bank.py

```python
class Account:
    def __init__(self, name, number, balance):
        self.name = name
        self.number = number
        self.balance = balance

    def deposit(self, amount):
        if amount <= 0:
            raise ValueError('amount must be positive')
        self.balance += amount

    def withdraw(self, amount):
        if amount > self.balance:
            raise RuntimeError('balance not enough')
        self.balance -= amount

    def __str__(self):
        return 'Account({0}, {1}, {2})'.format(self.name, self.number, self.balance)
```

Initializer

Explicit is better than implicit.

Still remember differences between `__str__` and `__repr__`?

main.py

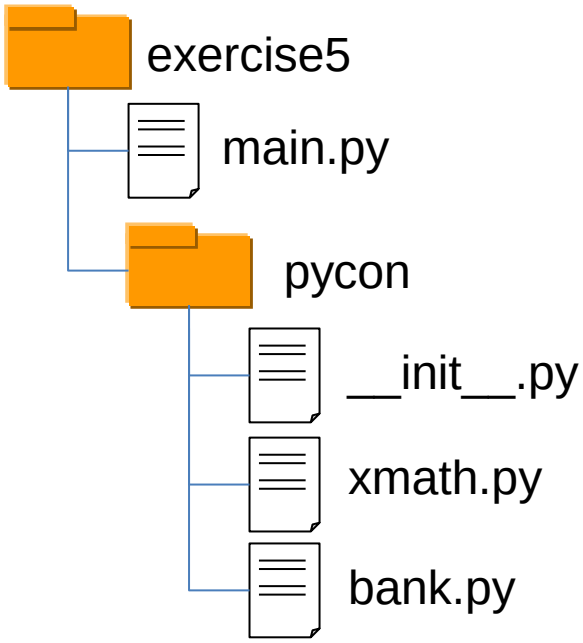
```python
import bank
acct = bank.Account('Justin', '123-4567', 1000)
acct.deposit(500)
acct.withdraw(200)
print acct
```

Packages

- **Any directory** with an **__init__.py** file - used to gather all package-wide definitions - is considered a **package**.
- `import pack.modu` will looks for a file **modu.py** in the directory **pack**.
  - This statement will look for an __init__.py file in the directory pack, execute all of its top-level statements.
  - Then it will look for a file pack/modu.py and execute all of its top-level statements.
  - After these operations, any variable, function, or class defined in modu.py is available in the `pack.modu` namespace.

Exercise 5

- There's a quick and dirty **main.py** located in the **/exercises/exercise5** of the lab file. Use modules, classes and packages learned in the previous slides to structure them as follow:



What You Should See?

- Basically, you should have the following main.py and run it correctly.

main.py

```
1  import pycon.xmath as math
2  import pycon.bank as bank
3
4  print math.max(10, 5)
5  print math.sum(1, 2, 3, 4, 5)
6  print math.pi
7
8  acct = bank.Account('Justin', '123-4567', 1000)
9  acct.deposit(500)
10 acct.withdraw(200)
11 print acct
```

```
10
15
3.14159265359
Account(Justin, 123-4567, 1300)
```

References

- String Type
  - http://docs.python.org/2/reference/datamodel.html#object.__repr__
  - http://docs.python.org/py3k/library/stdtypes.html#old-string-formatting
  - http://docs.python.org/py3k/library/string.html#string-formatting
- List, Set, Dict, Tuple Types
  - http://openhome.cc/Gossip/Python/ListType.html
  - http://openhome.cc/Gossip/Python/SetType.html
  - http://openhome.cc/Gossip/Python/DictionaryType.html
  - http://openhome.cc/Gossip/Python/TupleType.html
- Functions, Modules, Classes and Packages
  - http://openhome.cc/Gossip/Python/ModuleABC.html
  - http://openhome.cc/Gossip/Python/Class.html
  - http://docs.python-guide.org/en/latest/writing/structure/
- Short Cuts
  - http://maxburstein.com/blog/python-shortcuts-for-the-python-beginner/

The Community

- BDFL
  - **Guido van Rossum** (www.python.org/~guido)
  - The creator of Python, is often referred to as the **Benevolent Dictator For Life**.
- PSF
  - **Python Software Foundation** (www.python.org/psf)
  - Its mission is to promote, protect, and advance the Python programming language, and to support and facilitate the growth of a diverse and international community of Python programmers.
  - A 501(c)(3) non-profit corporation that holds the intellectual property rights behind the Python programming language.

- PEPs
  - **Python Enhancement Proposals** (www.python.org/dev/peps)
  - Describes changes to Python itself, or the standards around it.
  - Notable PEPs
    - **PEP 1** -- PEP Purpose and Guidelines.
    - **PEP 8** -- Style Guide for Python Code
    - **PEP 20** -- The Zen of Python
    - **PEP 257** -- Docstring Conventions

```
import this
```

- PyCon
  - **Python Conference** (www.pycon.org)
  - **PyCon Taiwan (tw.pycon.org)**
- PIGgies
  - **Python User Groups** (wiki.python.org/moin/LocalUserGroups)
  - Taiwan Python User Group (wiki.python.org.tw)

Documentation

- What happens if you type `len.__doc__` in the interactive shell?
- Remember `help`? What's the relationship between `help(len)` and `len.__doc__`?
- Where's `len.__doc__` from?

```
>>> len.__doc__
'len(object) -> integer\n\nReturn the number of items of a sequence or mapping.'
>>> help(len)
```

```
Help on built-in function len in module __builtin__:

len(...)
    len(object) -> integer

    Return the number of items of a sequence or mapping.
(END)
```

Press 'q' to quit

DocStrings

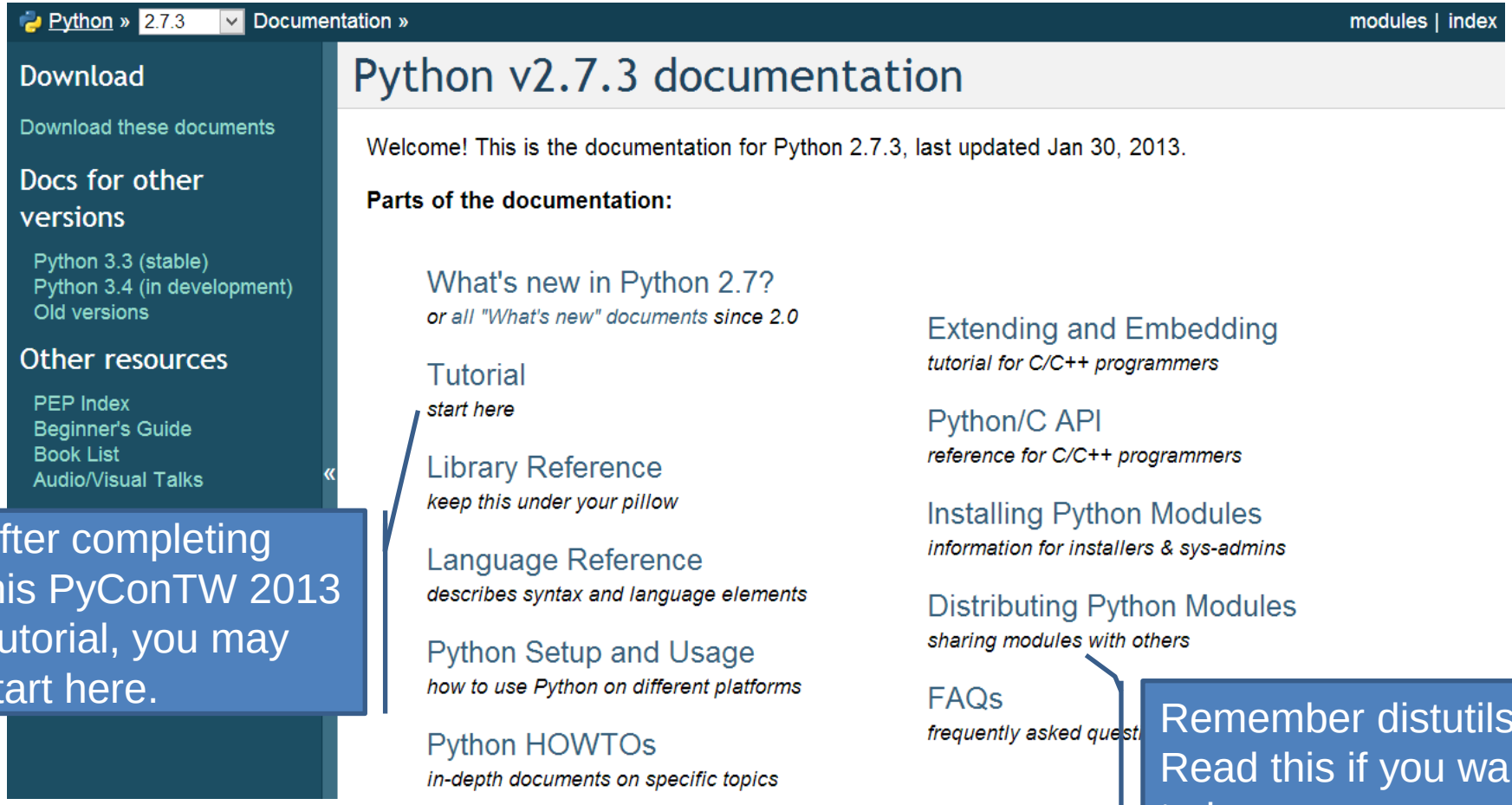
- Type the following code in the interactive shell.

```
def max(a, b):
    '''max(a, b) -> value

       With two arguments, return the largest argument.'''
    return a if a > b else b
```

- Type `max.__doc__` in the interactive shell.
- Type `help(max)` in the interactive shell.
- You'll know what DocStrings are.
- Remember to read **PEP 257** if you want to comply with **DocString Conventions**.

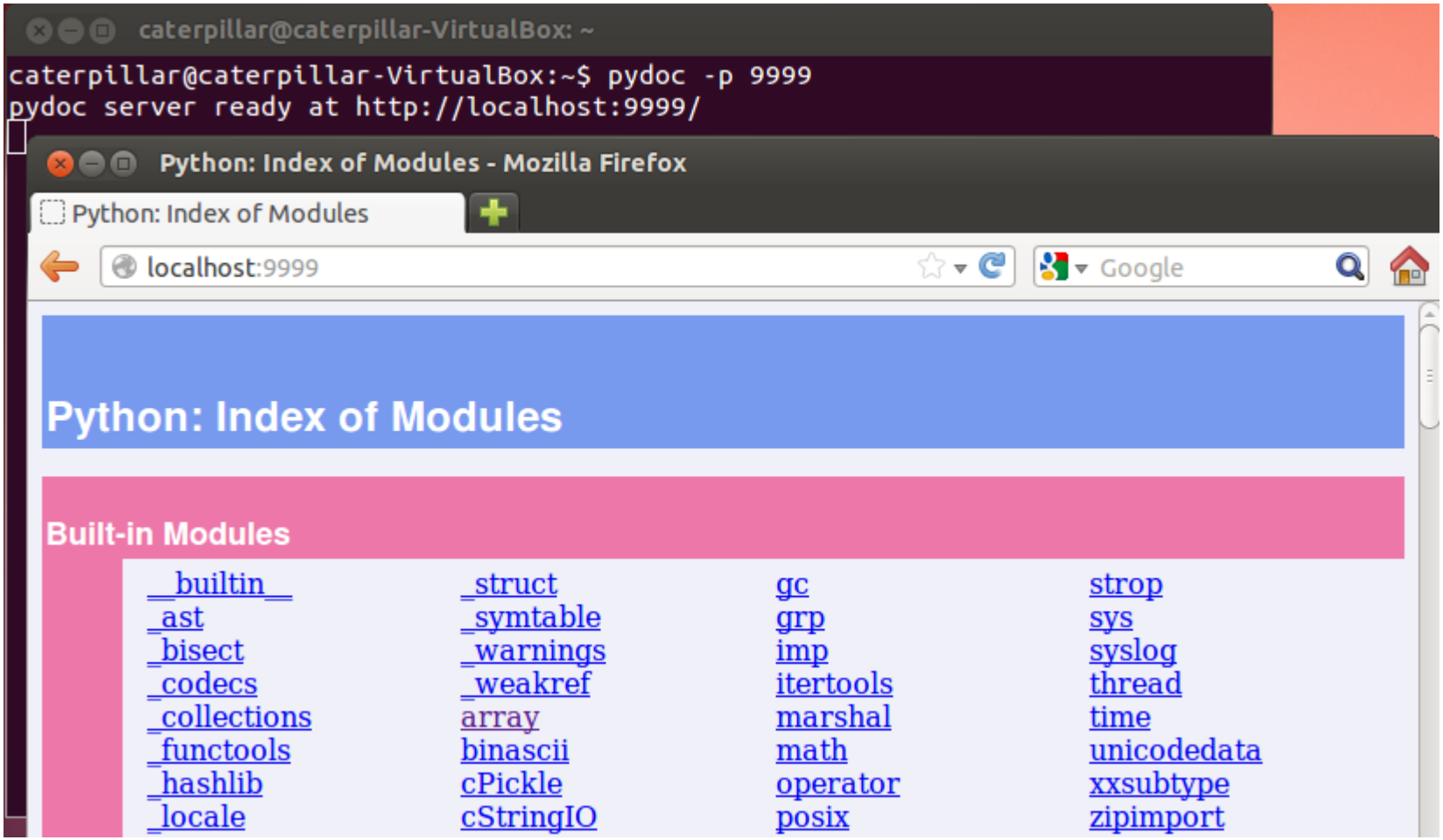
Official Documentation

- docs.python.org



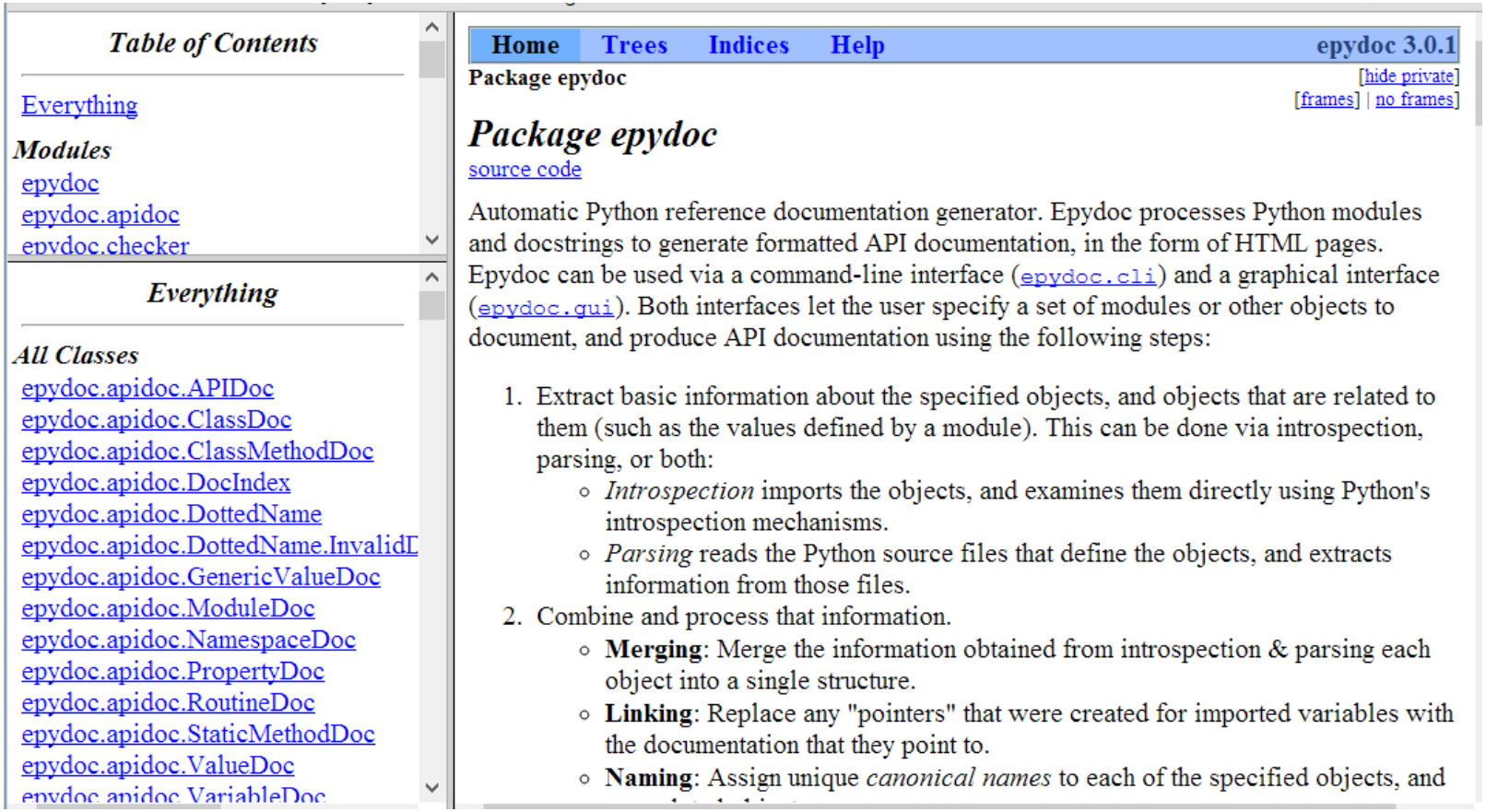
PyDoc

- The pydoc module automatically generates documentation from Python modules.



