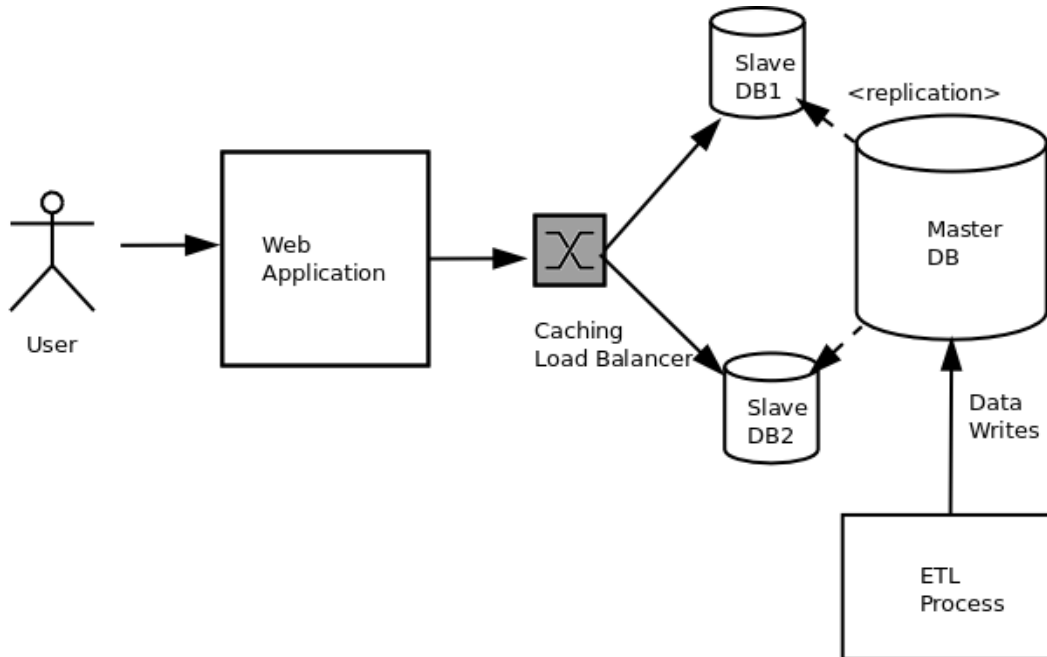
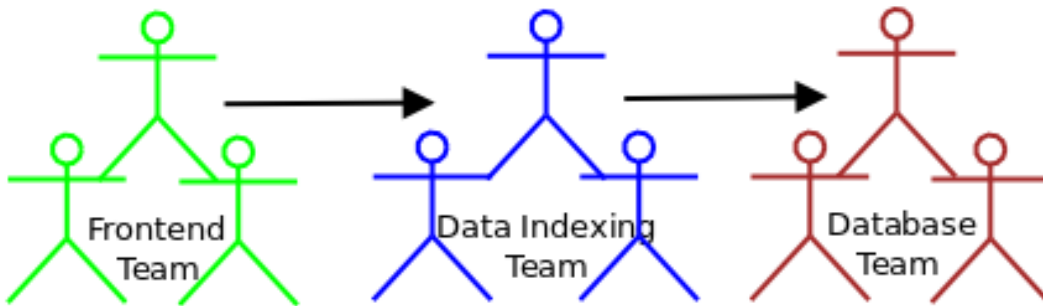
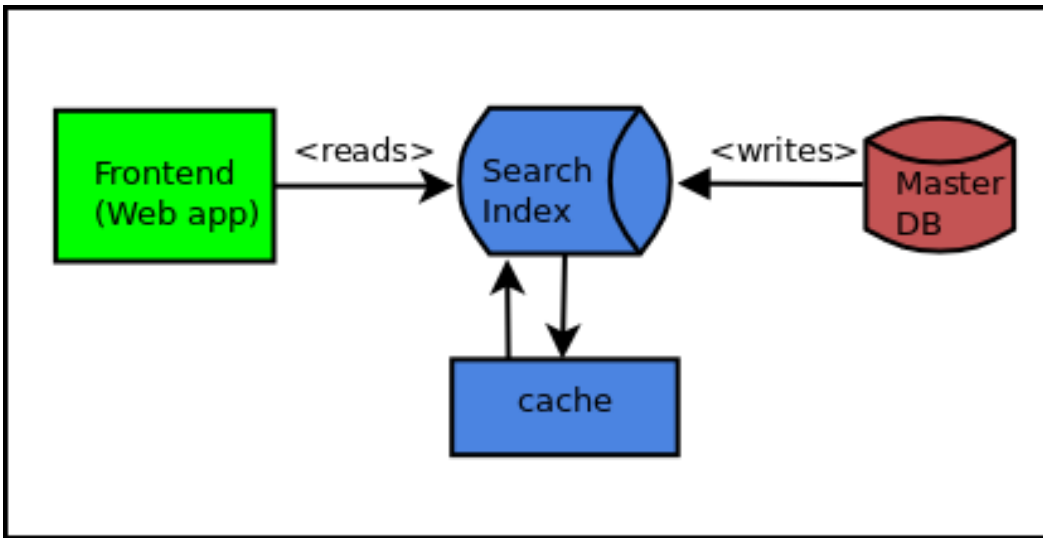
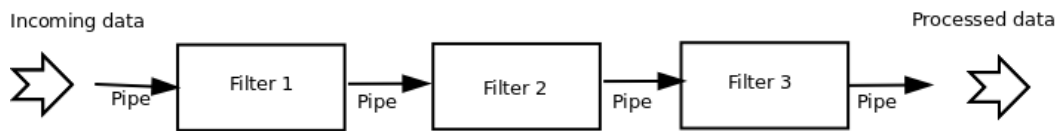
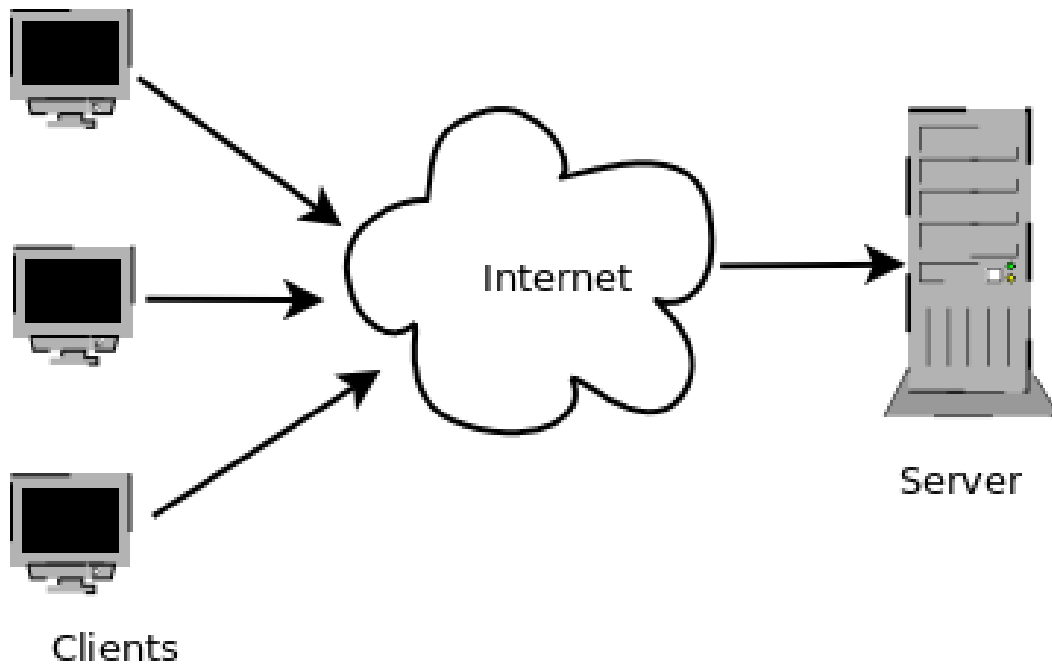
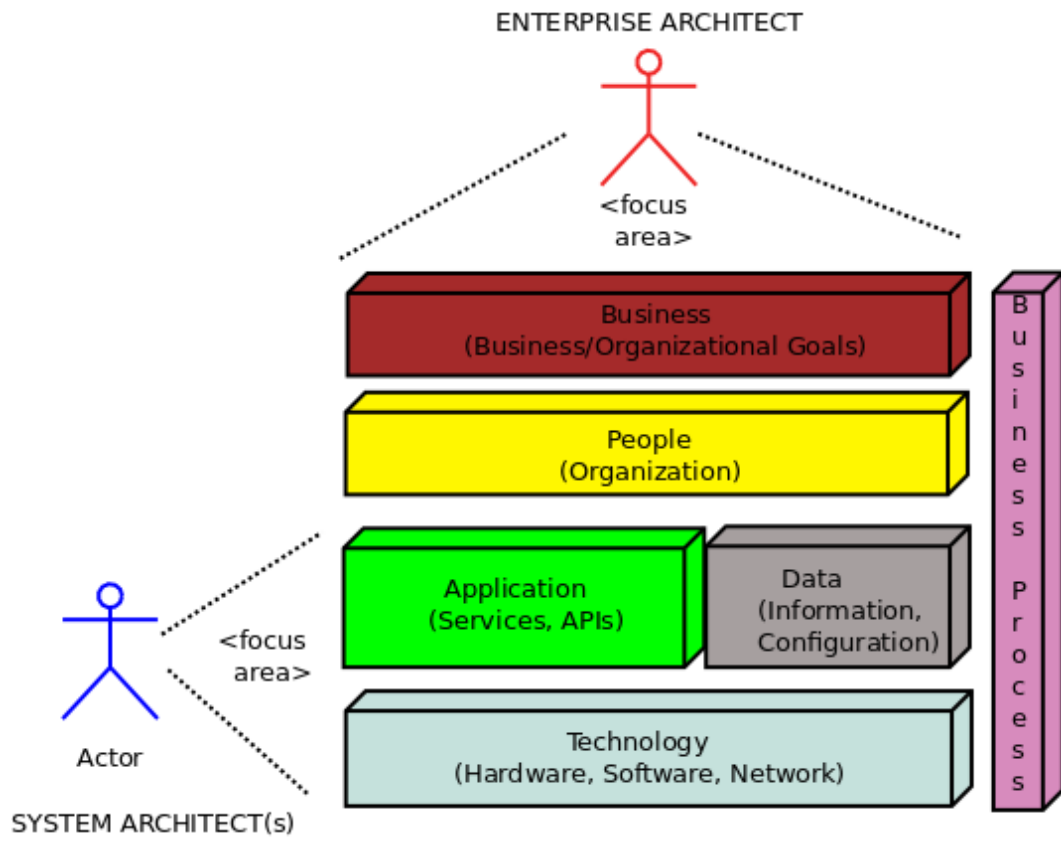