EpyDoc

- Looks for something like JavaDoc?
- epydoc.sourceforge.net



Data Management Functions

- Built-in Functions (located in the **`__builtin__`** module)
  - `range(start, stop[, step])`
  - `zip([iterable, ...])`
  - `enumerate(sequence, start=0)`
  - `reduce(function, iterable[, initializer])`

Exercise 6

- How to iterate through a list with an index? For examples, given a list `names = ['Justin', 'caterpillar', 'openhome']`, print the followings.

```
0, Justin
1, caterpillar
2, openhome
```

- Hints:
  - 1. Fill in the blanks with proper codes.

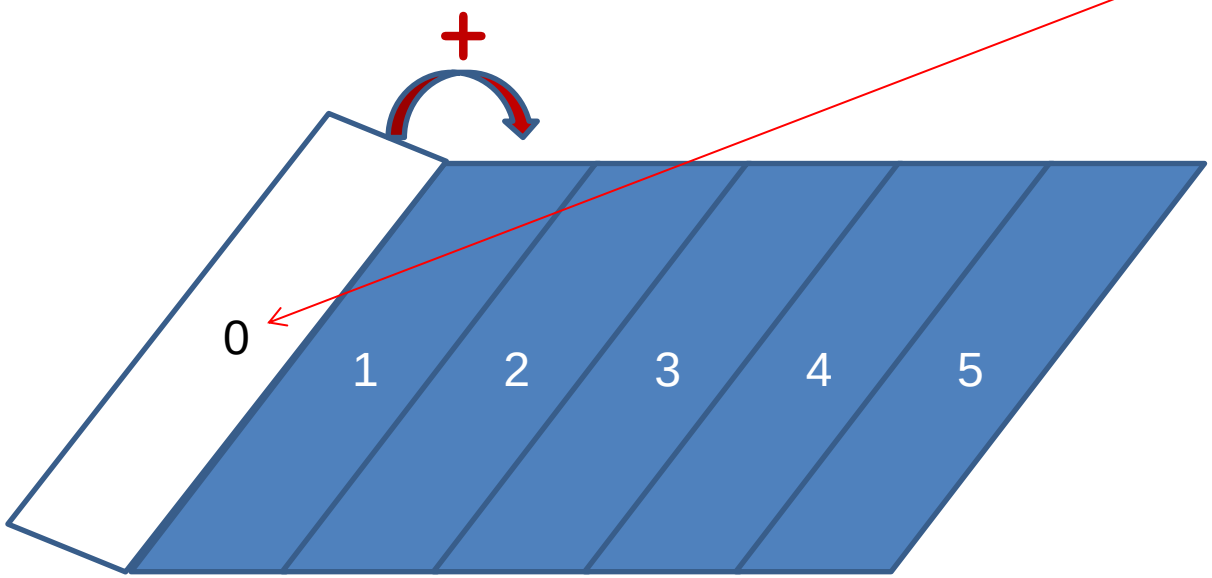
```
names = ['Justin', 'caterpillar', 'openhome']
for ______ in ______:
    print '{0}, {1}'.format(______)
```

  - 2. Look up documentations about `range`, `zip` and `enumerate`.

reduce

- Sometimes, it's called `foldLeft`.

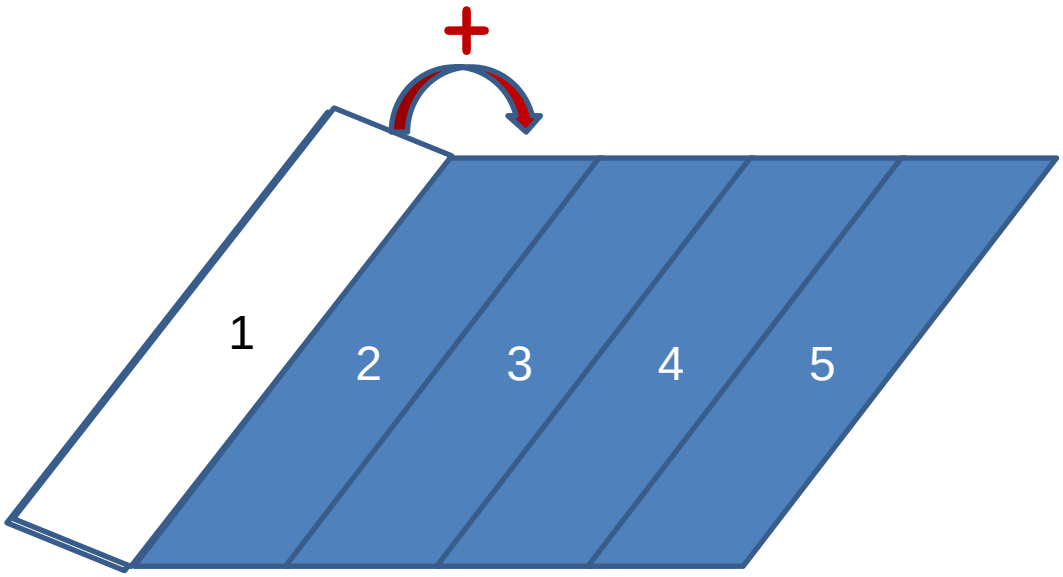
```
reduce(lambda sum, elem: sum + elem, [1, 2, 3, 4, 5], 0)
```



reduce

- Sometimes, it's called `foldLeft`.

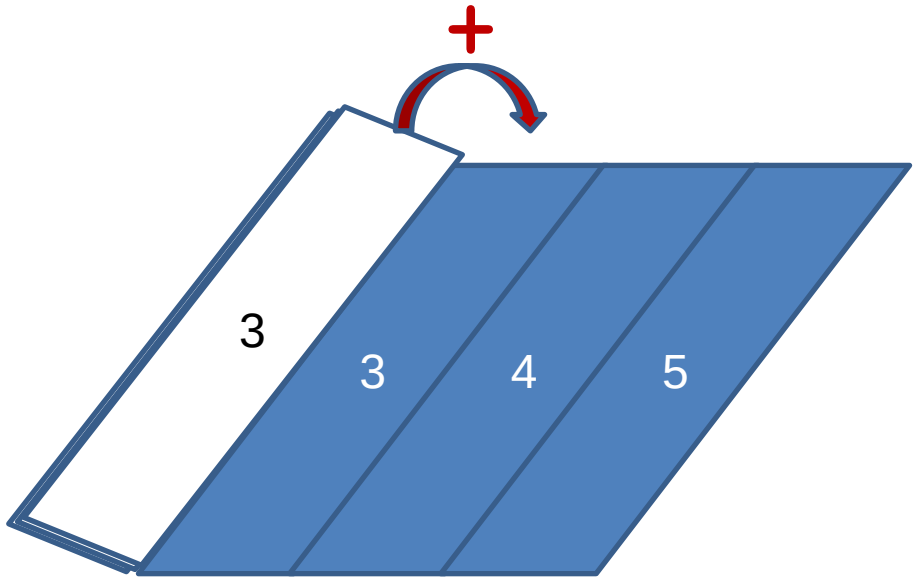
```
reduce(lambda sum, elem: sum + elem, [1, 2, 3, 4, 5], 0)
```



reduce

- Sometimes, it's called `foldLeft`.

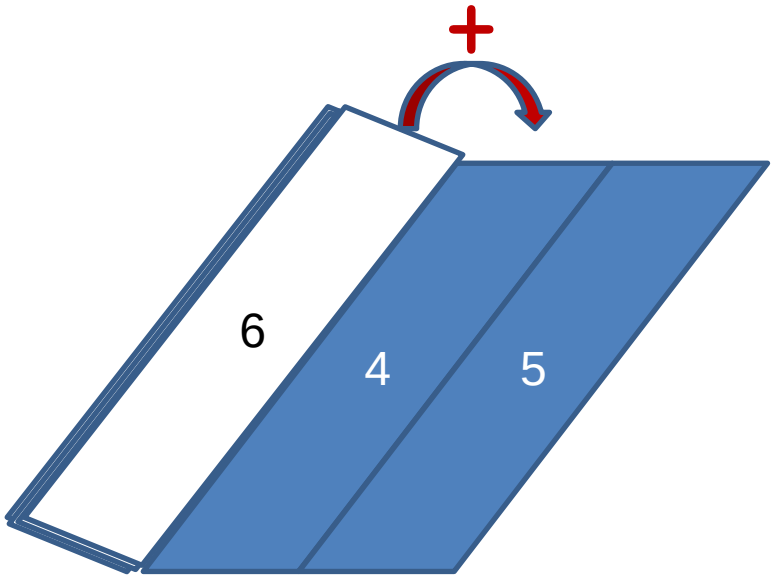
```
reduce(lambda sum, elem: sum + elem, [1, 2, 3, 4, 5], 0)
```



reduce

- Sometimes, it's called `foldLeft`.

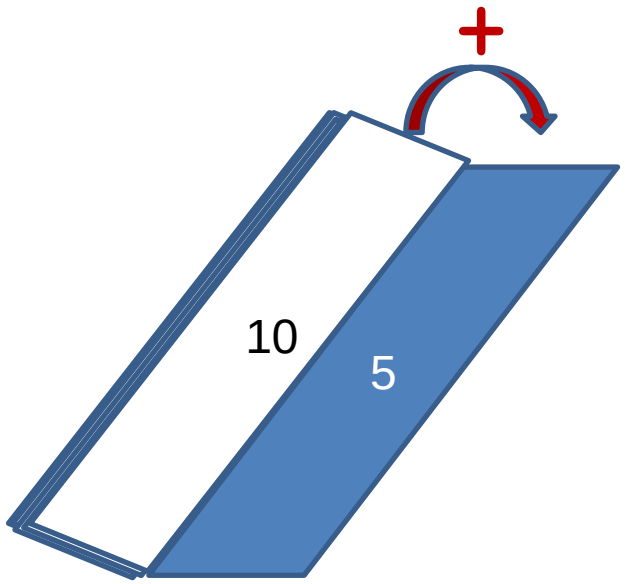
```
reduce(lambda sum, elem: sum + elem, [1, 2, 3, 4, 5], 0)
```



reduce

- Sometimes, it's called `foldLeft`.

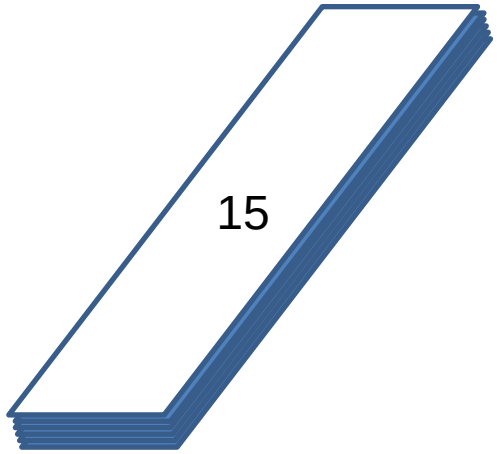
```
reduce(lambda sum, elem: sum + elem, [1, 2, 3, 4, 5], 0)
```



reduce

- Sometimes, it's called `foldLeft`.

```
reduce(lambda sum, elem: sum + elem, [1, 2, 3, 4, 5], 0)
```



`reduce`

- `reduce` is a really versatile function that can be used in millions of different ways.
- Once you want to calculate something from a list, consider using `reduce` instead of a `for` loop.

Exercise 7

- Use **`reduce`** and **list comprehensions** to revise the following code (avaliable in lab/exercises/exercise7/main.py).

main.py

```
1  def ascending(a, b): return a - b
2  def descending(a, b): return -ascending(a, b)
3  # selection sort
4  def sorted(xs, compare = ascending):
5      return [] if not xs else __select(xs, compare)
6
7  def __select(xs, compare):
8      selected = xs[0]
9      for elem in xs[1:]:
10         if compare(elem, selected) < 0:
11             selected = elem
12
13     remain = []
14     selected_list = []
15     for elem in xs:
16         if elem != selected:
17             remain.append(elem)
18         else:
19             selected_list.append(elem)
20
21     return xs if not remain else selected_list + __select(remain, compare)
22
23 print sorted([2, 1, 3, 6, 5])
24 print sorted([2, 1, 3, 6, 5], descending)
```

Persistence

- Object serialization
  - `marshal`, `pickle`, `cPickle`
- DBM (Database Manager)
  - Simple “database” interface. Dbm objects behave like mappings (dictionaries) , except that **keys and values are always strings**.
- `shelve`
  - A “shelf” is a persistent, dictionary-like object. **The values can be essentially arbitrary Python objects**.
- DB-API 2.0 (PEP 249)
- Object-Relational Mapping (3rd-party libraries)
  - SQLAlchemy (www.sqlalchemy.org)
  - SQLObject (www.sqlobject.org)

`marshal`, `pickle`, `cPickle`

- A more primitive serialization module is `marshal`. It exists primarily to support Python's .pyc files.
- In general, `pickle` should always be the preferred way to serialize Python objects.
  - It keeps track of the objects it has already serialized, so that later references to the same object won't be serialized again.
  - It can serialize user-defined classes and their instances.
  - Its serialization format is guaranteed to be backwards compatible across Python releases.
- `cPickle` is written in C, so it can be up to 1000 times faster than `pickle`.

pickle

```
class DVD:
    def __init__(self, title, year=None,
        duration=None, director_id=None):
        self.title = title
        self.year = year
        self.duration = duration
        self.director_id = director_id
        self.filename = self.title.replace(' ', '_') + '.pkl'

    def check_filename(self, filename):
        if filename is not None:
            self.filename = filename
```

```
def save(self, filename=None):
    self.check_filename(filename)
    fh = None
    try:
        data = (self.title, self.year,
                self.duration, self.director_id)
        fh = open(self.filename, 'wb')
        pickle.dump(data, fh)
    except (EnvironmentError, pickle.PicklingError) as err:
        raise SaveError(str(err))
    finally:
        if fh is not None:
            fh.close()

def load(self, filename=None):
    self.check_filename(filename)
    fh = None
    try:
        fh = open(self.filename, 'rb')
        data = pickle.load(fh)
        (self.title, self.year,
         self.duration, self.director_id) = data
    except (EnvironmentError, pickle.PicklingError) as err:
        raise LoadError(str(err))
    finally:
        ...
```

DBM

- The `dbm` module provides an interface to the Unix “(n)dbm” library.

docs.python.org/2.7/library/anydbm.html#module-anydbm

```
import anydbm

# Open database, creating it if necessary.
db = anydbm.open('cache', 'c')

# Record some values
db['www.python.org'] = 'Python Website'
db['www.cnn.com'] = 'Cable News Network'

# Loop through contents.  Other dictionary methods
# such as .keys(), .values() also work.
for k, v in db.iteritems():
    print k, '\t', v

# Storing a non-string key or value will raise an exception (most
# likely a TypeError).
db['www.yahoo.com'] = 4

# Close when done.
db.close()
```

shelve

- A “shelf” is a persistent, dictionary-like object. The difference with “dbm” databases is that the values (not the keys!) in a shelf can be anything that the pickle module can handle.

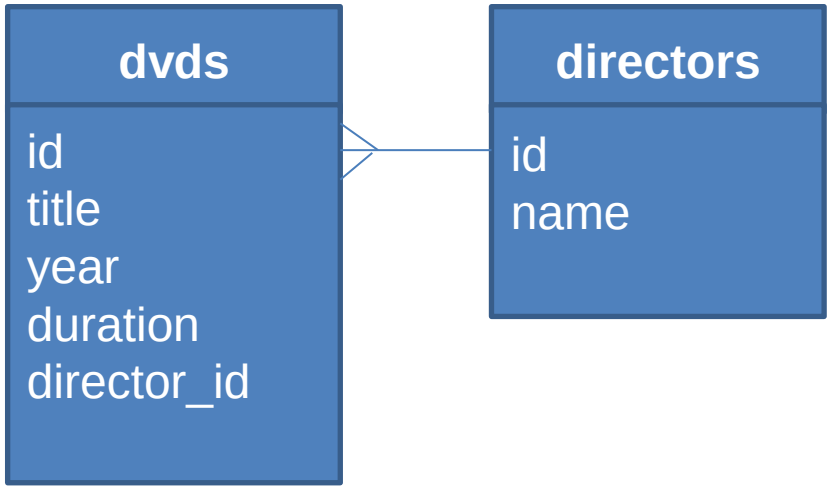
```
class DvdDao:
    def __init__(self, shelve_name):
        self.shelve_name = shelve_name

    def save(self, dvd):
        shelve_db = None
        try:
            shelve_db = shelve.open(self.shelve_name)
            shelve_db[dvd.title] = (dvd.year,
                dvd.duration, dvd.director_id)
            shelve_db.sync()
        finally:
            if shelve_db is not None:
                shelve_db.close()
```

```
    def all(self):
        shelve_db = None
        try:
            shelve_db = shelve.open(self.shelve_name)
            return [DVD(title, *shelve_db[title])
                    for title in sorted(shelve_db, key=str.lower)]
        finally:
            if shelve_db is not None:
                shelve_db.close()
        return []

    def load(self, title):
        shelve_db = None
        try:
            shelve_db = shelve.open(self.shelve_name)
            if title in shelve_db:
                return DVD(title, *shelve_db[title])
        finally:
            if shelve_db is not None:
                shelve_db.close()
        return None
```

```
    def remove(self, title):
        shelve_db = None
        try:
            shelve_db = shelve.open(self.shelve_name)
            del shelve_db[title]
            shelve_db.sync()
        finally:
            if shelve_db is not None:
                shelve_db.close()
```

DB-API 2.0（PEP 249）

- The `sqlite3` module provides a SQL interface compliant with the DB-API 2.0.



```
def connect(name):
    create = not os.path.exists(name)
    conn = sqlite3.connect(name)
    if create:
        cursor = conn.cursor()
        cursor.execute("CREATE TABLE directors ("
            "id INTEGER PRIMARY KEY AUTOINCREMENT UNIQUE NOT NULL, "
            "name TEXT UNIQUE NOT NULL)")
        cursor.execute("CREATE TABLE dvds ("
            "id INTEGER PRIMARY KEY AUTOINCREMENT UNIQUE NOT NULL, "
            "title TEXT NOT NULL, "
            "year INTEGER NOT NULL, "
            "duration INTEGER NOT NULL, "
            "director_id INTEGER NOT NULL, "
            "FOREIGN KEY (director_id) REFERENCES directors)")
        conn.commit()

    return conn
```

```
def add_dvd(conn, title, year, duration, director):
    director_id = get_and_set_director(conn, director)
    cursor = conn.cursor()
    cursor.execute("INSERT INTO dvds "
                   "(title, year, duration, director_id) "
                   "VALUES (?, ?, ?, ?)",
                   (title, year, duration, director_id))
    conn.commit()

def get_and_set_director(conn, director):
    director_id = get_director_id(conn, director)
    if director_id is not None:
        return director_id
    cursor = conn.cursor()
    cursor.execute("INSERT INTO directors (name) VALUES (?)",
                   (director,))
    conn.commit()
    return get_director_id(conn, director)

def get_director_id(conn, director):
    cursor = conn.cursor()
    cursor.execute("SELECT id FROM directors WHERE name=?",
                   (director,))
    fields = cursor.fetchone()
    return fields[0] if fields is not None else None
```

```
def all_dvds(conn):
    cursor = conn.cursor()
    sql = ("SELECT dvds.title, dvds.year, dvds.duration, "
           "directors.name FROM dvds, directors "
           "WHERE dvds.director_id = directors.id"
           " ORDER BY dvds.title")
    cursor.execute(sql)
    return [(str(fields[0]), fields[1], fields[2], str(fields[3]))
            for fields in cursor]

def all_directors(conn):
    cursor = conn.cursor()
    cursor.execute("SELECT name FROM directors ORDER BY name")
    return [str(fields[0]) for fields in cursor]
```

Exercise 8

- There’re three incomplete source files located in lab/exercises/exercise8. Choose what you are interested in and complete it.
- All code you need were listed in the previous slides.

References

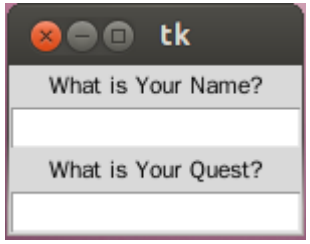
- The Community
  - http://www.python.org/~guido/
  - http://www.python.org/psf/
  - http://www.python.org/dev/peps/
  - http://www.pycon.org/
  - http://wiki.python.org/moin/LocalUserGroups/
- Documentation
  - http://docs.python.org/2.7/
  - http://docs.python.org/2/library/pydoc.html
- Data Management Functions
  - http://docs.python.org/2.7/library/functions.html
- Persistence
  - http://docs.python.org/2/library/pickle.html
  - http://docs.python.org/2.7/library/dbm.html
  - http://docs.python.org/2/library/shelve.html
  - http://docs.python.org/2.7/library/sqlite3.html

Libraries vs Frameworks

- **What is the difference between a framework and a library?**
- Using libraries, your code is in control: **you decides** when to ask questions, when to read responses, and when to process those results.

```
name = raw_input('What is your name?')
process_name(name)
quest = raw_input('What is your quest?')
process_quest(quest)
```

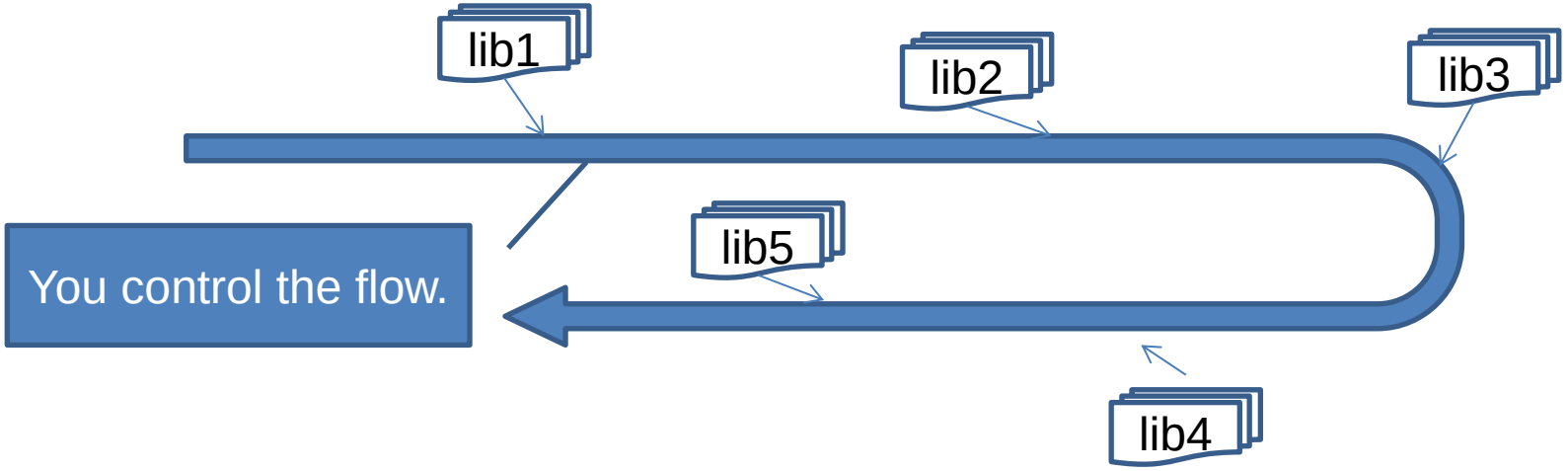
- **A framework decides** when to call your functions. **The control is inverted - it calls you rather you calling the framework**.



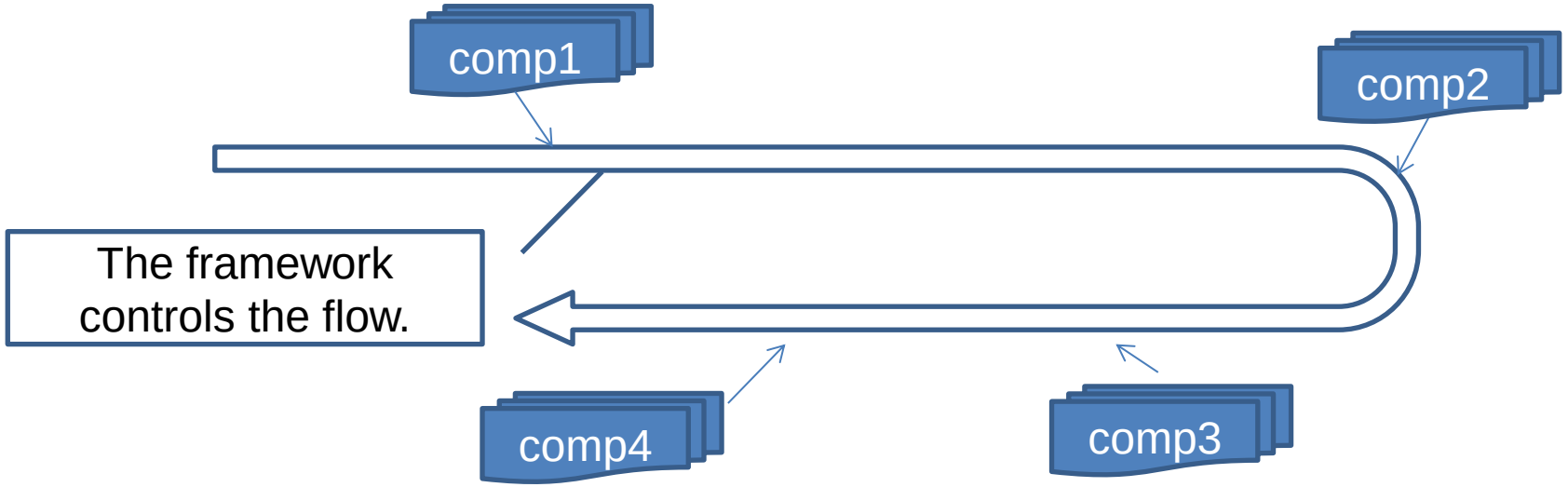

```
import Tkinter

top = Tkinter.Tk()

Tkinter.Label(top, text='What is Your Name?').pack()
name_var = Tkinter.StringVar()
name_entry = Tkinter.Entry(top, textvariable=name_var)
name_entry.pack()
name_entry.bind('<FocusOut>', lambda event: process_name(name_var))

Tkinter.Label(top, text='What is Your Quest?').pack()
quest_var = Tkinter.StringVar()
quest_entry = Tkinter.Entry(top, textvariable=quest_var)
quest_entry.pack()
quest_entry.bind('<FocusOut>', lambda event:
process_name(quest_var))

Tkinter.mainloop()
```

Inversion of Control

- Using libraries

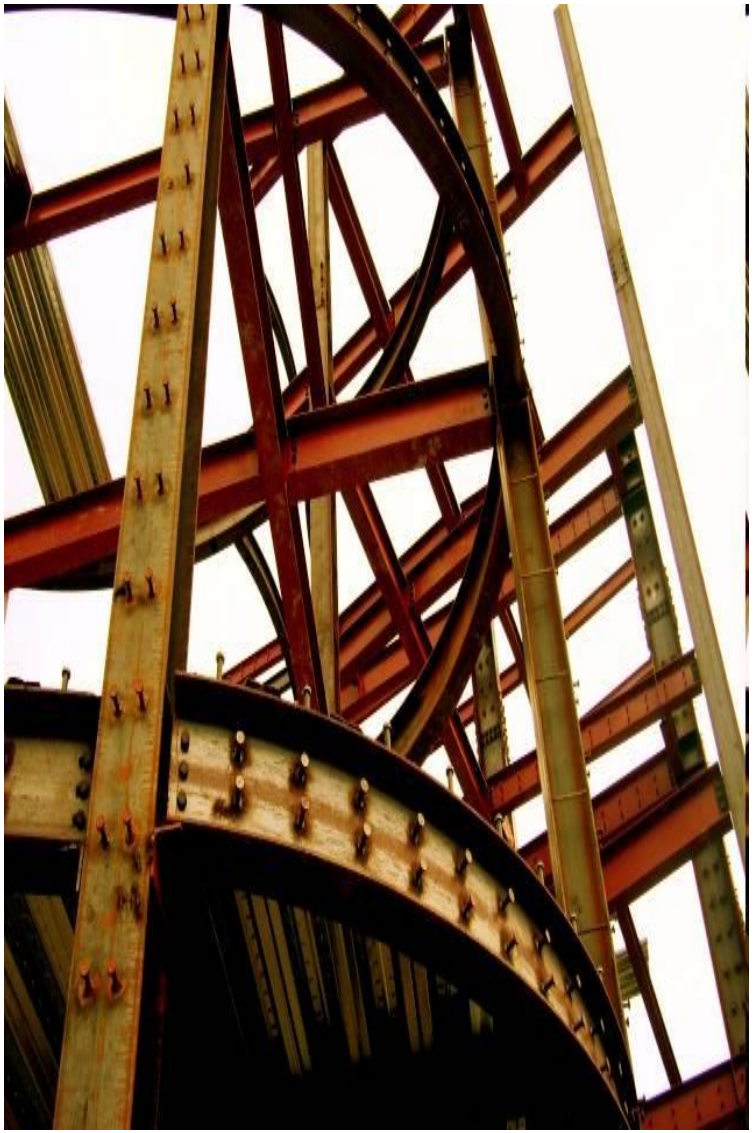


- Using frameworks



Do We Need a Framework?