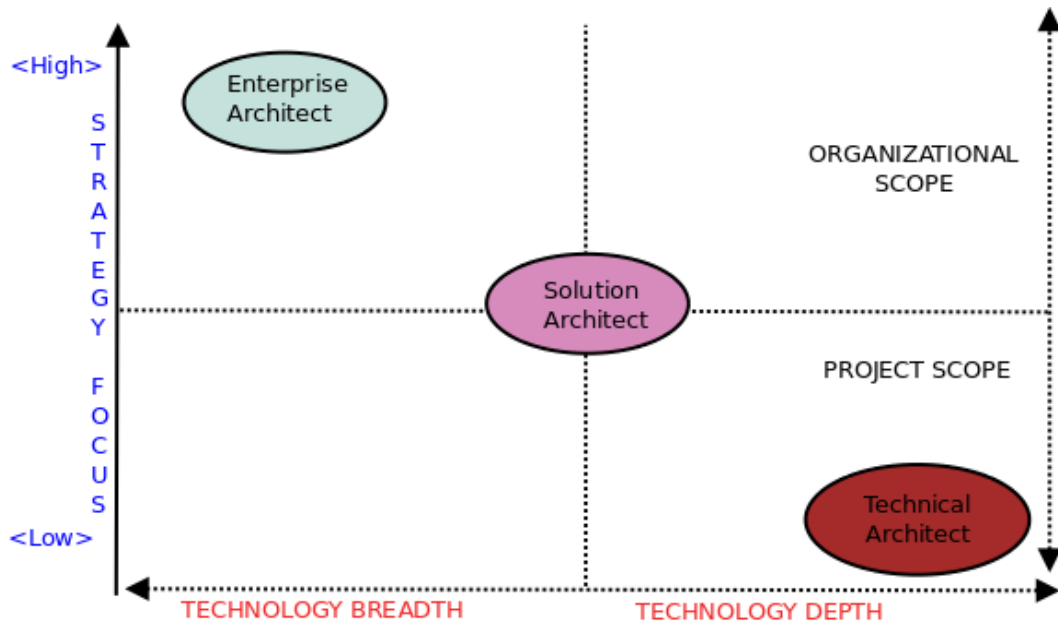
## Chapter 1 Principles of Software Architecture

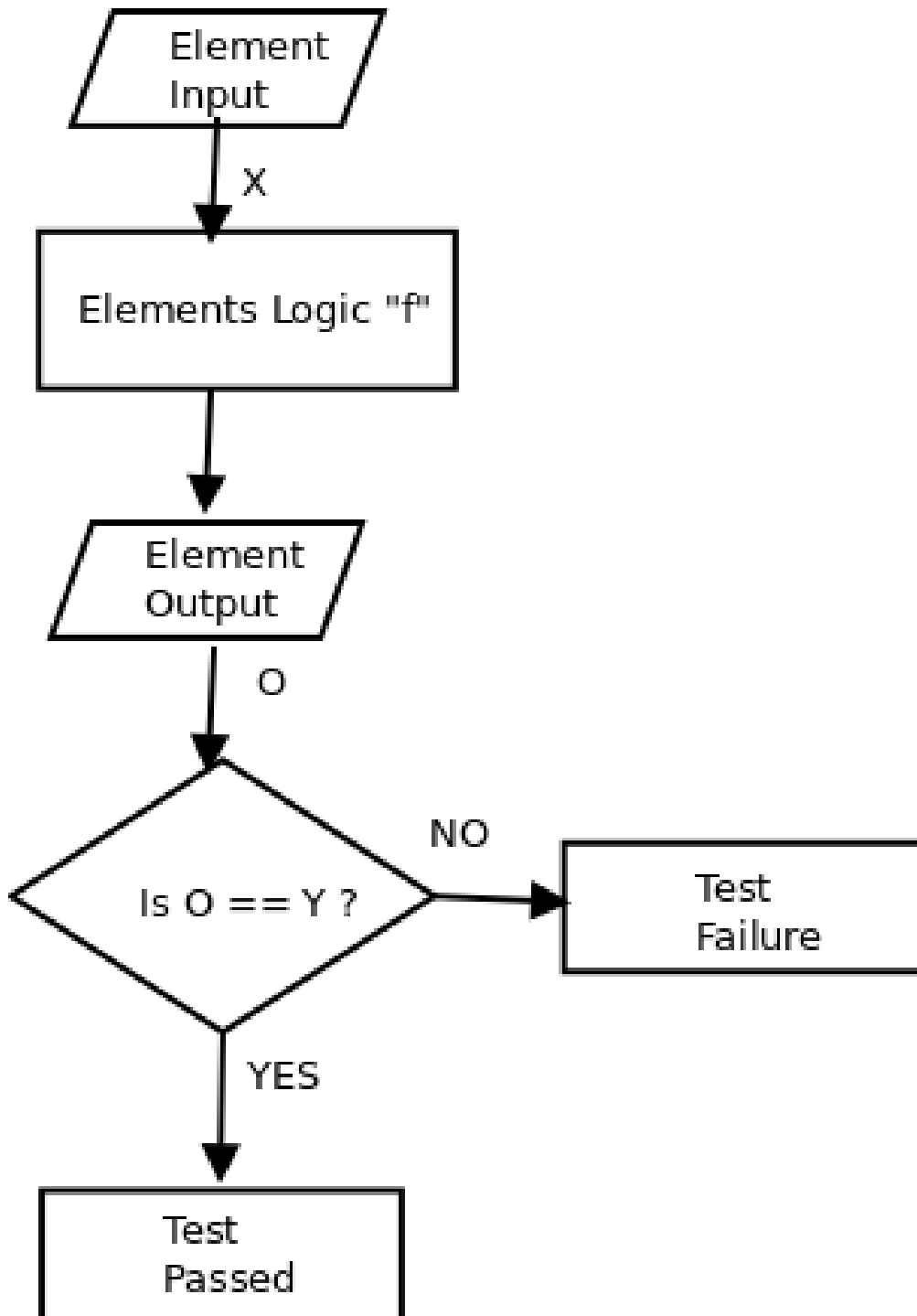


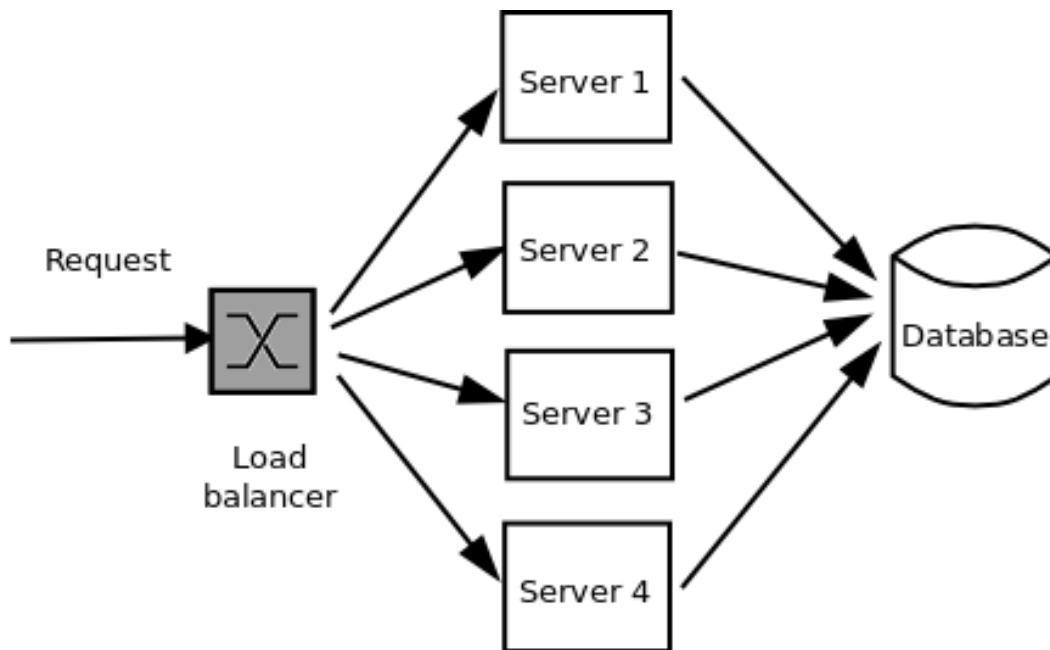
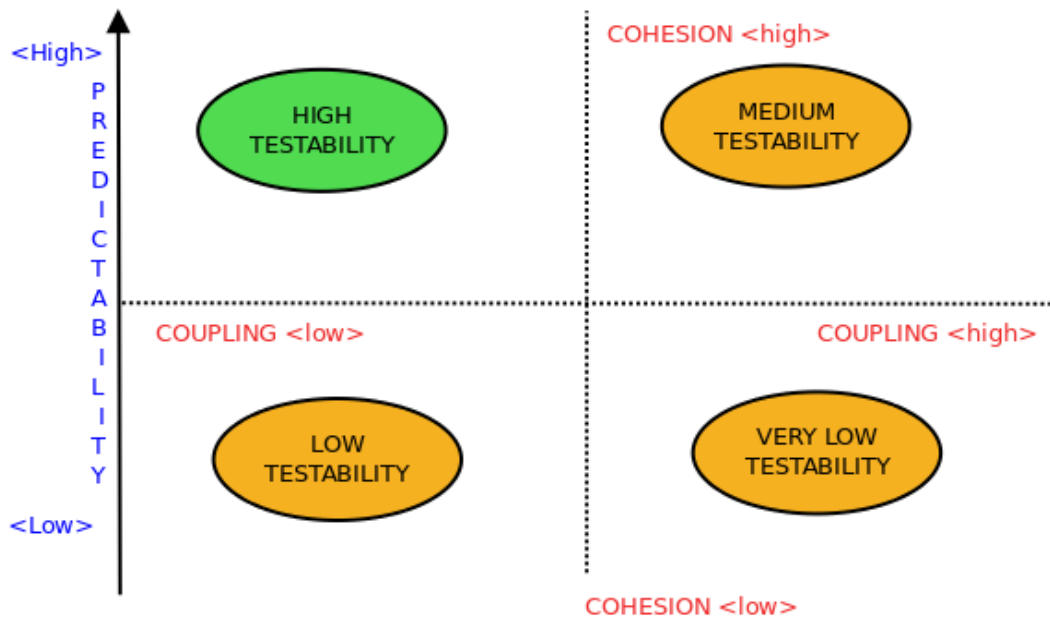