- **Libraries bring developers freedom.**
- **Frameworks bring developers constraints.**
  - Do we need a framework?
  - Do we want to follow the flow?
  - Do we make decisions according to technical reasons, or business reasons?
- **A right framework brings you a heaven; the wrong one brings you a hell.**



Getting Started with Django

- Django (www.djangoproject.com) is a high-level Python Web framework that encourages rapid development and clean, pragmatic design.
  - Object-relational mapper
  - Automatic admin interface
  - Elegant URL design
  - Template system
  - Cache system
  - Internationalization

Design Your Models

Inheritance

```
class Reporter(models.Model):
    full_name = models.CharField(max_length=70)

    def __unicode__(self):
        return self.full_name

class Article(models.Model):
    pub_date = models.DateField()
    headline = models.CharField(max_length=200)
    content = models.TextField()
    reporter = models.ForeignKey(Reporter)

    def __unicode__(self):
        return self.headline
```

```
# No reporters are in the system yet.
>>> Reporter.objects.all()
[]

# Create a new Reporter.
>>> r = Reporter(full_name='John Smith')

# Save the object into the database. You have to call save() explicitly.
>>> r.save()

# Now it has an ID.
>>> r.id
1
```

Design Your URLs

```
from django.conf.urls import patterns

urlpatterns = patterns('',
    (r'^articles/(\d{4})/$', 'news.views.year_archive'),
    (r'^articles/(\d{4})/(\d{2})/$', 'news.views.month_archive'),
    (r'^articles/(\d{4})/(\d{2})/(\d+)/$', 'news.views.article_detail'),
)
```

Write Your Views and Templates

A request parameter.

```
def year_archive(request, year):
    a_list = Article.objects.filter(pub_date__year=year)
    return render_to_response('news/year_archive.html', {'year': year, 'article_list': a_list})
```

```
<html>
<head>
    <title>{% block title %}{% endblock %}</title>
</head>
<body>
    <img src="sitelogo.png" alt="Logo" />
    {% block content %}{% endblock %}
</body>
</html>
```

```
{% extends "base.html" %}

{% block title %}Articles for {{ year }}{% endblock %}

{% block content %}
<h1>Articles for {{ year }}</h1>

{% for article in article_list %}
    <p>{{ article.headline }}</p>
    <p>By {{ article.reporter.full_name }}</p>
    <p>Published {{ article.pub_date|date:"F j, Y" }}</p>
{% endfor %}
{% endblock %}
```

Creating a Project（Exercise 9）

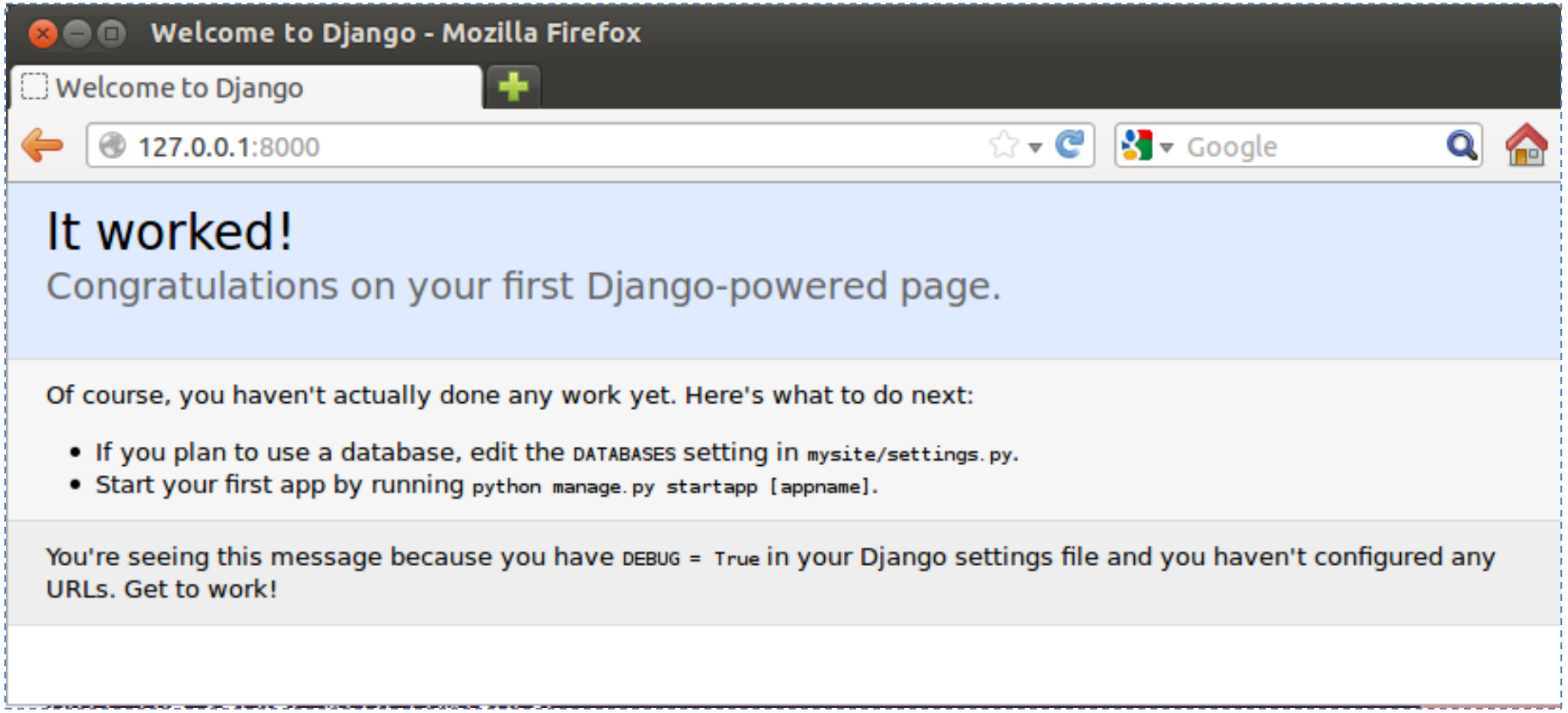
- We’d like to install an offical realse of **Django 1.5.1** with **pip** under a virtual Python environment provided by **virtualenv**. And Then, create our first django project.

```
~/scripts$ virtualenv --distribute venv
~/scripts$ cd venv
~/scripts/venv$ source bin/activate
~/scripts/venv$ pip install Django==1.5.1
~/scripts/venv$ python -c 'import django; print django.get_version()'
~/scripts/venv$ django-admin.py startproject mysite
~/scripts/venv$ ls -al mysite
~/scripts/venv$ cd mysite
~/scripts/venv$ python manage.py runserver
```

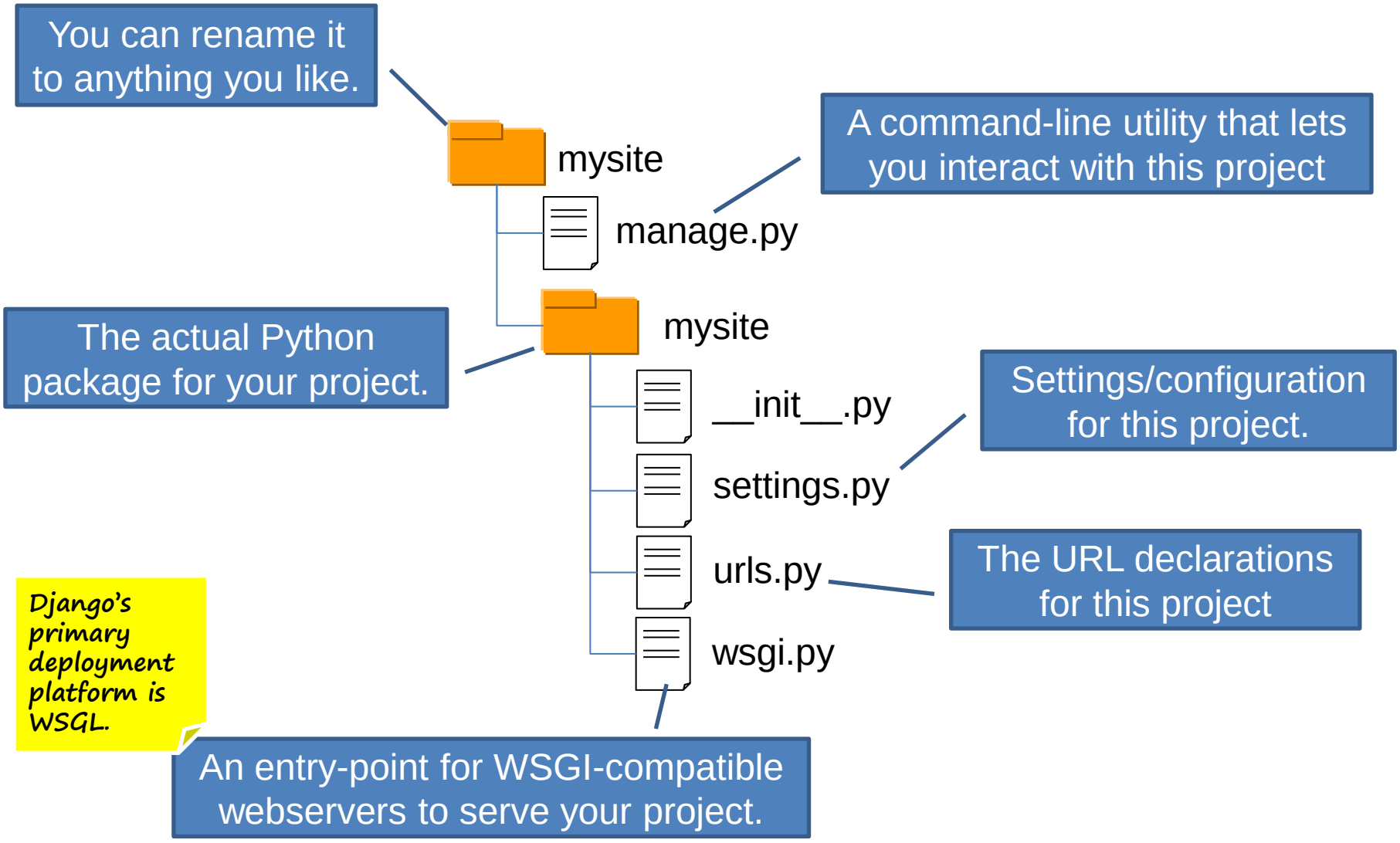
What You Should See

```
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$ python -c 'import djang
o; print django.get_version()'
1.5.1
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$ django-admin.py startpr
oject mysite
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$ ls -al mysite
總計 16
drwxrwxr-x 3 caterpillar caterpillar 4096  5月 16 14:52 .
drwxrwxr-x 8 caterpillar caterpillar 4096  5月 16 14:52 ..
-rw-rw-r-- 1 caterpillar caterpillar  249  5月 16 14:52 manage.py
drwxrwxr-x 2 caterpillar caterpillar 4096  5月 16 14:52 mysite
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv$ cd mysite
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv/mysite$ python manage.py
 runserver
Validating models...

0 errors found
May 16, 2013 - 01:54:08
Django version 1.5.1, using settings 'mysite.settings'
Development server is running at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

What You Should See



What `startproject` Created



Creating a Database and an App (Exercise 10)

- Edit **mysite/settings.py**. Change the following keys in the `DATABASES 'default'` item to match your database connection settings.

settings.py

```
12  DATABASES = {
13      'default': {
14          'ENGINE': 'django.db.backends.sqlite3', # Add 'postgresql_psycopg2', 'mysql', 'sqlite3' or 'oracle'.
15          'NAME': '/home/caterpillar/scripts/venv/mysite/db.sqlite3',  # Or path to database file if using sqlite3.
16          # The following settings are not used with sqlite3:
17          'USER': '',
18          'PASSWORD': '',
19          'HOST': '',                      # Empty for localhost through domain sockets or '127.0.0.1' for localhost
20          'PORT': '',                      # Set to empty string for default.
21      }
22  }
```

- `python manage.py syncdb`

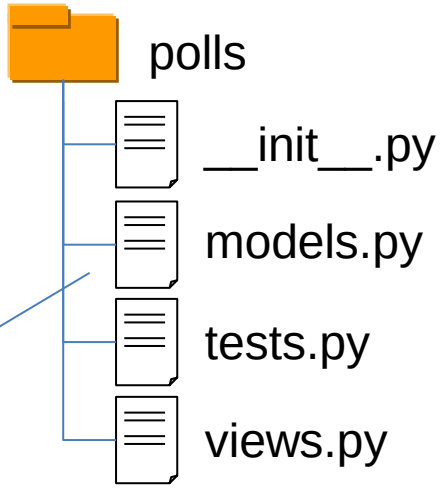
What You Should See

```
Creating tables ...
Creating table auth_permission
Creating table auth_group_permissions
Creating table auth_group
Creating table auth_user_groups
Creating table auth_user_user_permissions
Creating table auth_user
Creating table django_content_type
Creating table django_session
Creating table django_site

You just installed Django's auth system, which means you don't have any superuse
rs defined.
Would you like to create one now? (yes/no): yes
Username (leave blank to use 'caterpillar'):
Email address: caterpillar@openhome.cc
Password:
Password (again):
Superuser created successfully.
Installing custom SQL ...
Installing indexes ...
Installed 0 object(s) from 0 fixture(s)
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv/mysite$
```

- Type the following command to create a simple poll app.
  - `python manage.py startapp polls`
- Edit the **polls/models.py** so it looks like this:

models.py

```python
from django.db import models

class Poll(models.Model):
    question = models.CharField(max_length=200)
    pub_date = models.DateTimeField('date published')

    def was_published_recently(self):
        return self.pub_date >= timezone.now() - datetime.timedelta(days=1)

    def __unicode__(self):
        return self.question

class Choice(models.Model):
    poll = models.ForeignKey(Poll)
    choice_text = models.CharField(max_length=200)
    votes = models.IntegerField()

    def __unicode__(self):
        return self.choice_text
```



- Edit the **settings.py** again, and change the `INSTALLED_APPS` setting to include the string `'polls'`.

settings.py

```
111
112 INSTALLED_APPS = (
113     'django.contrib.auth',
114     'django.contrib.contenttypes',
115     'django.contrib.sessions',
116     'django.contrib.sites',
117     'django.contrib.messages',
118     'django.contrib.staticfiles',
119     # Uncomment the next line to enable the admin:
120     # 'django.contrib.admin',
121     # Uncomment the next line to enable admin documentation:
122     # 'django.contrib.admindocs',
123     'polls'
124 )
```

- Type the following command to create tables for the polls app.
  - `python manage.py sql polls`
  - `python manage.py syncdb`

What You Should See

```
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv/mysite$ python manage.py
 sql polls
BEGIN;
CREATE TABLE "polls_poll" (
    "id" integer NOT NULL PRIMARY KEY,
    "question" varchar(200) NOT NULL,
    "pub_date" datetime NOT NULL
)
;
CREATE TABLE "polls_choice" (
    "id" integer NOT NULL PRIMARY KEY,
    "poll_id" integer NOT NULL REFERENCES "polls_poll" ("id"),
    "choice_text" varchar(200) NOT NULL,
    "votes" integer NOT NULL
)
;

COMMIT;
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv/mysite$ python manage.py
 syncdb
Creating tables ...
Creating table polls_poll
Creating table polls_choice
Installing custom SQL ...
Installing indexes ...
Installed 0 object(s) from 0 fixture(s)
(venv)caterpillar@caterpillar-VirtualBox:~/scripts/venv/mysite$
```

Playing API with the Python shell

- Type the following command to set the `DJANGO_SETTINGS_MODULE` environment variable, which gives Django the Python import path to your settings.py file.
  - `python manage.py shell`

Basic ORM

```
>>> from polls.models import Poll, Choice
>>> from django.utils import timezone
>>> p = Poll(question="What's new?", pub_date=timezone.now())
>>> p.save()
>>> p.id
1
>>> p.question
"What's new?"
>>> p.pub_date
datetime.datetime(2013, 2, 6, 3, 8, 40, 994702, tzinfo=<UTC>)
>>> p.question = "What's up?"
>>> p.save()
>>> Poll.objects.all()
[<Poll: What's up?>]
>>> Poll.objects.filter(id=1)
[<Poll: What's up?>]
>>> Poll.objects.filter(question__startswith='What')
[<Poll: What's up?>]
>>> Poll.objects.get(pub_date__year=timezone.now().year)
<Poll: What's up?>
>>> Poll.objects.get(id=2)
Traceback (most recent call last):
  File "<console>", line 1, in <module>
  File "/home/caterpillar/scripts/venv/local/lib/python2.7/site-packages/django/
db/models/manager.py", line 143, in get
```

One-to-One Relationship

```
>>> p = Poll.objects.get(pk=1)
>>> p.choice_set.create(choice_text='Not much', votes=0)
<Choice: Not much>
>>> p.choice_set.create(choice_text='The sky', votes=0)
<Choice: The sky>
>>> c = p.choice_set.create(choice_text='Just hacking again', votes=0)
>>> c.poll
<Poll: What's up?>
>>> p.choice_set.all()
[<Choice: Not much>, <Choice: The sky>, <Choice: Just hacking again>]
>>> p.choice_set.count()
3
>>> Choice.objects.filter(poll__pub_date__year=timezone.now().year)
[<Choice: Not much>, <Choice: The sky>, <Choice: Just hacking again>]
>>> c = p.choice_set.filter(choice_text__startswith='Just hacking')
>>> c.delete()
>>>
```

Writing Your First View (Exercise 11)

- Let's write your first view. Open the file **polls/views.py** and put the following Python code in it:

views.py

```python
from django.http import HttpResponse

def index(request):
    return HttpResponse("Hello, world. You're at the poll index.")

def detail(request, poll_id):
    return HttpResponse("You're looking at poll {id}.".format(id = poll_id))

def results(request, poll_id):
    return HttpResponse("You're looking at the results of poll {id}.".format(id = poll_id))

def vote(request, poll_id):
    return HttpResponse("You're voting on poll {id}.".format(id = poll_id))
```

- Create a file called **urls.py** in the **polls** directory. Include the following code:

urls.py

```
from django.conf.urls import patterns, url

from polls import views

urlpatterns = patterns('',
    # ex: /polls/
    url(r'^$', views.index, name='index'),
    # ex: /polls/5/
    url(r'^(?P<poll_id>\d+)/$', views.detail, name='detail'),
    # ex: /polls/5/results/
    url(r'^(?P<poll_id>\d+)/results/$', views.results, name='results'),
    # ex: /polls/5/vote/
    url(r'^(?P<poll_id>\d+)/vote/$', views.vote, name='vote'),
)
```

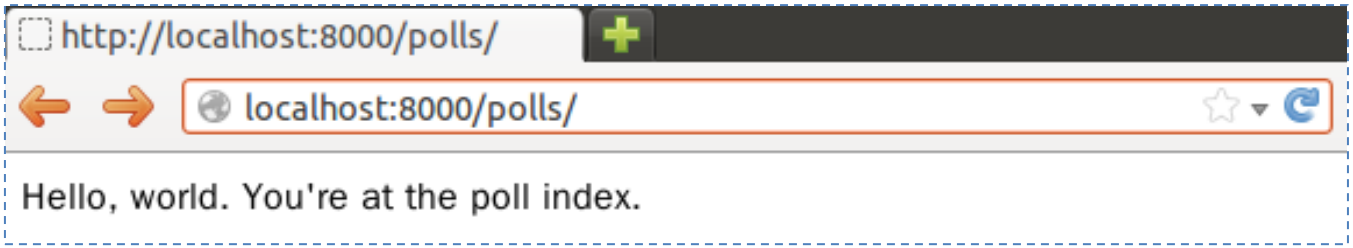
- Open **urls.py** in the **mysite** directory. Include the following code:

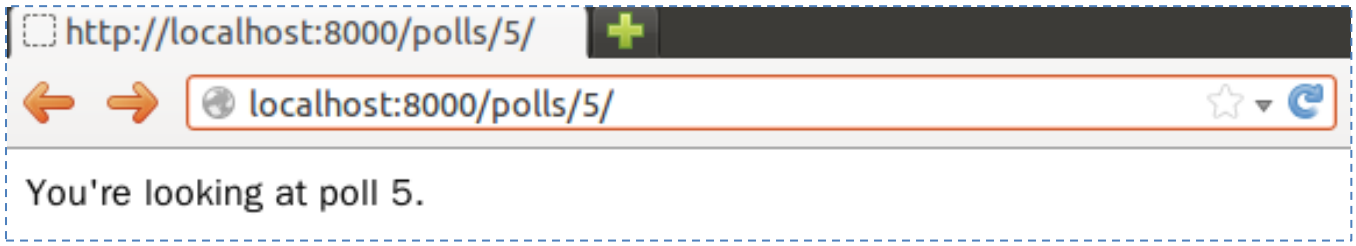
urls.py

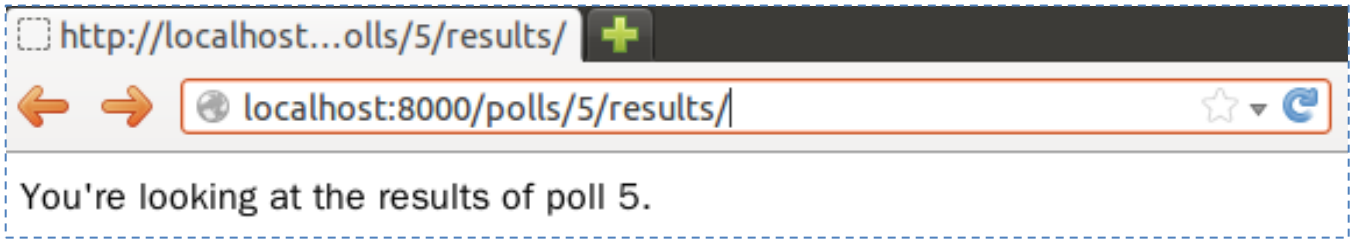
```
urlpatterns = patterns('',
    url(r'^polls/', include('polls.urls'))
    # Examples:
    # url(r'^$', 'mysite.views.home', name='home'),
    # url(r'^mysite/', include('mysite.foo.urls')),
```

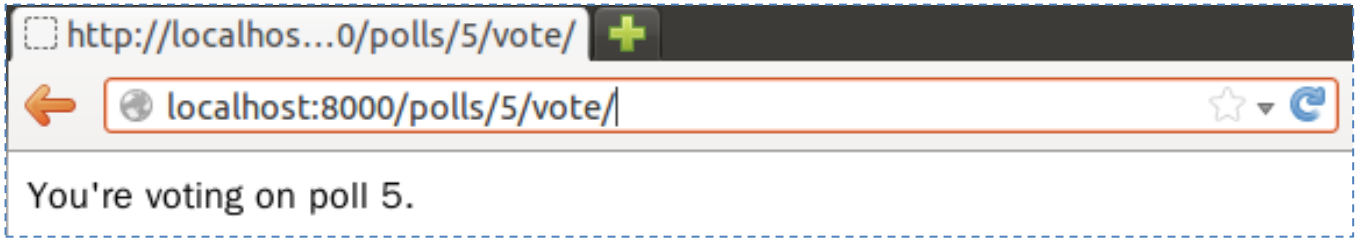
- Type the following command to start the Django development server.
  - `python manage.py runserver`
- Visit the following urls with your browser.
  - http://localhost:8000/polls/
  - http://localhost:8000/polls/5/
  - http://localhost:8000/polls/5/results/
  - http://localhost:8000/polls/5/vote/

What You Should See









Controllers or Views?

- We are using Django **MVC** framework. Are functions `index`, `details`, `results` and `vote` belong to **controllers or views?**
  - Well, the standard names are debatable.
  - In Django's case, a "view" is the Python callback function for a particular URL.
  - Where does the "controller" fit in, then? In Django's case, it's probably the framework itself.
  - As you'll see soon, you might say that Django is a **MTV** framework – that is, "**Model**", "**Template**", and "**View**".

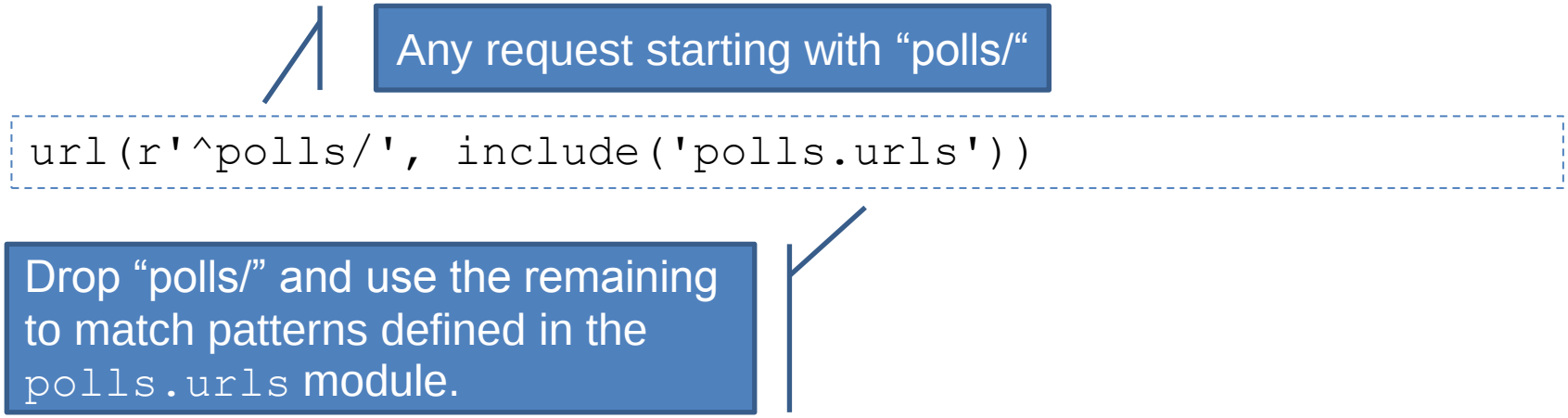
- (Is there `before_filter` in Django as in Rails?
  - **No**. `before_`, `around_` and `after_ filter` concepts aren't present in Django.
  - It’s not hard to hard-code what you need. Or, you can use a generic decorator, such as those provided by the Django authentication system.)

URLconf

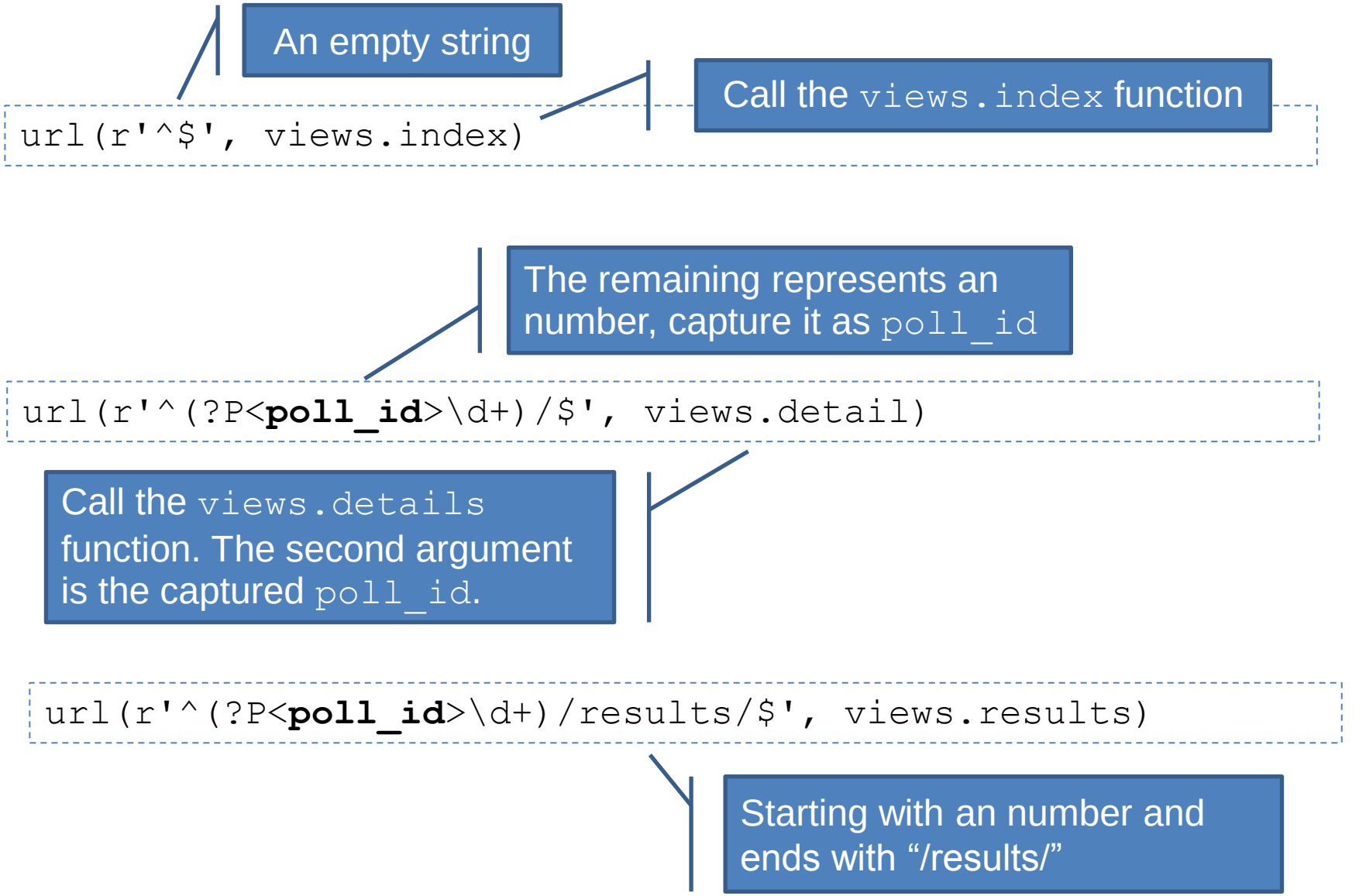
- Determining which view is called is done by Python modules informally titled '**URLconfs**'.
  - These modules are pure Python code and are **a simple mapping between URL patterns to Python callback functions** (your views).
- The `url()` function needs two required arguments and one suggested argument.
  - `regex`: **URL patterns are simple regular expressions**.
  - `view`: When Django finds a regular expression match, Django calls the specified view function, with an `HttpRequest` object as the first argument and any "captured" values from the regular expression as other arguments.
  - `name`: Naming your URL lets you refer to it unambiguously from elsewhere in Django especially templates.

Simple URL Patterns

- For `urlpatterns` in **mysite/urls.py**.



- For `urlpatterns` in **polls/urls.py**.

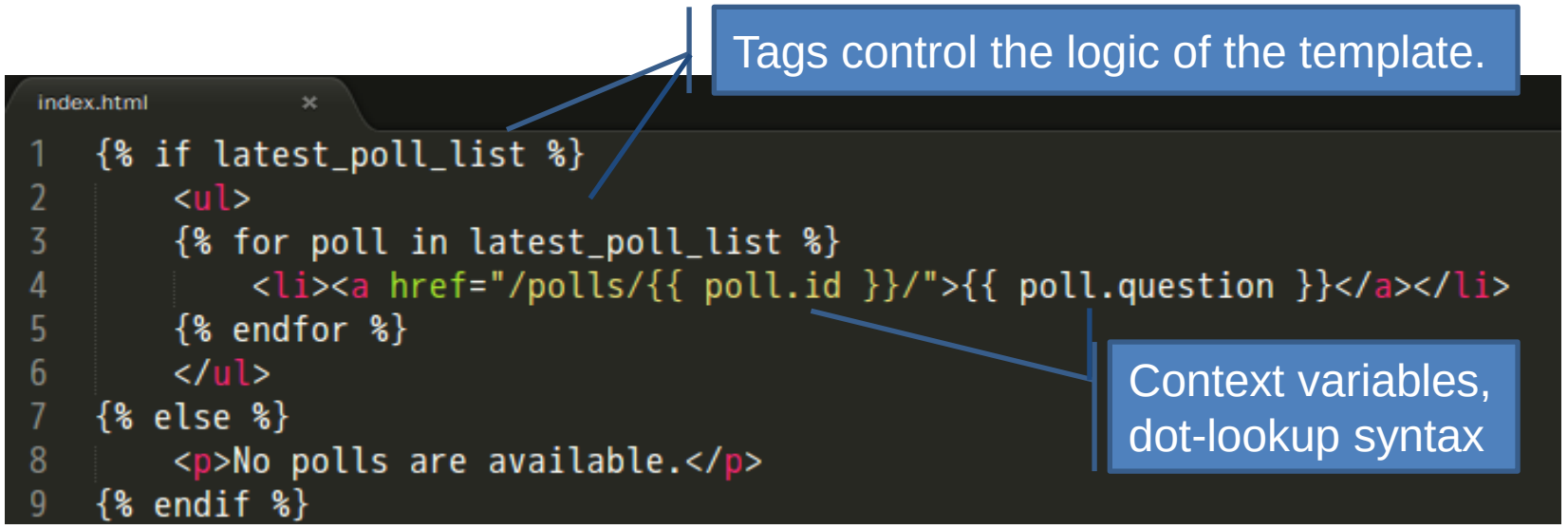


References

- Libraries vs Frameworks
  - http://martinfowler.com/bliki/InversionOfControl.html
- Getting Started with Django
  - https://docs.djangoproject.com/en/1.5/intro/overview/
  - https://docs.djangoproject.com/en/1.5/
  - https://docs.djangoproject.com/en/1.5/intro/install/
  - http://stackoverflow.com/questions/12339608/installing-django-1-5development-version-in-virtualenv
  - https://docs.djangoproject.com/en/1.5/intro/tutorial01/
- Writing Your First View
  - https://docs.djangoproject.com/en/1.5/intro/tutorial03/
  - https://docs.djangoproject.com/en/dev/faq/general/#django-appears-to-be-a-mvc-framework-but-you-call-the-controller-the-view-and-the-view-the-template-how-come-you-don-t-use-the-standard-names
  - https://docs.djangoproject.com/en/1.5/topics/auth/default/

Using the Template System

- Edit the Python code to change the way the page looks? We don't want to back to the spaghetti world.
- Use Django's template system to separate the design from Python.



Writing Templates（Exercise 12）

- Create a directory called **templates** in your **polls** directory. Django will look for templates in there.
- Create another directory called **polls**, and within that Create a file called **index.html**.
  - In other words, your template should be at **polls/templates/polls/index.html**.
- Put the following code in that template:

index.html