## Chapter 2: Writing Modifiable and Readable Code

```
Chapter 2: Modifiability
(arch) $ python -m mccabe --min 1 power.py
1:1: 'power' 1
(arch) $
(arch) $ python -m mccabe --min 1 factorial.py
1:1: 'factorial' 2
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ pylint --reports=n metrictest.py
***** Module metrictest
C: 22, 0: Exactly one space required around comparison
    if d<=30:
        ^^ (bad-whitespace)
C: 24, 0: Exactly one space required around comparison
    elif d<45:
        ^ (bad-whitespace)
C: 26, 0: Exactly one space required around comparison
    elif d<60:
        ^ (bad-whitespace)
C: 28, 0: Exactly one space required after comma
    return ('bus:335E','bus:connector')
        ^ (bad-whitespace)
C: 29, 0: Exactly one space required around comparison
    elif d>80:
        ^ (bad-whitespace)
C: 31, 0: Exactly one space required after comma
    return random.choice(('bus:330','bus:331',':'.join((favorite_option,
        ^ (bad-whitespace)
C: 31, 0: Exactly one space required after comma
    return random.choice(('bus:330','bus:331',':'.join((favorite_option,
        ^ (bad-whitespace)
C: 32, 0: Wrong continued indentation (remove 4 spaces).
        favorite_route))))
```



```
Chapter 2: Modifiability
File Edit View Search Terminal Help
C: 11, 0: Invalid function name "fn" (invalid-name)
C: 11, 0: Invalid argument name "x" (invalid-name)
C: 11, 0: Invalid argument name "y" (invalid-name)
W: 15, 4: Unreachable code (unreachable)
C: 15, 4: Invalid function name "find_optimal_route_to_my_office_from_home" (invalid-name)
C: 15, 4: Missing function docstring (missing-docstring)
C: 21, 8: Invalid variable name "d" (invalid-name)
E: 32,19: Undefined variable 'random' (undefined-variable)
W: 15, 4: Unused variable 'find_optimal_route_to_my_office_from_home' (unused-variable)
C: 39, 0: Invalid class name "C" (invalid-name)
C: 43, 8: Invalid attribute name "x" (invalid-name)
C: 44, 8: Invalid attribute name "y" (invalid-name)
C: 46, 4: Invalid method name "f" (invalid-name)
C: 46, 4: Missing method docstring (missing-docstring)
C: 49, 4: Invalid method name "g" (invalid-name)
C: 49, 4: Invalid argument name "x" (invalid-name)
C: 49, 4: Invalid argument name "y" (invalid-name)
C: 49, 4: Missing method docstring (missing-docstring)
W: 49,19: Unused argument 'y' (unused-argument)
C: 56, 0: Invalid class name "D" (invalid-name)
W: 59, 4: __init__ method from base class 'C' is not called (super-init-not-called)
W: 62, 4: Arguments number differs from overridden 'f' method (arguments-differ)
W: 68, 4: Arguments number differs from overridden 'g' method (arguments-differ)
C: 75, 0: Invalid argument name "a" (invalid-name)
C: 75, 0: Invalid argument name "b" (invalid-name)
C: 75, 0: Missing function docstring (missing-docstring)
E: 77,15: Undefined variable 'c' (undefined-variable)
W: 9, 0: Unused import sys (unused-import)
```

```
Chapter 2: Modifiability
File Edit View Search Terminal Help
$ flake8 --statistics --count metrictest.py
metrictest.py:8:1: F401 'sys' imported but unused
metrictest.py:10:1: E302 expected 2 blank lines, found 1
metrictest.py:22:13: E225 missing whitespace around operator
metrictest.py:24:15: E225 missing whitespace around operator
metrictest.py:26:15: E225 missing whitespace around operator
metrictest.py:28:31: E231 missing whitespace after ','
metrictest.py:29:15: E225 missing whitespace around operator
metrictest.py:31:20: F821 undefined name 'random'
metrictest.py:31:44: E231 missing whitespace after ','
metrictest.py:31:54: E231 missing whitespace after ','
metrictest.py:32:69: E127 continuation line over-indented for visual indent
metrictest.py:37:1: W293 blank line contains whitespace
metrictest.py:41:25: E231 missing whitespace after ','
metrictest.py:44:1: W293 blank line contains whitespace
metrictest.py:50:18: E225 missing whitespace around operator
metrictest.py:52:15: E225 missing whitespace around operator
metrictest.py:53:21: E225 missing whitespace around operator
metrictest.py:55:1: E302 expected 2 blank lines, found 1
metrictest.py:61:18: E231 missing whitespace after ','
metrictest.py:62:13: E225 missing whitespace around operator
metrictest.py:69:18: E225 missing whitespace around operator
metrictest.py:74:1: E302 expected 2 blank lines, found 1
metrictest.py:75:9: E225 missing whitespace around operator
metrictest.py:76:16: F821 undefined name 'c'
1      E127 continuation line over-indented for visual indent
10     E225 missing whitespace around operator
5      E231 missing whitespace after ','
3      E302 expected 2 blank lines, found 1
1      F401 'sys' imported but unused
2      F821 undefined name 'c'
2      W293 blank line contains whitespace
24
```

```
Chapter 2: Modifiability
(arch) $ python -m mccabe --min 3 metrictest.py
54:1: 'C.g' 3
14:1: 'find_optimal_route_to_my_office_from_home' 7
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ flake8 --max-complexity 3 metrictest.py | grep complex
metrictest.py:14:1: C901 'find_optimal_route_to_my_office_from_home' is too complex (7)
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ pyflakes metrictest.py
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ pyflakes metrictest.py
metrictest.py:8: 'sys' imported but unused
metrictest.py:36: undefined name 'random'
metrictest.py:82: undefined name 'c'
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ python -m mccabe metrictest.py --min 5
1:1: 'find_optimal_route_to_my_office_from_home' 5
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ python -m mccabe metrictest.py --min 3
9:1: 'find_optimal_route_to_my_office_from_home' 4
(arch) $
```

```
Chapter 2: Modifiability
(arch) $ pylint --reports=n metrictest.py
***** Module metrictest
W: 42,38: Unused argument 'ynum' (unused-argument)
R: 35, 0: Too few public methods (1/2) (too-few-public-methods)
R: 57, 4: Method could be a function (no-self-use)
This option 'required-attributes' will be removed in Pylint 2.0This option 'ignore-iface-methods' will be removed in Pylint 2.0(arch) $
```

## Chapter 3: Testability - Writing Testable Code

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ python3 test_datetimehelper.py
Setting up...
.
-----
Ran 1 test in 0.000s

OK
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ python3 test_datetimehelper.py
...
-----
Ran 3 tests in 0.001s

OK
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ python3 test_datetimehelper.py -v
test_date (__main__.DateTimeHelperTestCase)
Test date() method ... ok
test_us_india_conversion (__main__.DateTimeHelperTestCase)
Test us=>india date format conversion ... ok
test_weekday (__main__.DateTimeHelperTestCase)
Test weekday() method ... ok
-----
Ran 3 tests in 0.001s

OK
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ nose2
...
-----
Ran 3 tests in 0.001s

OK
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ nose2 -v
test_date (test_datetimehelper.DateTimeHelperTestCase)
Test date() method ... ok
test_us_india_conversion (test_datetimehelper.DateTimeHelperTestCase)
Test us=>india date format conversion ... ok
test_weekday (test_datetimehelper.DateTimeHelperTestCase)
Test weekday() method ... ok

-----
Ran 3 tests in 0.001s

OK
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ pytest
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.0, py-1.4.31, pluggy-0.3.1
rootdir: /home/anand/Documents/ArchitectureBook/code/chap3, inifile:
collected 3 items

test_datetimehelper.py ...

===== 3 passed in 0.02 seconds =====
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ py.test -v
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.0, py-1.4.31, pluggy-0.3.1 -- /home/anand/arch3/env/bin/python3
cachedir: .cache
rootdir: /home/anand/Documents/ArchitectureBook/code/chap3, inifile:
plugins: cov-2.3.1
collected 4 items

test_datetimehelper.py::DateTimeHelperTestCase::test_date PASSED
test_datetimehelper.py::DateTimeHelperTestCase::test_us_india_conversion PASSED
test_datetimehelper.py::DateTimeHelperTestCase::test_weekday PASSED
test_datetimehelper2.py::TestDateTimeHelper::test_us_india_conversion PASSED

===== 4 passed in 0.02 seconds =====
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ nose2 -v
test_date (test_datetimehelper.DateTimeHelperTestCase)
Test date() method ... ok
test_us_india_conversion (test_datetimehelper.DateTimeHelperTestCase)
Test us=>india date format conversion ... ok
test_weekday (test_datetimehelper.DateTimeHelperTestCase)
Test weekday() method ... ok
test_datetimehelper2.TestDateTimeHelper.test_us_india_conversion ... ok

-----
Ran 4 tests in 0.001s

OK
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ coverage run test_datetimehelper.py
...
-----
Ran 3 tests in 0.001s

OK
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ coverage report -m
Name                               Stmts  Miss  Cover  Missing
-----
datetimehelper.py                   14     1   93%    9
test_datetimehelper.py              26     0  100%
-----
TOTAL                               40     1   98%
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ nose2 -v -C
test_date (test_datetimehelper.DateTimeHelperTestCase)
Test date() method ... ok
test_us_india_conversion (test_datetimehelper.DateTimeHelperTestCase)
Test us=>india date format conversion ... ok
test_weekday (test_datetimehelper.DateTimeHelperTestCase)
Test weekday() method ... ok
test_datetimehelper2.TestDateTimeHelper.test_us_india_conversion ... ok

-----
Ran 4 tests in 0.002s

OK
----- coverage: platform linux, python 3.5.2-final-0 -----
Name                               Stmts  Miss  Cover
-----
datetimehelper.py                   14     1   93%
test_datetimehelper.py              26     1   96%
test_datetimehelper2.py              5     0  100%
-----
TOTAL                               45     2   96%
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ nose2 -C --coverage-report html
...
-----
Ran 4 tests in 0.002s

OK
----- coverage: platform linux, python 3.5.2-final-0 -----
Coverage HTML written to dir htmlcov
```

Coverage report - Mozilla Firefox

file:///home/anand/Documents/ArchitectureBook/code/chap3/htmlcov/index.html

Coverage report: 96%

Module \	statements	missing	excluded	coverage
datetimehelper.py	14	1	0	93%
test_datetimehelper.py	26	1	0	96%
test_datetimehelper2.py	5	0	0	100%
<b>Total</b>	<b>45</b>	<b>2</b>	<b>0</b>	<b>96%</b>

coverage.py v4.2, created at 2016-08-21 17:16

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ pytest --cov .
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.0, py-1.4.31, pluggy-0.3.1
rootdir: /home/anand/Documents/ArchitectureBook/code/chap3, inifile:
plugins: cov-2.3.1
collected 4 items

test_datetimehelper.py ...
test_datetimehelper2.py .

----- coverage: platform linux, python 3.5.2-final-0 -----
Name                               Stmts  Miss  Cover
-----
datetimehelper.py                   14      1   93%
test_datetimehelper.py              26      1   96%
test_datetimehelper2.py              5      0  100%
-----
TOTAL                                45      2   96%

===== 4 passed in 0.04 seconds =====
```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ nose2 -v test_textsearch
test_textsearch.transplant_class.<locals>.C (test_search)
Test search via a mock ... ok

-----
Ran 1 test in 0.001s

OK
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$
```



```

(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ pytest --cov textsearcher
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.0, py-1.4.31, pluggy-0.3.1
rootdir: /home/anand/Documents/ArchitectureBook/code/chap3, inifile:
plugins: cov-2.3.1
collected 5 items

test_datetimehelper.py ...
test_datetimehelper2.py .
test_textsearch.py .

----- coverage: platform linux, python 3.5.2-final-0 -----
Name                Stmts  Miss  Cover
-----
textsearcher.py      19      2   89%

===== 5 passed in 0.04 seconds =====

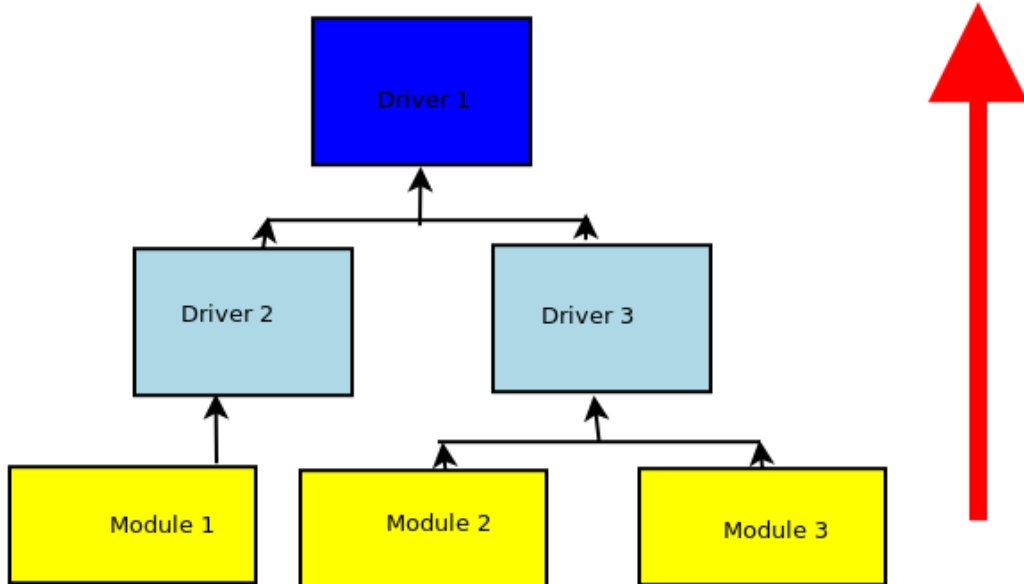
```

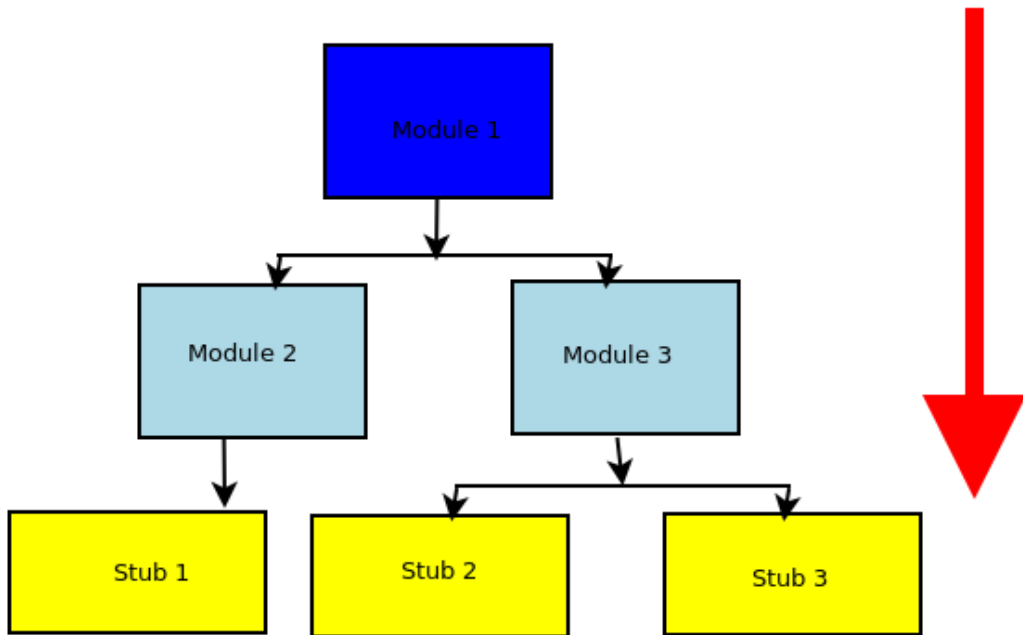
```

(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ python3 factorial.py
*****
File "factorial.py", line 13, in __main__.factorial
Failed example:
    factorial(0)
Exception raised:
Traceback (most recent call last):
  File "/usr/lib/python3.5/doctest.py", line 1321, in __run
    compileflags, 1), test.globs)
  File "<doctest __main__.factorial[3]>", line 1, in <module>
    factorial(0)
  File "factorial.py", line 17, in factorial
    return functools.reduce(operator.mul, range(1,n+1))
TypeError: reduce() of empty sequence with no initial value
*****
1 items had failures:
  1 of  4 in __main__.factorial
***Test Failed*** 1 failures.

```