```
{% if latest_poll_list %}
    <ul>
    {% for poll in latest_poll_list %}
        <li><a href="/polls/{{ poll.id }}/">{{ poll.question }}</a></li>
    {% endfor %}
    </ul>
{% else %}
    <p>No polls are available.</p>
{% endif %}
```

- Create a file called **detail.html** and put the following code in that template:

detail.html

```
<h1>{{ poll.question }}</h1>
<ul>
{% for choice in poll.choice_set.all %}
    <li>{{ choice.choice_text }}</li>
{% endfor %}
</ul>
```

- Open polls/views.py and revise the functions `index` and `detail` as follows:

views.py

```python
from django.shortcuts import render

from polls.models import Poll
from django.http import Http404

def index(request):
    latest_poll_list = Poll.objects.all().order_by('-pub_date')[:5]
    context = {'latest_poll_list': latest_poll_list}
    return render(request, 'polls/index.html', context)

def detail(request, poll_id):
    try:
        poll = Poll.objects.get(pk=poll_id)
    except Poll.DoesNotExist:
        raise Http404
    return render(request, 'polls/detail.html', {'poll': poll})
```

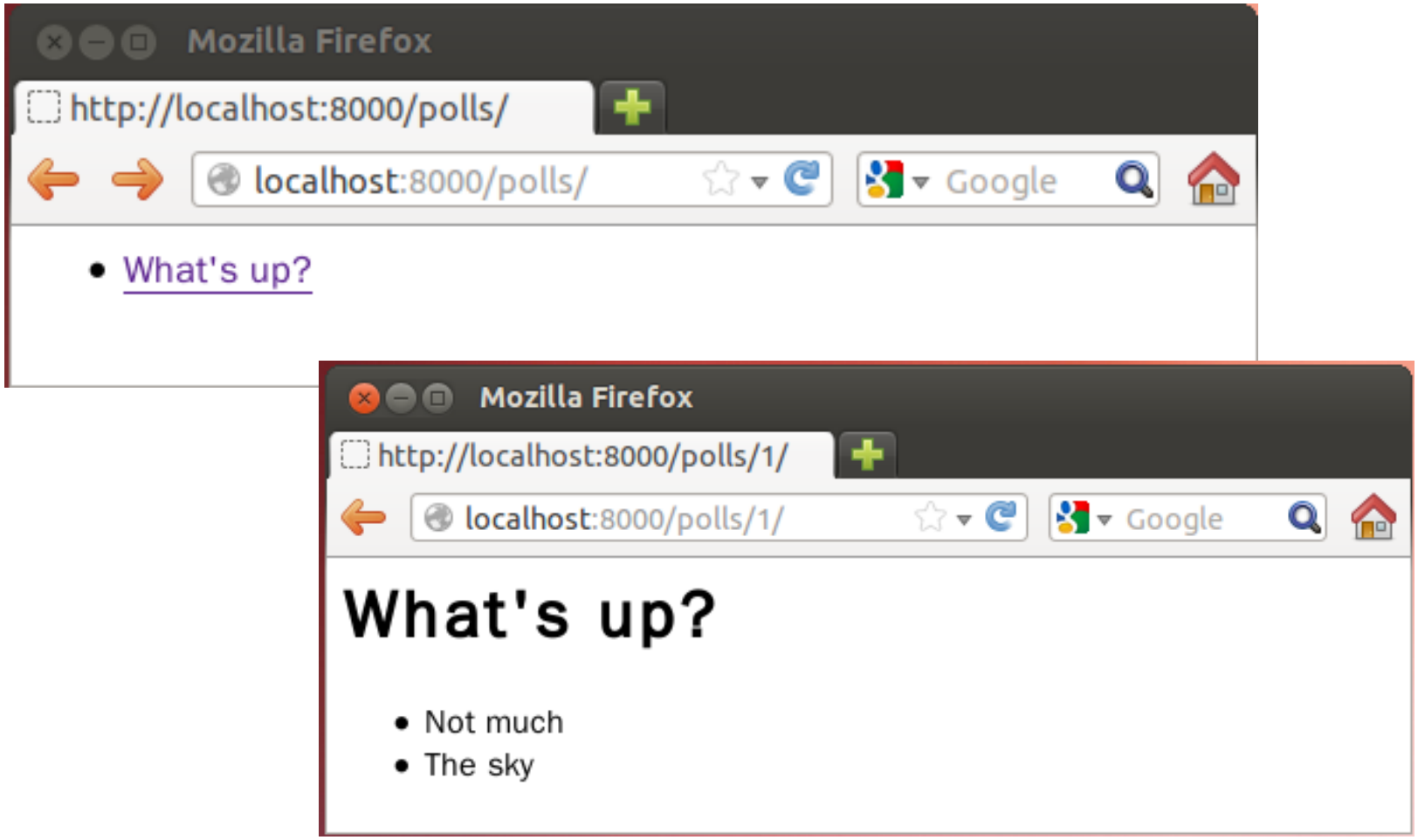
Context variables

A template name

Raise a 404 error

- Use the interactive Python shell.
  - `python manage.py shell`
- Create a new poll.
  - `from polls.models import Poll, Choice`
  - `from django.utils import timezone`
  - `p = Poll(question="What's up?", pub_date=timezone.now())`
  - `p.save()`
- Create two choices.
  - `p.choice_set.create(choice_text='Not much', votes=0)`
  - `p.choice_set.create(choice_text='The sky', votes=0)`

What You Should See



A shortcut: `render()`

```
from django.http import HttpResponse
from django.template import Context, loader
from polls.models import Poll

def index(request):
    latest_poll_list = Poll.objects.order_by('-pub_date')[:5]
    template = loader.get_template('polls/index.html')
    context = Context({
        'latest_poll_list': latest_poll_list,
    })
    return HttpResponse(template.render(context))
```

All Django wants is the `HttpResponse`.

```
from django.shortcuts import render

from polls.models import Poll

def index(request):
    latest_poll_list = Poll.objects.all().order_by('-pub_date')[:5]
    context = {'latest_poll_list': latest_poll_list}
    return render(request, 'polls/index.html', context)
```

A shortcut: `get_object_or_404()`

```
from django.http import Http404
# ...
def detail(request, poll_id):
    try:
        poll = Poll.objects.get(pk=poll_id)
    except Poll.DoesNotExist:
        raise Http404
    return render(request, 'polls/detail.html', {'poll': poll})
```

```
from django.shortcuts import render, get_object_or_404
# ...
def detail(request, poll_id):
    poll = get_object_or_404(Poll, pk=poll_id)
    return render(request, 'polls/detail.html', {'poll': poll})
```

Removing Hardcoded URLs in Templates

- Since you defined the `name` argument in the `url()` functions in the `polls.urls` module…

urls.py

```
5  urlpatterns = patterns('',
6      # ex: /polls/
7      url(r'^$', views.index, name='index'),
8      # ex: /polls/5/
9      url(r'^(?P<poll_id>\d+)/$', views.detail, name='detail'),
10     # ex: /polls/5/results/
11     url(r'^(?P<poll_id>\d+)/results/$', views.results, name='results'),
12     # ex: /polls/5/vote/
13     url(r'^(?P<poll_id>\d+)/vote/$', views.vote, name='vote'),
14 )
```

- You can remove a reliance on specific URL paths…

index.html

```
{% if latest_poll_list %}
    <ul>
    {% for poll in latest_poll_list %}
        <li><a href="/polls/{{ poll.id }}/">{{ poll.question }}</a></li>
    {% endfor %}
    </ul>
{% else %}
    <p>No polls are available.</p>
{% endif %}
```

- By using the `{% url %}` template tag:

index.html

```
{% if latest_poll_list %}
    <ul>
    {% for poll in latest_poll_list %}
        <li><a href="{% url 'detail' poll.id %}">{{ poll.question }}</a></li>
    {% endfor %}
    </ul>
{% else %}
    <p>No polls are available.</p>
{% endif %}
```

Namespacing URL Names（Exercise 13）

- In the **mysite/urls.py** file, change `url` to `include` namespacing:

urls.py

```
7  urlpatterns = patterns('',
8      url(r'^polls/', include('polls.urls', namespace='polls'))
9      # Examples:
```

- Change the url of your **polls/index.html** template:

index.html

```
1  {% if latest_poll_list %}
2      <ul>
3      {% for poll in latest_poll_list %}
4          <li><a href="{% url 'polls:detail' poll.id %}">{{ poll.question }}</a></li>
5      {% endfor %}
6      </ul>
7  {% else %}
8      <p>No polls are available.</p>
9  {% endif %}
```

- Update **polls/detail.html** to contains an HTML `<form>` element:

detail.html

```
1  <h1>{{ poll.question }}</h1>
2
3  {% if error_message %}<p><strong>{{ error_message }}</strong></p>{% endif %}
4
5  <form action="{% url 'polls:vote' poll.id %}" method="post">
6  {% csrf_token %}
7
8  {% for choice in poll.choice_set.all %}
9      <input type="radio" name="choice" id="choice{{ forloop.counter }}" value="{{ choice.id }}" />
10     <label for="choice{{ forloop.counter }}">{{ choice.choice_text }}</label><br />
11 {% endfor %}
12
13 <input type="submit" value="Vote" />
14 </form>
```

Avoid Cross Site Request Forgeries

Indicate how many times the for tag has gone through its loop.

- Add the following to **polls/views.py**:

views.py

```
1  from django.shortcuts import get_object_or_404, render
2  from django.core.urlresolvers import reverse
3  from django.http import Http404, HttpResponseRedirect
4  from polls.models import Poll, Choice
5
```

views.py

```
18 def results(request, poll_id):
19     poll = get_object_or_404(Poll, pk=poll_id)
20     return render(request, 'polls/results.html', {'poll': poll})
21
22 def vote(request, poll_id):
23     p = get_object_or_404(Poll, pk=poll_id)
24     try:
25         selected_choice = p.choice_set.get(pk=request.POST['choice'])
26     except (KeyError, Choice.DoesNotExist):
27         return render(request, 'polls/detail.html', {
28             'poll': p,
29             'error_message': "You didn't select a choice.",
30         })
31     else:
32         selected_choice.votes += 1
33         selected_choice.save()
34         return HttpResponseRedirect(reverse('polls:results', args=(p.id,)))
```

Return a string like '/polls/3/results/'

Writing a Simple Form（Exercise 13 Continued）

- Create a **polls/results.html** template:

results.html

```
<h1>{{ poll.question }}</h1>

<ul>
{% for choice in poll.choice_set.all %}
    <li>{{ choice.choice_text }} -- {{ choice.votes }} vote{{ choice.votes|pluralize }}</li>
{% endfor %}
</ul>

<a href="{% url 'polls:detail' poll.id %}">Vote again?</a>
```

What You Should See

A Bit About CSRF

- Include malicious code or a link in a page that accesses a web application that the user has authenticated and the session has not timed out.
- A **Cross-Site Request Forgery** Example.
  - Bob's session at www.webapp.com is still alive.
  - In a message board, Bob views a post from a hacker where there is a crafted HTML image element.

```
<img src="http://www.webapp.com/project/1/destroy">
```

- The actual crafted image or link isn't necessarily situated in the web application's domain, it can be anywhere – in a forum, blog post or email.
- POST requests also can be sent (automatically).

```
<a href="http://www.harmless.com/" onclick="
  var f = document.createElement('form');
  f.style.display = 'none';
  this.parentNode.appendChild(f);
  f.method = 'POST';
  f.action = 'http://www.example.com/account/destroy';
  f.submit();
  return false;">To the harmless survey</a>
```

```
<img src="http://www.harmless.com/img" width="400"
height="400" onmouseover="..." />
```

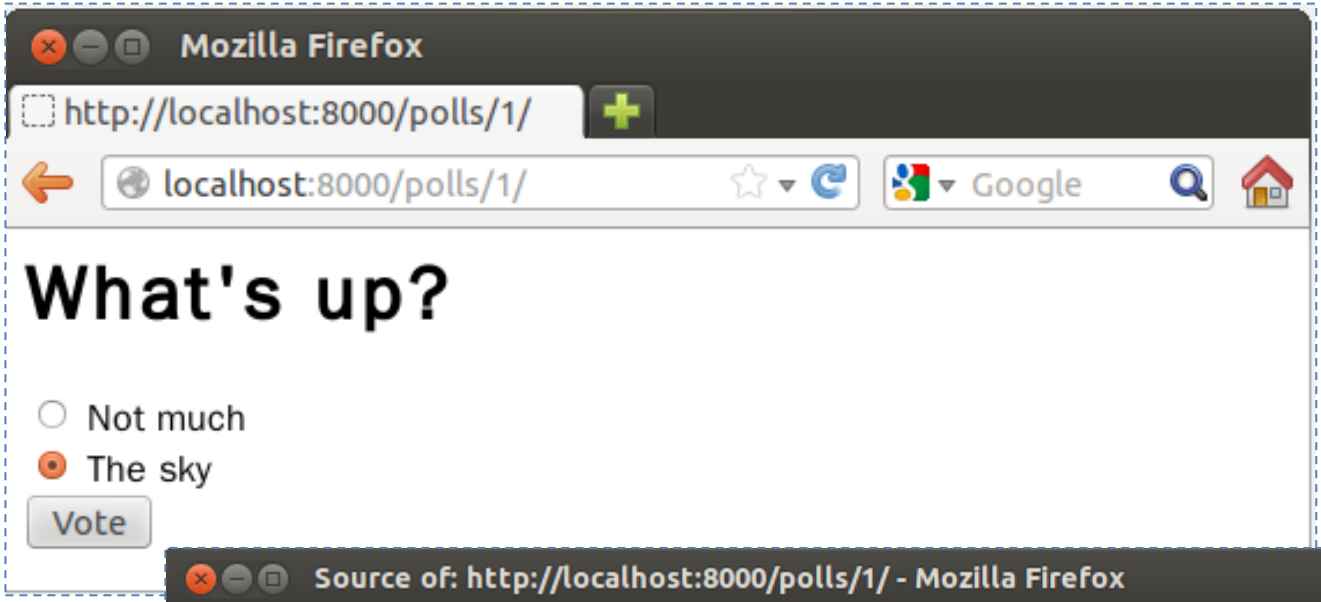
CSRF Countermeasures

- Use **GET** and **POST** appropriately.
  - Use GET if the request is **idempotent**.
  - Use POST if the request changes the **state** of the server.
- Use a security token in non-GET requests.
  - (If your web application is RESTful, you might be used to additional HTTP verbs, such as PUT or DELETE.)

detail.html

```
1  <h1>{{ poll.question }}</h1>
2
3  {% if error_message %}<p><strong>{{ error_message }}</strong></p>{% endif %}
4
5  <form action="{% url 'polls:vote' poll.id %}" method="post">
6  {% csrf_token %}
```

Avoid Cross Site Request Forgeries



Source of: http://localhost:8000/polls/1/ - Mozilla Firefox

```
1  <h1>What&#39;s up?</h1>
2
3
4
5  <form action="/polls/1/vote/" method="post">
6  <input type='hidden' name='csrfmiddlewaretoken' value='guOEO9VGyeeQAKs7dxTURbqG4t4aLI1q' />
7
8
9      <input type="radio" name="choice" id="choice1" value="1" />
10     <label for="choice1">Not much</label><br />
11
12     <input type="radio" name="choice" id="choice2" value="2" />
13     <label for="choice2">The sky</label><br />
14
15
16 <input type="submit" value="Vote" />
17 </form>
```

Testing

- The `assert` statement
  - A convenient way to insert debugging assertions into a program.
- The `doctest` module
  - Search for pieces of text that look like interactive sessions, and then executes them to verify that they work exactly as shown.
- The `unittest` module
  - Sometimes referred to as “PyUnit”, a Python language version of JUnit.
- Third-party testing tools
  - nose (nose.readthedocs.org/en/latest/)
  - pytest (pytest.org)

Before we go on…

- Within a module, the module's name (as a string) is available as the value of the global variable **`__name__`**.
- When you run a Python module with:

```
python fibo.py <arguments>
```

- The code in the module will be executed, just as if you imported it, but with the `__name__` set to **`'__main__'`**.
- This means that you can include a self-test at the end of the module:

```
if __name__ == "__main__":
    self_test_code_here
```

assert

- A convenient way to insert assertions into a program:

```
assert_stmt ::=  "assert" expression ["," expression]
```

- The `assert expression` is equivalent to:

```
if __debug__:
   if not expression: raise AssertionError
```

- The `assert expression1, expression2` is equivalent to:

```
if __debug__:
   if not expression1: raise AssertionError(expression2)
```

- The built-in variable **`__debug__`** is `True` under normal circumstances, `False` when optimization is requested (command line option **`-O`**).