```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ python3 factorial.py
Trying:
  factorial(1)
Expecting:
  1
ok
Trying:
  factorial(5)
Expecting:
  120
ok
Trying:
  factorial(10)
Expecting:
  3628800
ok
Trying:
  factorial(0)
Expecting:
  1
ok
1 items had no tests:
  __main__
1 items passed all tests:
  4 tests in __main__.factorial
4 tests in 2 items.
4 passed and 0 failed.
Test passed.
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ █
```

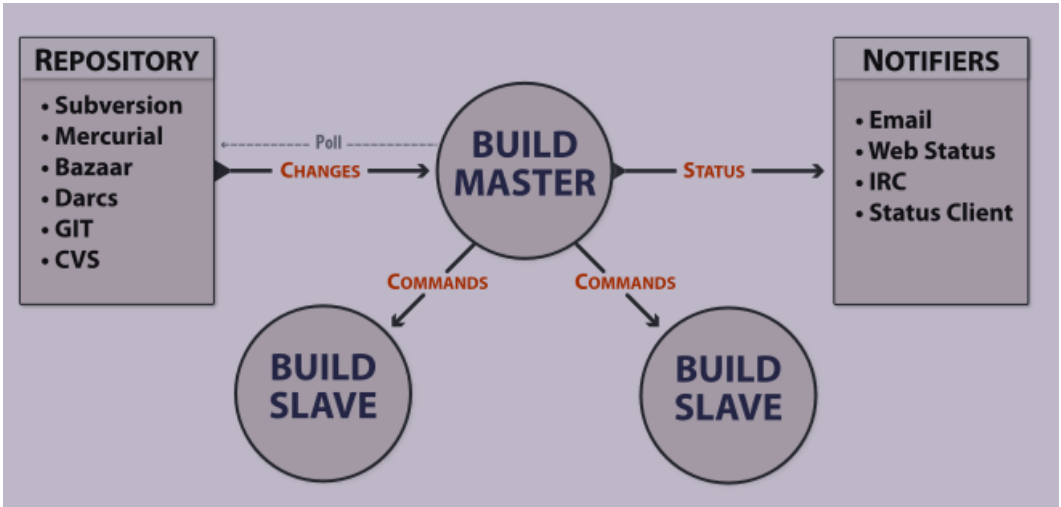
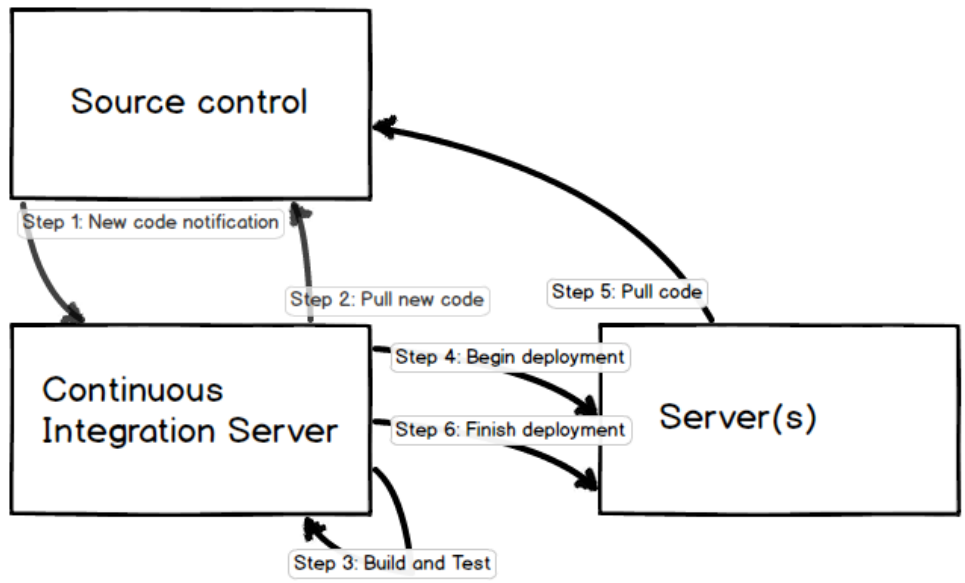




```
(env) anand@ubuntu-pro-book:~/Documents/ArchitectureBook/code/chap3$ pytest -s selenium_testcase.py
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.0, py-1.4.31, pluggy-0.3.1
rootdir: /home/anand/Documents/ArchitectureBook/code/chap3, inifile:
plugins: cov-2.3.1
collected 1 items

selenium_testcase.py Community URL=> https://www.python.org/community/
.

===== 1 passed in 16.35 seconds =====
```



```
Chapter 3: Testability
(env) $ py.test -s test_palindrome.py -v
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.7, py-1.4.33, pluggy-0.4.0 -- /home/anand/py3/env/bin/python3
cachedir: .cache
rootdir: /home/user/programs/chap3, inifile:
plugins: cov-2.4.0
collected 2 items

test_palindrome.py::test_basic PASSED
test_palindrome.py::test_with_spaces PASSED

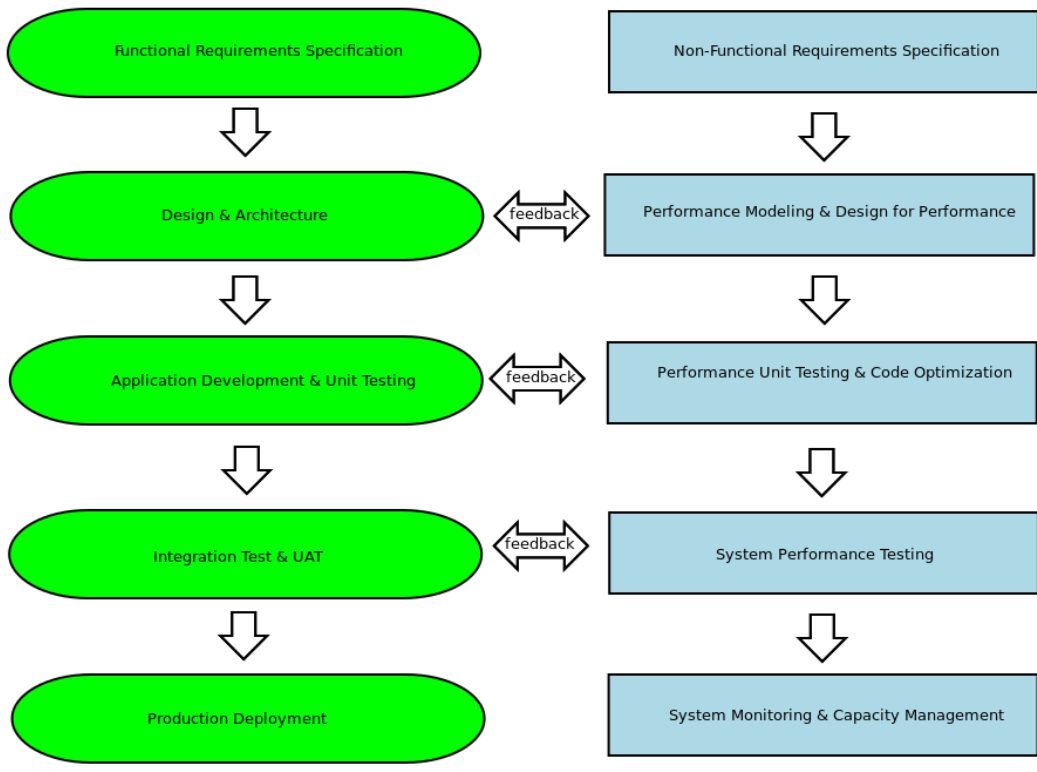
===== 2 passed in 0.01 seconds =====
(env) $
```

```
Chapter 3: Testability
(env) $ py.test -s test_palindrome.py -v
===== test session starts =====
platform linux -- Python 3.5.2, pytest-3.0.7, py-1.4.33, pluggy-0.4.0 -- /home/anand/py3/env/bin/python3
cachedir: .cache
rootdir: /home/user/programs/chap3, inifile:
plugins: cov-2.4.0
collected 3 items

test_palindrome.py::test_basic PASSED
test_palindrome.py::test_with_spaces PASSED
test_palindrome.py::test_with_punctuations PASSED

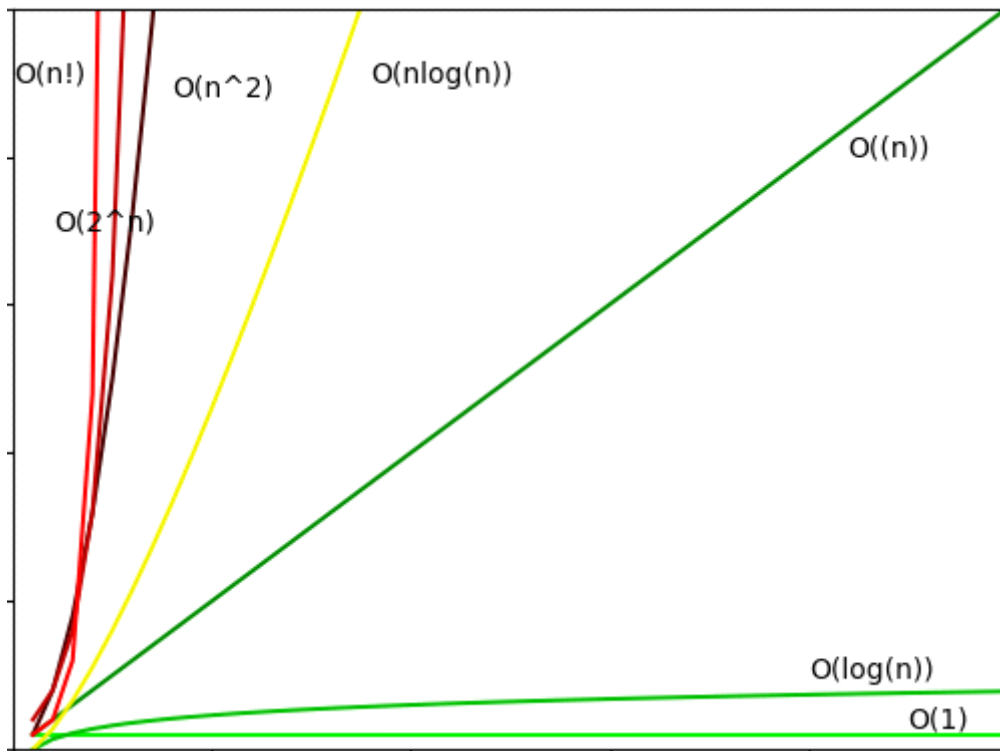
===== 3 passed in 0.03 seconds =====
(env) $
```

## **Chapter 4: Good Performances is Rewarding**



SOFTWARE DEVELOPMENT LIFE CYCLE

PERFORMANCE ENGINEERING LIFE CYCLE



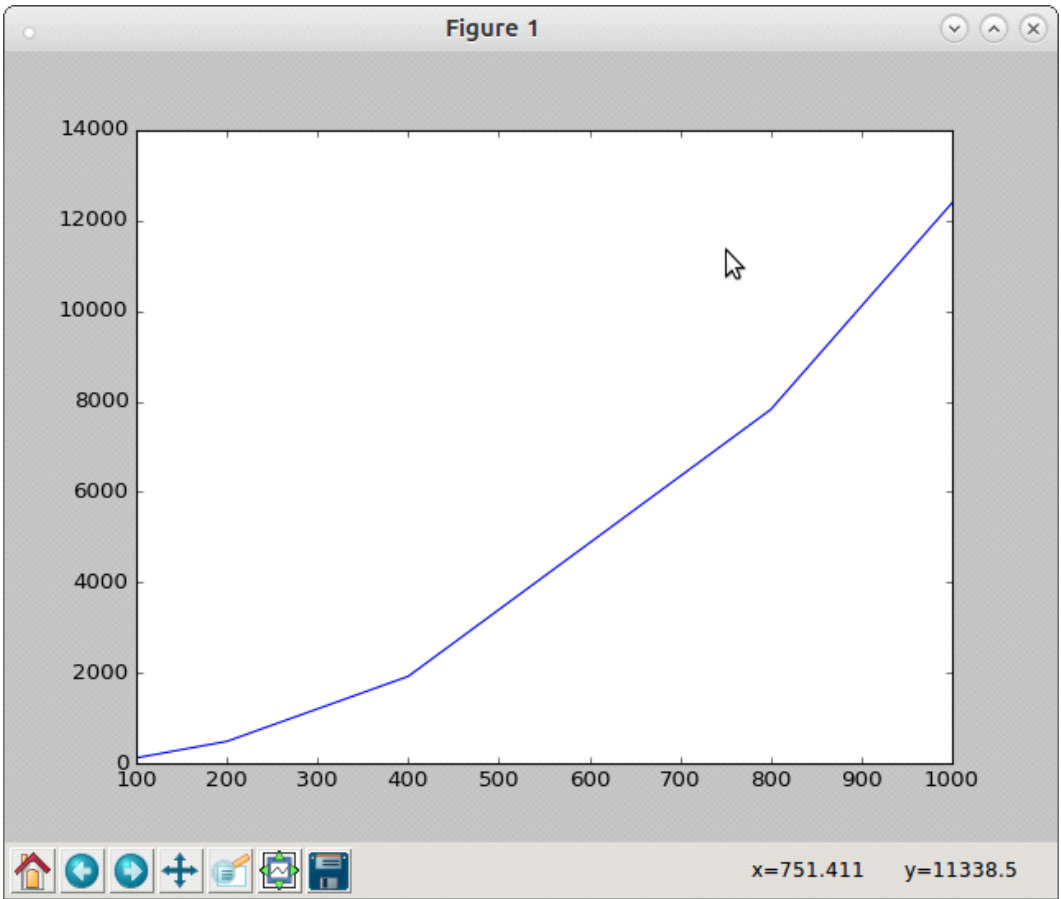


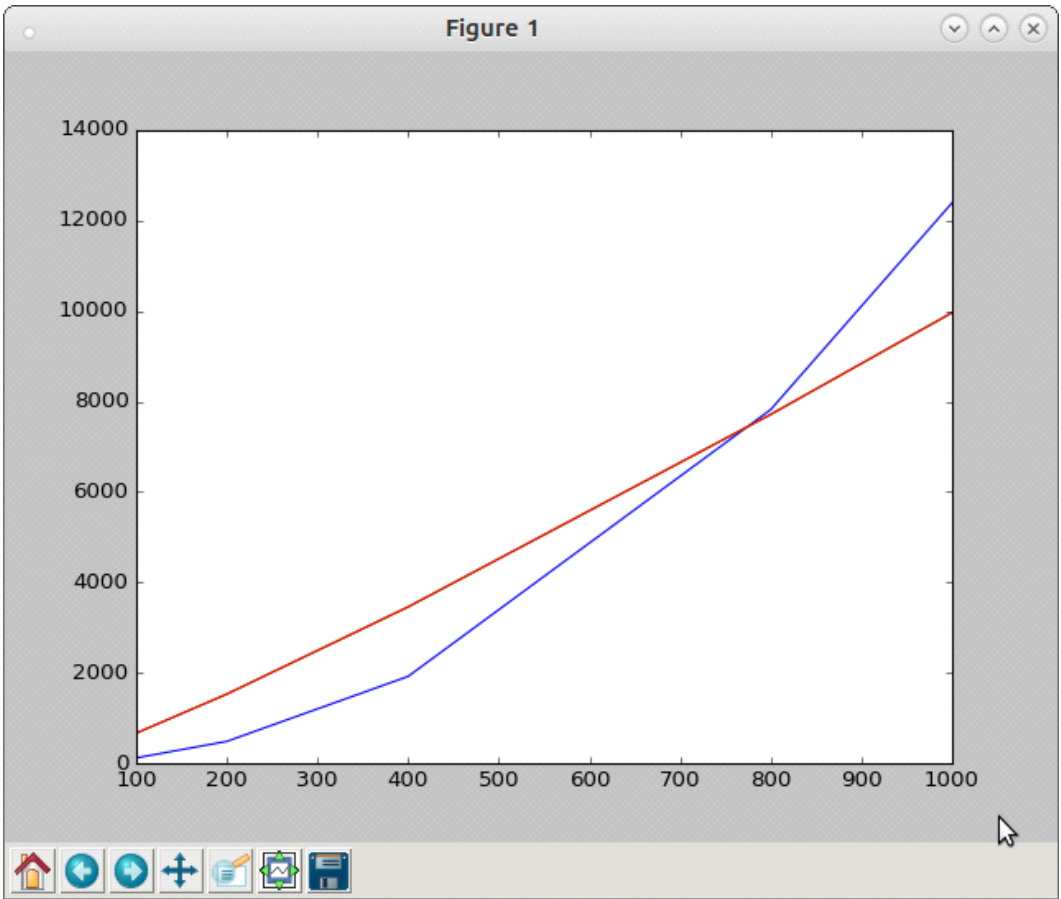
```
anand@ubuntu-pro-book: /home/user/programs
File Edit View Search Terminal Help
$ time wget http://www.google.com -O /dev/null
--2016-12-28 16:59:27-- http://www.google.com/
Resolving www.google.com (www.google.com)... 216.58.197.36, 2404:6800:4007:807::2004
Connecting to www.google.com (www.google.com)|216.58.197.36|:80... connected.
HTTP request sent, awaiting response... 302 Found
Location: http://www.google.co.in/?gfe_rd=cr&ei=F6JjWITaLeeK8Qfvj70QBg [following]
--2016-12-28 16:59:27-- http://www.google.co.in/?gfe_rd=cr&ei=F6JjWITaLeeK8Qfvj70QBg
Resolving www.google.co.in (www.google.co.in)... 216.58.197.35, 2404:6800:4007:807::2003
Connecting to www.google.co.in (www.google.co.in)|216.58.197.35|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [text/html]
Saving to: '/dev/null'

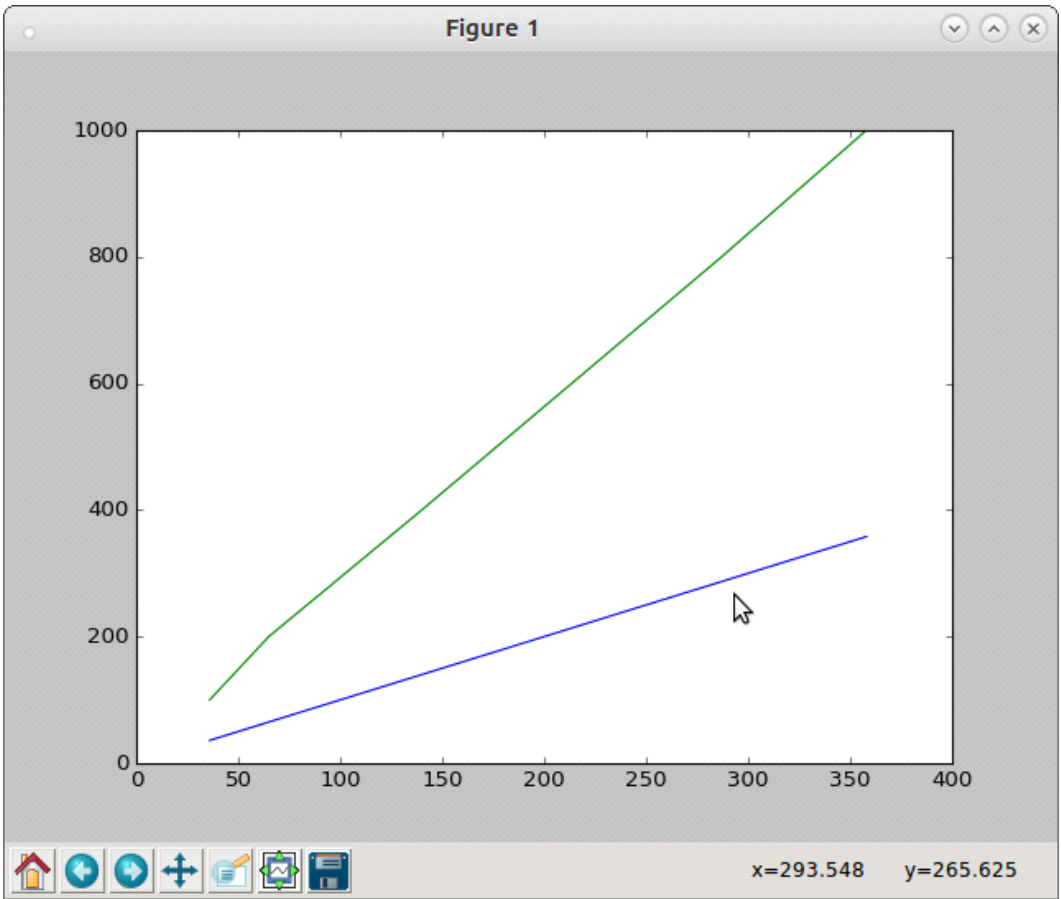
/dev/null          [ <=>          ] 12.14K  --.-KB/s   in 0.004s