```
caterpillar@caterpillar-VirtualBox:~$ python
Python 2.7.3 (default, Aug  1 2012, 05:16:07)
[GCC 4.6.3] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> assert 1 == 1
>>> assert 1 != 1
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AssertionError
>>> __debug__
True
>>>
caterpillar@caterpillar-VirtualBox:~$ python -O
Python 2.7.3 (default, Aug  1 2012, 05:16:07)
[GCC 4.6.3] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> assert 1 != 1
>>> __debug__
False
>>>
```

When to Use Assertions?

- Preconditions（in private functions only）
  - The requirements which a function requires its caller to fulfill.
- Postconditions
  - Verifying the promises made by a function to its caller.
- Class invariants
  - Validating object state.
- Internal Invariants
  - Using assertions instead of comments.
- Unreachable code（Control-Flow Invariants）
  - Parts of your program which you expect to be unreachable.

Preconditions

- An Example:

Defensive Programming

```
def __set_refresh_Interval(interval):
    if interval > 0 and interval <= 1000 / MAX_REFRESH_RATE:
        raise ValueError('Illegal interval: ' + interval)
    # set the refresh interval or others ...
```

```
def __set_refresh_Interval(rate):
    (assert interval > 0 and interval <= 1000 / MAX_REFRESH_RATE,
            'Illegal interval: ' + interval)
    # set the refresh interval or others ...
```

Internal Invariants

```
if balance >= 10000:
    ...
elif 10000 > balance >= 100:
    ...
else: # the balance should be less than 100
    ...
```

An assumption concerning a program's behavior

```
if balance >= 10000:
    ...
else if 10000 > balance >= 100:
    ...
else:
    assert balance < 100, balance
    ...
```

Internal Invariants

```
if suit == Suit.CLUBS:
    ...
elif suit == Suit.DIAMONDS:
    ...
elif suit == Suit.HEARTS:
    ...
elif suit == Suit.SPADES:
    ...
```

A programmer believes that one of the conditions will always be fulfilled.

```
if suit == Suit.CLUBS:
    ...
elif suit == Suit.DIAMONDS:
    ...
elif suit == Suit.HEARTS:
    ...
elif suit == Suit.SPADES:
    ...
else:
    assert False, suit
```

Unreachable code

- An example:

```
def foo(list):
    for ele in list:
        if ...:
            return
    # execution should never reach this point!!!
```

```
def foo(list):
    for ele in list:
        if ...:
            return
    assert False
```

doctest

- Checks that a module's **docstrings** are up-to-date.
- Performs regression testing by verifying that interactive examples from a test.
- Writes tutorial for a package, liberally illustrated with input-output examples. This has the flavor of **"literate testing"** or **"executable documentation"**.

Checking Examples in Docstrings

```
 4  def sorted(xs, compare = ascending):
 5      '''
 6      sorted(xs) -> new sorted list from xs' item in ascending order.
 7      sorted(xs, func) -> new sorted list. func should return a negative integer,
 8                          zero, or a positive integer as the first argument is
 9                          less than, equal to, or greater than the second.
10
11      >>> sorted([2, 1, 3, 6, 5])
12      [1, 2, 3, 5, 6]
13      >>> sorted([2, 1, 3, 6, 5], ascending)
14      [1, 2, 3, 5, 6]
15      >>> sorted([2, 1, 3, 6, 5], descending)
16      [6, 5, 3, 2, 1]
17      >>> sorted([2, 1, 3, 6, 5], lambda a, b: a - b)
18      [1, 2, 3, 5, 6]
19      >>> sorted([2, 1, 3, 6, 5], lambda a, b: b - a)
20      [6, 5, 3, 2, 1]
21      '''
22
23      return [] if not xs else __select(xs, compare)
```

```
33  if __name__ == '__main__':
34      import doctest
35      doctest.testmod()
```

```
caterpillar@caterpillar-VirtualBox:~/scripts$ python util.py
caterpillar@caterpillar-VirtualBox:~/scripts$ python util.py -v
Trying:
    sorted([2, 1, 3, 6, 5])
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], ascending)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], descending)
Expecting:
    [6, 5, 3, 2, 1]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: a - b)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: b - a)
Expecting:
    [6, 5, 3, 2, 1]
ok
4 items had no tests:
    __main__
    __main__.__select
    __main__.ascending
    __main__.descending
1 items passed all tests:
   5 tests in __main__.sorted
5 tests in 5 items.
5 passed and 0 failed.
Test passed.
```

Print a detailed log.

Checking Examples in a Text File

util_test.txt

```
The ``util`` module
=====================

Using ``sorted``
------------------

>>> from util import *
>>> sorted([2, 1, 3, 6, 5])
[1, 2, 3, 5, 6]
>>> sorted([2, 1, 3, 6, 5], ascending)
[1, 2, 3, 5, 6]
>>> sorted([2, 1, 3, 6, 5], descending)
[6, 5, 3, 2, 1]
>>> sorted([2, 1, 3, 6, 5], lambda a, b: a - b)
[1, 2, 3, 5, 6]
>>> sorted([2, 1, 3, 6, 5], lambda a, b: b - a)
[6, 5, 3, 2, 1]
```

```
import doctest
doctest.testfile("util_test.txt")
```

```
caterpillar@caterpillar-VirtualBox:~/scripts$ python -m doctest -v util_test.txt

Trying:
    from util import *
Expecting nothing
ok
Trying:
    sorted([2, 1, 3, 6, 5])
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], ascending)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], descending)
Expecting:
    [6, 5, 3, 2, 1]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: a - b)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: b - a)
Expecting:
    [6, 5, 3, 2, 1]
ok
1 items passed all tests:
   6 tests in util_test.txt
6 tests in 1 items.
6 passed and 0 failed.
Test passed.
```

We can simply type this command to load a test file.

Exercise 14

- Pick up **util.py** located in the **exercises/exercise14** of the lab file. Replace those two `print` statement with the following:

```
if __name__ == '__main__':
    import doctest
    doctest.testmod()
```

- Write docstrings as you seen in the slide of “Checking Examples in Docstrings”.
- Run the following commands and see what happens.
  - `python util.py`
  - `python util.py -v`

What You Should See

```
caterpillar@caterpillar-VirtualBox:~/scripts$ python util.py
caterpillar@caterpillar-VirtualBox:~/scripts$ python util.py -v
Trying:
    sorted([2, 1, 3, 6, 5])
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], ascending)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], descending)
Expecting:
    [6, 5, 3, 2, 1]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: a - b)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: b - a)
Expecting:
    [6, 5, 3, 2, 1]
ok
4 items had no tests:
    __main__
    __main__.__select
    __main__.ascending
    __main__.descending
1 items passed all tests:
   5 tests in __main__.sorted
5 tests in 5 items.
5 passed and 0 failed.
Test passed.
```

- Edit a text file ‘util_text.txt’ as you see in the slide of “Checking Examples in a Text File”.
- Run the following commands and see what happens.
  - `python -m doctest util_test.txt`
  - `python -m doctest -v util_test.txt`

What You Should See

```
caterpillar@caterpillar-VirtualBox:~/scripts$ python -m doctest util_test.txt
caterpillar@caterpillar-VirtualBox:~/scripts$ python -m doctest -v util_test.txt

Trying:
    from util import *
Expecting nothing
ok
Trying:
    sorted([2, 1, 3, 6, 5])
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], ascending)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], descending)
Expecting:
    [6, 5, 3, 2, 1]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: a - b)
Expecting:
    [1, 2, 3, 5, 6]
ok
Trying:
    sorted([2, 1, 3, 6, 5], lambda a, b: b - a)
Expecting:
    [6, 5, 3, 2, 1]
ok
1 items passed all tests:
   6 tests in util_test.txt
6 tests in 1 items.
6 passed and 0 failed.
Test passed.
```

References

- Using the Template System
  - https://docs.djangoproject.com/en/1.5/intro/tutorial04/
  - https://docs.djangoproject.com/en/1.5/topics/templates/
- A Bit About Cross-Site Request Forgery
  - http://guides.rubyonrails.org/security.html#cross-site-request-forgery-csrf
  - http://www.ithome.com.tw/itadm/article.php?c=80062
- Testing
  - http://docs.python.org/2/tutorial/modules.html
  - http://docs.python.org/2/reference/simple_stmts.html#the-assert-statement
  - http://docs.python.org/2/library/constants.html#__debug__
  - http://docs.oracle.com/javase/1.4.2/docs/guide/lang/assert.html
  - http://docs.python.org/2/library/doctest.html

`unittest` (Testing Continued)

- Test case
  - The smallest unit of testing.
- Test fixture
  - Represents the preparation needed to perform one or more tests, and any associate cleanup actions.
- Test suite
  - A collection of test cases, test suites, or both.
- Test runner
  - A component which orchestrates the execution of tests and provides the outcome to the user.

Test Case

- `unittest` provides a base class, `TestCase`, which may be used to create new test cases.

```
import unittest
import calculator

class CalculatorTestCase(unittest.TestCase):
    def setUp(self):
        self.args = (3, 2)

    def tearDown(self):
        self.args = None

    def test_plus(self):
        expected = 5;
        result = calculator.plus(*self.args);
        self.assertEquals(expected, result);

    def test_minus(self):
        expected = 1;
        result = calculator.minus(*self.args);
        self.assertEquals(expected, result);
```

The individual test is defined with a method whose name starts with `test`.

Test Fixture

- Often, many small test cases will use the same fixture.
- The test runner will run `setUp` prior to each test and invoke `tearDown` after each test.
  - One real case is creating a new table and inserting data in `setUp`, running a test, and then dropping the table in `tearDown`.

Test Suite

- Add specified tests

```
suite = unittest.TestSuite()
suite.addTest(CalculatorTestCase('test_plus'))
suite.addTest(CalculatorTestCase('test_minus'))
```

```
tests = ['test_plus', 'test_minus']
suite = unittest.TestSuite(map(CalculatorTestCase, tests))
```

- Create a test suite and populate it with all tests of a test case automatically.

```
unittest.TestLoader().loadTestsFromTestCase(CalculatorTestCase)
```

- Add one test suite to a test suite.

```
suite2 = unittest.TestSuite()
suite2.addTest(suite)
suite2.addTest(OtherTestCase('test_orz'))
```

- Compose all suites.

```
suite1 = module1.TheTestSuite()
suite2 = module2.TheTestSuite()
alltests = unittest.TestSuite([suite1, suite2])
```

- So, you can compose tests freely.

Test Runner

- Use `TextTestRunner` directly.

```
suite = (unittest.TestLoader()
                 .loadTestsFromTestCase(CalculatorTestCase))
unittest.TextTestRunner(verbosity=2).run(suite)
```

- Or…

```
unittest.main(verbosity=2)
```

```
caterpillar@caterpillar-VirtualBox:~/scripts$ python test_calculator.py
test_minus (__main__.CalculatorTestCase) ... ok
test_plus (__main__.CalculatorTestCase) ... ok

----------------------------------------------------------------------
Ran 2 tests in 0.000s

OK
```

Command-Line Interface

- Run tests from modules, classes or even individual test methods:

```
python -m unittest test_module1 test_module2
python -m unittest test_module.TestClass
python -m unittest test_module.TestClass.test_method
```

- Run tests with higher verbosity by passing in the `-v` flag:

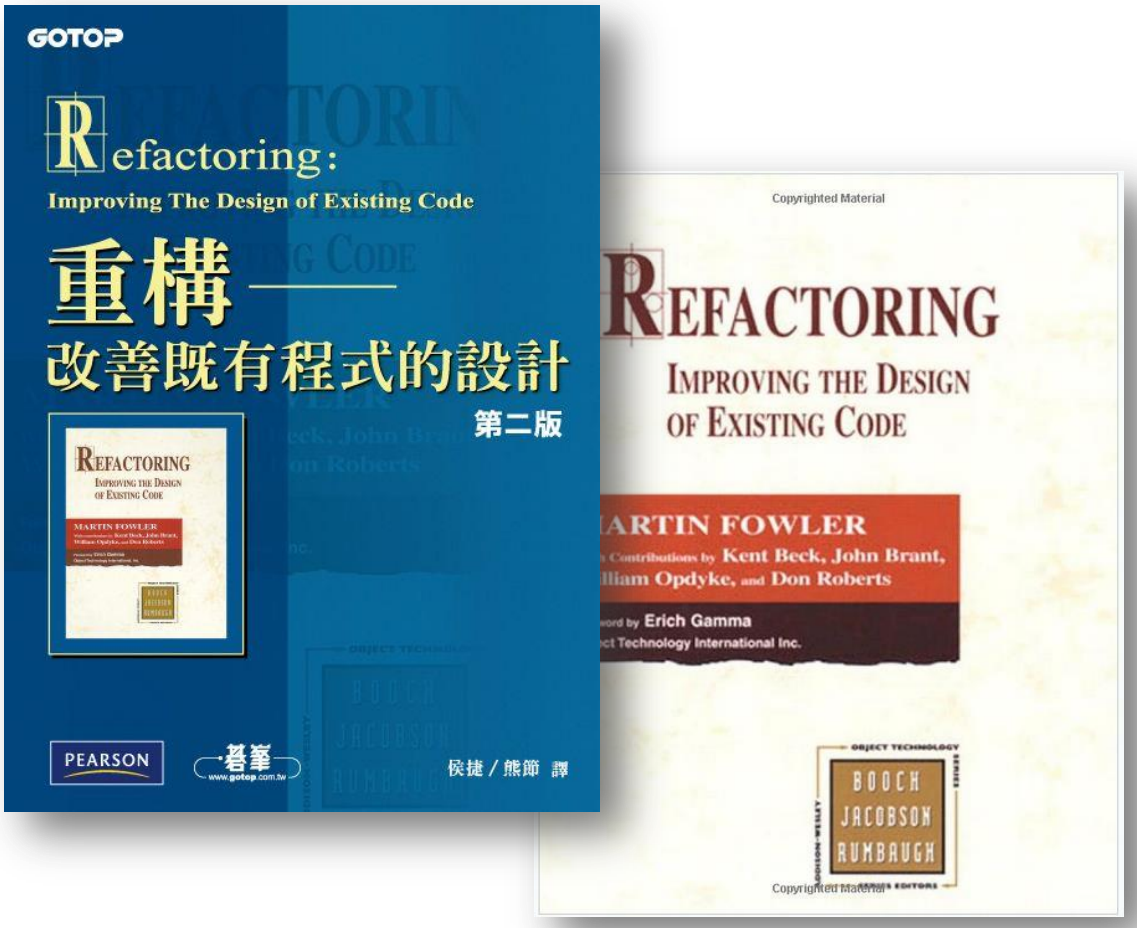
```
python -m unittest -v test_module
```

- For a list of all the command-line options:

```
python -m unittest -h
```

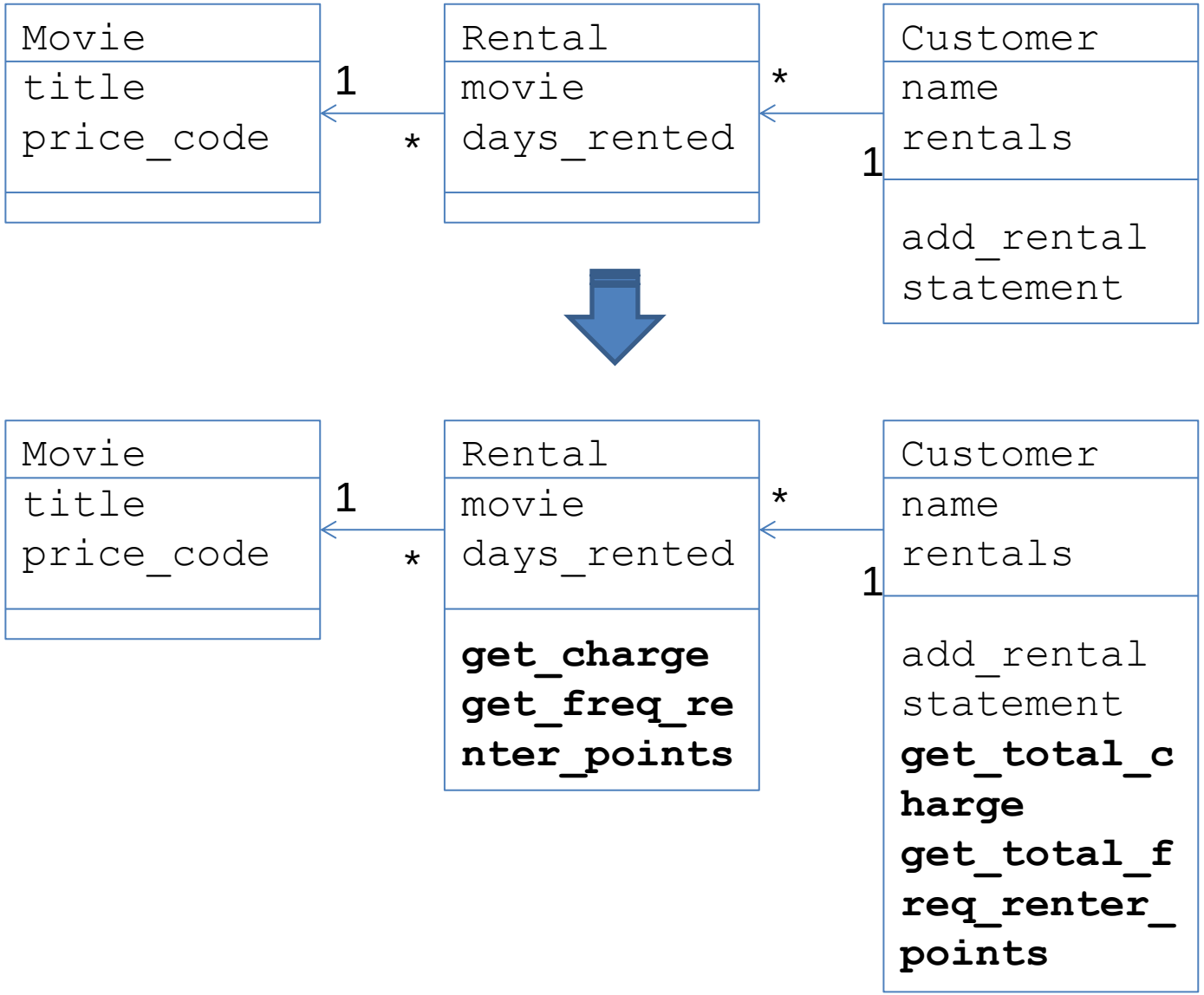
Exercise 15

- http://jjhou.boolan.com/jjtbooks-refactoring.htm



- The file **‘dvdlib.py’** located in **lab/exercises/exercise15** is a replication of the sample program in the chapter 1 of the book ‘Refactoring’.
- We’re refactoring the `statement` method of the `Customer` class according the process of the “Decomposing and Redistributing the Statement Method” session in “Refactoring”.
- We’re using `unittest` to ensure that our each refactoring doesn’t break anything.

What Should You See



Profiling

- `timeit`
  - Measures execution time of small code snippets.
- `cProfile`
  - Describes the run time performance of a program.
  - Provides a variety of statistics.
  - **Recommended for most users**; it's a C extension.
- `profile`
  - A pure Python module whose interface is imitated by `cProfile`, so they are mostly interchangeable; `cProfile` has a much lower overhead but is newer and might not be available on all systems.

timeit

- How to generate the following string?

```
'0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29
,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,5
6,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,
83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99'
```

- Yes or no?
  - String concatenation is slow.

```
all = ''
for s in strs:
    all = all + s + ','
all = all + '99'
```

Provides strings '0' '1' '2' … '98'

  - The function `join` is fast.

```
','.join(strs)
```

Provides strings '0' '1' '2' … '99'

timeit

- Answers: Yes, Yes

```
s = '''
all = ''
for s in strs:
    all = all + s + ','
all = all + '99'
'''
```

```
>>> import timeit
>>> timeit.timeit(s, 'strs=[str(n) for n in xrange(99)]')
16.828123807907104
>>> timeit.timeit('",".join(strs)', 'strs=[str(n) for n in xrange(100)]')
2.0565779209136963
>>>
```

Total elapsed time, in seconds.

- You guessed right answers? …

A generator

```
>>> timeit.timeit(s, 'strs=(str(n) for n in xrange(99))')
0.09822702407836914
>>> timeit.timeit('",".join(strs)', 'strs=(str(n) for n in xrange(100))')
0.6068770885467529
>>>
```

timeit

- Python interface

Default: 1000000

```
>>> timeit.timeit('strs=[str(n) for n in xrange(99)]\n' + s, number=10000)
0.42182493209838867
>>> timeit.timeit('strs=(str(n) for n in xrange(99))\n' + s, number=10000)
0.44387197494506836
>>> timeit.timeit('",".join([str(n) for n in xrange(100)])', number=10000)
0.26035404205322266
>>> timeit.timeit('",".join(str(n) for n in xrange(100))', number=10000)
0.2916388511657715
>>> timeit.timeit('",".join(map(str, xrange(100)))', number=10000)
0.17061090469360352
>>>
```

- Command-Line Interface

```
~$ python -m timeit '",".join(str(n) for n in xrange(100))'
10000 loops, best of 3: 23.6 usec per loop
```

A More Realistic Example

timeit_sorting.py

```
1  import timeit
2  repeats = 1000
3  for f in ('selectionSort', 'insertionSort', 'bubbleSort'):
4      t = timeit.Timer('{0}([10, 9, 1, 2, 5, 3, 8, 7])'.format(f),
5          'from sorting import selectionSort, insertionSort, bubbleSort')
6      sec = t.timeit(repeats) / repeats
7      print '{f}\t{sec:.6f} sec'.format(**locals())
```

```
caterpillar@caterpillar-VirtualBox:~/scripts$ python timeit_sorting.py
selectionSort   0.000026 sec
insertionSort   0.000023 sec
bubbleSort      0.000061 sec
```

cProfile (profile)

- Profile an application with a main entry point

profile_sorting.py

```
1  import cProfile
2  import sorting
3  import random
4  l = range(500)
5  random.shuffle(l)
6  cProfile.run('sorting.selectionSort(l)')
```

```
      250503 function calls (250004 primitive calls) in 0.316 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
     1    0.000    0.000    0.316    0.316 <string>:1(<module>)
124750    0.151    0.000    0.218    0.000 sorting.py:11(<lambda>)
124750    0.067    0.000    0.067    0.000 sorting.py:3(ascending)
     1    0.000    0.000    0.316    0.316 sorting.py:6(selectionSort)
 500/1    0.017    0.000    0.316    0.316 sorting.py:9(__select)
   500    0.080    0.000    0.299    0.001 {_functools.reduce}
     1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

The Column Headings

- ncalls
  - “number of calls”, lists the number of calls to the specified function.
- tottime
  - “total time”, spent in the given function (and excluding time made in calls to sub-functions).
- percall
  - tottime / ncalls
- cumtime
  - “cumulative time”, spent in this and all subfunctions (from invocation till exit).
- percall
  - the quotient of cumtime divided by primitive calls.
- filename:lineno(function)
  - provides the respective data of each function

pstats

- To save the results of a profile into a file:

```
cProfile.run('sorting.selectionSort(l)', 'select_stats')
```

- To load the statistics data:

```
import pstats
p = pstats.Stats('select_stats')
p.strip_dirs().sort_stats('name').print_stats()
p.sort_stats('cumulative').print_stats(10)
p.sort_stats('time').print_stats(10)
```

```
   Ordered by: cumulative time

Function                                          called...
                                                      ncalls  tottime  cumtime
<string>:1(<module>)                              ->       1    0.000    0.297  sorting.py:6(selectionSort)
sorting.py:6(selectionSort)                       ->       1    0.000    0.297  sorting.py:9(__select)
sorting.py:9(__select)                            ->   499/1    0.016    0.297  sorting.py:9(__select)
                                                         500    0.073    0.282  {_functools.reduce}
{_functools.reduce}                               ->  124750    0.148    0.208  sorting.py:11(<lambda>)
sorting.py:11(<lambda>)                           ->  124750    0.060    0.060  sorting.py:3(ascending)
sorting.py:3(ascending)                           ->
{method 'disable' of '_lsprof.Profiler' objects}  ->
```

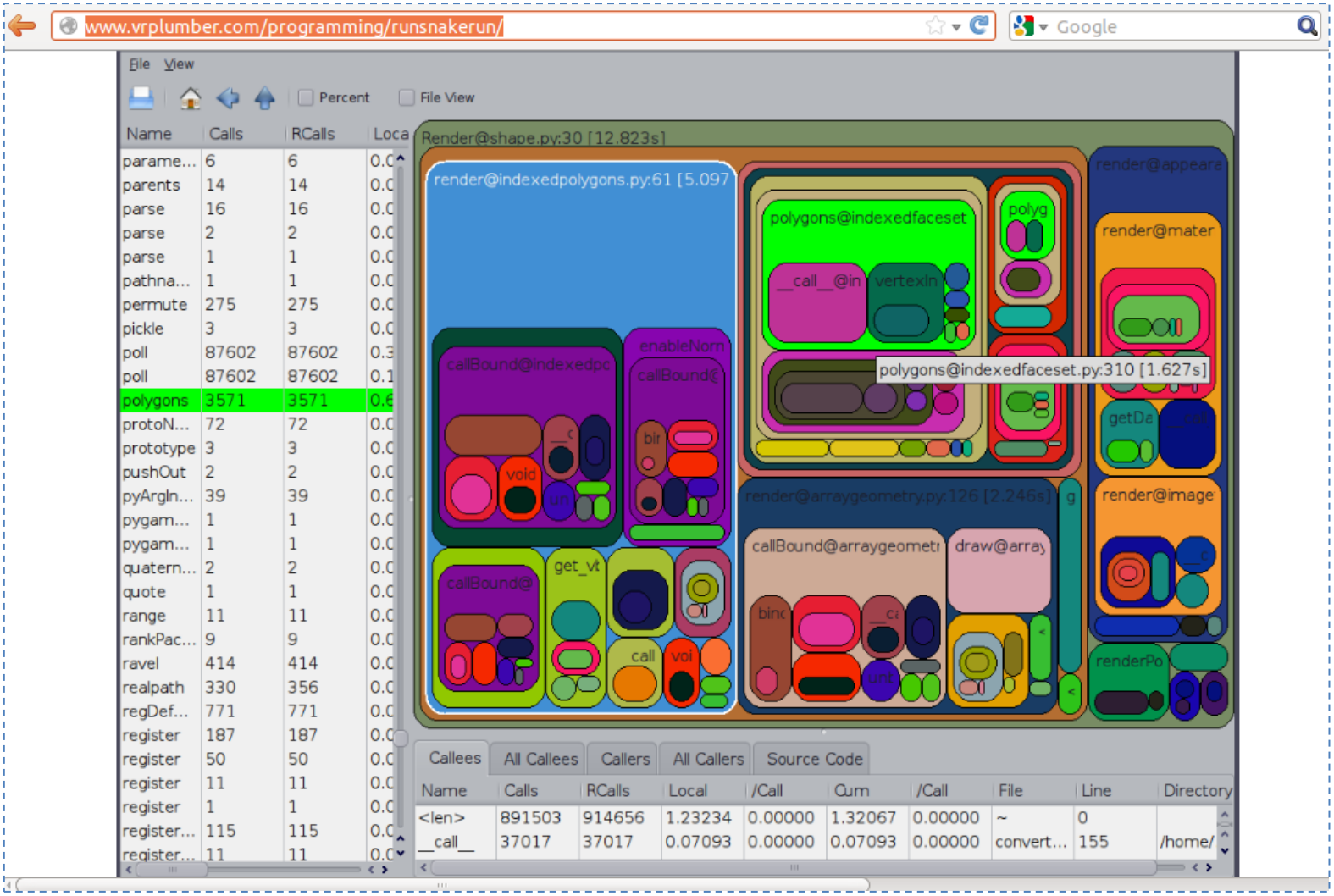
- The file cProfile.py can also be invoked as a script to profile another script.

```
python -m cProfile myscript.py
```

```
cProfile.py [-o output_file] [-s sort_order]
```

A Small GUI Utility

- http://www.vrplumber.com/programming/runsnakerun/



PyCon Taiwan

- PyCon Taiwan 2012
  - http://tw.pycon.org/2012/program/
- PyCon Taiwan 2013
  - http://tw.pycon.org/2013/en/program/

PyCon Taiwan 2012

- Personal choices
  - Even Faster Django
  - Pyjamas - A Python-based Web Application Development Framework
  - Developing Python Apps on Windows Azure
  - PyKinect: Body Iteration Application Development Using Python
  - STAF 在自動化測試上的延伸應用 – TMSTAF
  - Qt Quick GUI Programming with PySide
  - 所見非所得 - Metaclass 能幹嗎?

PyCon Taiwan 2013

- Personal choices
  - Use Pyramid Like a Pro
  - MoSQL: More than SQL, and less than ORM
  - 如何用 Django 在 24 小時內作出 prototype 微創業，以 petneed.me 為例
  - Python memory management & Impact to memory-hungry application (DT)
  - Dive into Python Class
  - Python Coding Style Guide - 哥寫的 Python 是 Google Style
  - Extend your legacy application with Python
  - CPython 程式碼解析

- Personal choices
  - Extend your legacy application with Python
  - CPython 程式碼解析
  - 駭客看 Django
  - 做遊戲學 Python
  - Big Data Analysis in Python
  - 周蟒 WEB 積木版與 Blockly
  - The Life of an Ubuntu Developer
  - 用 VPython 學 Python
  - 當 Python 遇上魔術方塊

References

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  - http://docs.python.org/2/library/unittest.html
  - https://python-guide.readthedocs.org/en/latest/writing/tests/
- Profiling
  - http://docs.python.org/2/library/timeit.html
  - http://docs.python.org/2/library/profile.html
  - http://www.vrplumber.com/programming/runsnakerun/
- PyCon Taiwan
  - http://tw.pycon.org/2012/program/
  - http://tw.pycon.org/2013/en/program/