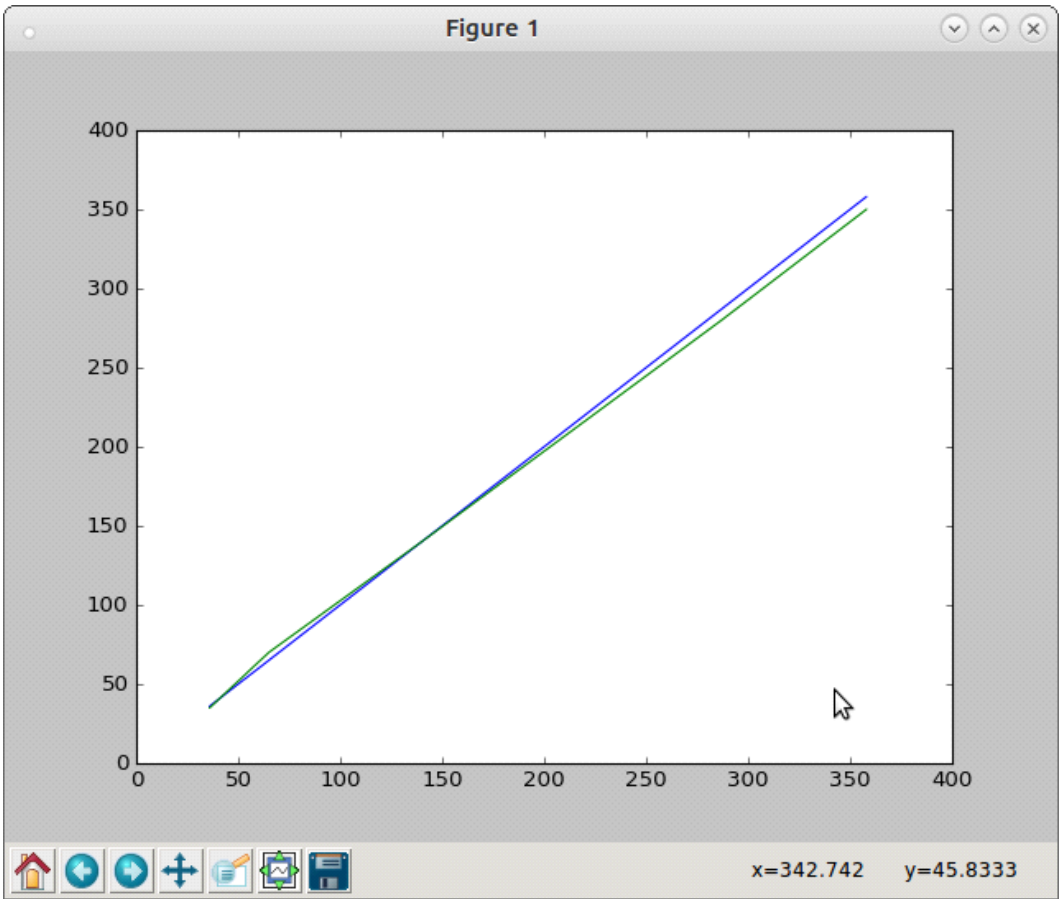
2016-12-28 16:59:27 (2.80 MB/s) - '/dev/null' saved [12429]

real    0m0.121s
user    0m0.004s
sys     0m0.008s
$
```









```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> cProfile.run("list(primes.Prime(100))")
477 function calls in 0.004 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
   1    0.000    0.000    0.004    0.004 <string>:1(<module>)
   1    0.000    0.000    0.000    0.000 primes.py:25(__init__)
   1    0.000    0.000    0.000    0.000 primes.py:30(__iter__)
  101    0.000    0.000    0.003    0.000 primes.py:33(__next__)
  271    0.003    0.000    0.003    0.000 primes.py:40(is_prime)
  100    0.001    0.000    0.003    0.000 primes.py:49(compute)
   1    0.000    0.000    0.004    0.004 {built-in method builtins.exec}
   1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

>>> █
```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> cProfile.run("list(primes.Prime(1000))")
5966 function calls in 0.043 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
   1    0.001    0.001    0.043    0.043 <string>:1(<module>)
   1    0.000    0.000    0.000    0.000 primes.py:25(__init__)
   1    0.000    0.000    0.000    0.000 primes.py:30(__iter__)
 1001    0.001    0.000    0.042    0.000 primes.py:33(__next__)
 3960    0.035    0.000    0.035    0.000 primes.py:40(is_prime)
 1000    0.005    0.000    0.040    0.000 primes.py:49(compute)
   1    0.000    0.000    0.043    0.043 {built-in method builtins.exec}
   1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

>>> █
```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> cProfile.run("list(primes.Prime(10000))")
72371 function calls in 0.458 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
   1    0.006   0.006   0.458   0.458 <string>:1(<module>)
   1    0.000   0.000   0.000   0.000 primes.py:25(_init_)
   1    0.000   0.000   0.000   0.000 primes.py:30(_iter_)
 10001  0.006   0.000   0.452   0.000 primes.py:33(_next_)
52365  0.417   0.000   0.417   0.000 primes.py:40(is_prime)
10000  0.028   0.000   0.445   0.000 primes.py:49(compute)
   1    0.000   0.000   0.458   0.458 {built-in method builtins.exec}
   1    0.000   0.000   0.000   0.000 {method 'disable' of '_lsprof.Profiler' objects}

>>> █
```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> cProfile.run("list(primes.Prime(1000))")
5966 function calls in 0.038 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
   1    0.001   0.001   0.038   0.038 <string>:1(<module>)
   1    0.000   0.000   0.000   0.000 primes.py:25(_init_)
   1    0.000   0.000   0.000   0.000 primes.py:30(_iter_)
  1001  0.002   0.000   0.037   0.000 primes.py:33(_next_)
 3960  0.029   0.000   0.029   0.000 primes.py:40(is_prime)
  1000  0.006   0.000   0.035   0.000 primes.py:49(compute)
   1    0.000   0.000   0.038   0.038 {built-in method builtins.exec}
   1    0.000   0.000   0.000   0.000 {method 'disable' of '_lsprof.Profiler' objects}

>>> █
```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> cProfile.run("list(primes.Prime(10000))")
72371 function calls in 0.232 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
   1    0.003    0.003    0.232    0.232 <string>:1(<module>)
   1    0.000    0.000    0.000    0.000 primes.py:25(__init__)
   1    0.000    0.000    0.000    0.000 primes.py:30(__iter__)
10001    0.005    0.000    0.228    0.000 primes.py:33(__next__)
52365    0.202    0.000    0.202    0.000 primes.py:40(is_prime)
10000    0.022    0.000    0.224    0.000 primes.py:49(compute)
   1    0.000    0.000    0.232    0.232 {built-in method builtins.exec}
   1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

>>>
```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> pstats.Stats('prime.stats').sort_stats('ncalls').print_stats()
Thu Dec 29 06:34:39 2016 prime.stats

577 function calls in 0.002 seconds

Ordered by: call count

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
  271    0.001    0.000    0.001    0.000 /home/user/programs/chap4/primes.py:41(is_prime)
  101    0.000    0.000    0.002    0.000 /home/user/programs/chap4/primes.py:34(__next__)
  100    0.000    0.000    0.000    0.000 {method 'append' of 'list' objects}
  100    0.000    0.000    0.001    0.000 /home/user/programs/chap4/primes.py:51(compute)
   1    0.000    0.000    0.000    0.000 /home/user/programs/chap4/primes.py:31(__iter__)
   1    0.000    0.000    0.002    0.002 <string>:1(<module>)
   1    0.000    0.000    0.000    0.000 /home/user/programs/chap4/primes.py:25(__init__)
   1    0.000    0.000    0.002    0.002 {built-in method builtins.exec}
   1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

<pstats.Stats object at 0x7f5b97262da0>
>>>
```



```

anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
>>> pstats.Stats('prime.stats').sort_stats('pcalls').print_callers()
Ordered by: primitive call count

Function                                                    was called by...
ncalls  tottime  cumtime
/home/user/programs/chap4/primes.py:41(is_prime) <- 271  0.001  0.001 /home/user/programs/chap4/primes.py:51(compute)
/home/user/programs/chap4/primes.py:34(__next__) <- 101  0.000  0.002 <string:1(<module>)
{method 'append' of 'list' objects} <- 100  0.000  0.000 /home/user/programs/chap4/primes.py:51(compute)
/home/user/programs/chap4/primes.py:51(compute) <- 100  0.000  0.001 /home/user/programs/chap4/primes.py:34(__next__)
/home/user/programs/chap4/primes.py:31(__iter__) <- 1  0.000  0.000 <string:1(<module>)
<string:1(<module>) <- 1  0.000  0.000 {built-in method builtin_s.exec}
/home/user/programs/chap4/primes.py:25(__init__) <- 1  0.000  0.000 <string:1(<module>)
{built-in method builtins.exec} <-
{method 'disable' of '_lsprof.Profiler' objects} <-

<pstats.Stats object at 0x7f5b9907e550>
>>>

```

```

anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ kernprof -l -v primes.py
Wrote profile results to primes.py.lprof
Timer unit: 1e-06 s

Total time: 0.04177 s
File: primes.py
Function: is_prime at line 40

Line #      Hits          Time Per Hit   % Time  Line Contents
=====
40          0           0.0      0.0      0.0      @profile
41          0           0.0      0.0      0.0      def is_prime(self):
42          0           0.0      0.0      0.0      """ Whether current value is prime ? """
43          0           0.0      0.0      0.0
44      3960       3339      0.8      8.0      vroot = int(self.value ** 0.5) + 1
45     41579     17141     0.4     41.0      for i in range(3, vroot, 2):
46     40579     19821     0.5     47.5          if self.value % i == 0:
47      2960       1072     0.4      2.6              return False
48      1000        397     0.4      1.0              return True

$

```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python3 -m memory_profiler mem_profile_example.py
Filename: mem_profile_example.py
Line #   Mem usage   Increment   Line Contents
=====
1    31.559 MiB   0.000 MiB   @profile
2
3    31.559 MiB   0.000 MiB   def squares(n):
                                return [x*x for x in range(1, n+1)]
$
```

```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python3 -m memory_profiler mem_profile_example.py
Filename: mem_profile_example.py
Line #   Mem usage   Increment   Line Contents
=====
1    31.418 MiB   0.000 MiB   @profile
2
3    70.027 MiB  38.609 MiB   def squares(n):
                                return [x*x for x in range(1, n+1)]
$
```

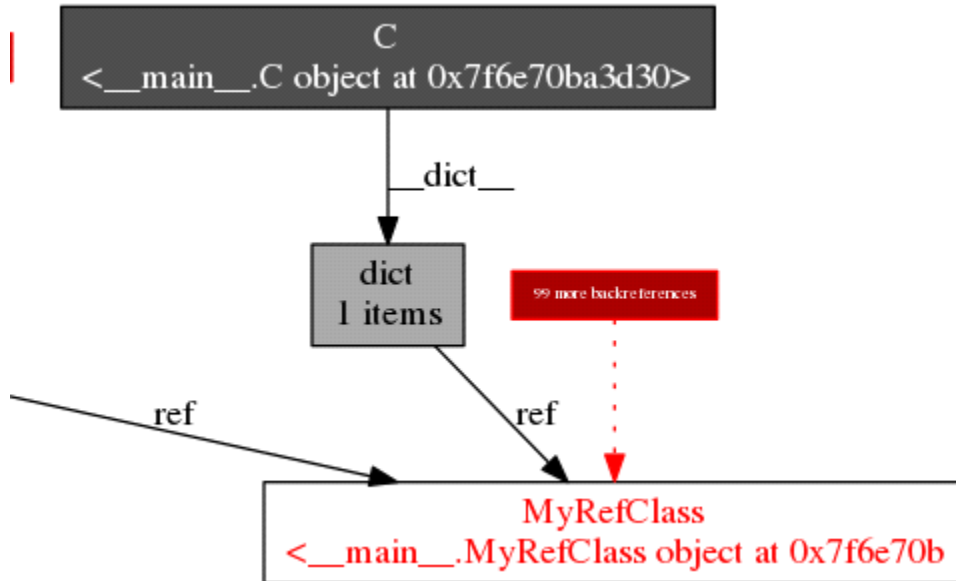
```
anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python3 -m memory_profiler sub_string.py
Filename: sub_string.py
Line #   Mem usage   Increment   Line Contents
=====
24    31.352 MiB   0.000 MiB   @profile
25
26    31.352 MiB   0.000 MiB   def sub_string(seq1, seq2):
27                                     """Return sub-strings from seq2 which are in seq1 """
28
29                                     # E.g: seq1 = ['introduction','discipline','animation']
30                                     # seq2 = ['in','on','is','mat','ton']
31                                     # Result = ['in','on','mat','is']
32
33                                     # Create all slices of lengths in a given range
34                                     min_l, max_l = min(map(len, seq2)), max(map(len, seq2))
35                                     sequences = {}
36
37                                     for i in range(min_l, max_l+1):
38                                         for string in seq1:
39                                             sequences.update({}.fromkeys(slices(string, i)))
40
41                                     subs = []
42                                     for item in seq2:
43                                         if item in sequences:
44                                             subs.append(item)
45
46                                     return subs
$
```

```

anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python3 -m memory_profiler sub_string.py
Filename: sub_string.py

```

Line #	Mem usage	Increment	Line Contents
24	32.523 MiB	0.000 MiB	@profile
25			def sub_string(seq1, seq2):
26			""" Return sub-strings from seq2 which are in seq1 """
27			
28			# E.g: seq1 = ['introduction', 'discipline', 'animation']
29			# seq2 = ['in', 'on', 'is', 'mat', 'ton']
30			# Result = ['in', 'on', 'mat', 'is']
31			
32			# Create all slices of lengths in a given range
33	32.523 MiB	0.000 MiB	min_l, max_l = min(map(len, seq2)), max(map(len, seq2))
34	32.523 MiB	0.000 MiB	sequences = {}
35			
36	38.770 MiB	6.246 MiB	for i in range(min_l, max_l+1):
37	38.770 MiB	0.000 MiB	for string in seq1:
38	38.770 MiB	0.000 MiB	sequences.update({}.fromkeys(slices(string, i)))
39			
40	38.770 MiB	0.000 MiB	subs = []
41	38.770 MiB	0.000 MiB	for item in seq2:
42	38.770 MiB	0.000 MiB	if item in sequences:
43	38.770 MiB	0.000 MiB	subs.append(item)
44			
45	38.770 MiB	0.000 MiB	return subs



```

anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python3 sub_string.py
Memory usage {'gra': None, 'usrq': None, 'slx': Non...gj': None, 'yzfp': None, 'egfa': None} size=588
7488 flat=3145824

```

types	# objects	total size
<class 'str	30048	2.14 MB
<class 'dict	1540	1.19 MB
<class 'type	462	458.64 KB
<class 'code	3067	431.45 KB
<class 'list	413	229.49 KB
<class 'set	363	139.91 KB
<class 'wrapper descriptor	1106	86.41 KB
<class 'tuple	1266	83.86 KB
<class 'weakref	975	76.17 KB
<class 'builtin function or method	920	64.69 KB
<class 'method descriptor	828	58.22 KB
<class 'abc.ABCMeta	51	48.13 KB
<class 'int	1489	41.66 KB
<class 'getset descriptor	504	35.44 KB
<class 'frozenset	42	27.94 KB

```

anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python -m memory_profiler counter_hound.py
Filename: counter_hound.py

```

Line #	Mem usage	Increment	Line Contents
4	40.906 MiB	0.000 MiB	@profile
5			def hound():
6	45.082 MiB	4.176 MiB	text=requests.get('https://www.gutenberg.org/files/2852/2852-0.txt').text
7	45.082 MiB	0.000 MiB	c = Counter()
8	49.570 MiB	4.488 MiB	words = [word.lower().strip() for word in text.split()]
9	50.266 MiB	0.695 MiB	c.update(words)

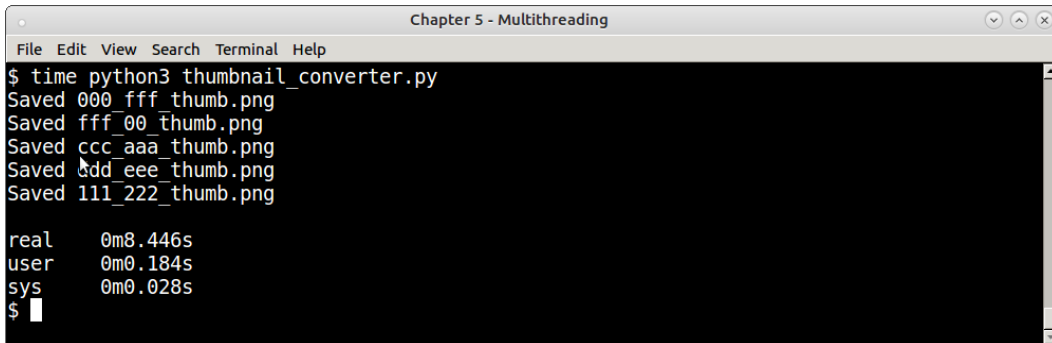
```

anand@ubuntu-pro-book: /home/user/programs/chap4
File Edit View Search Terminal Help
$ python -m memory_profiler bloom_hound.py
Filename: bloom_hound.py

```

Line #	Mem usage	Increment	Line Contents
4	40.996 MiB	0.000 MiB	@profile
5			def hound():
6	41.160 MiB	0.164 MiB	f=BloomFilter(capacity=100000, error_rate=0.01)
7	45.621 MiB	4.461 MiB	text=requests.get('https://www.gutenberg.org/files/2852/2852-0.txt').text
8			
9	49.742 MiB	4.121 MiB	for word in text.split():
10	49.742 MiB	0.000 MiB	word = word.lower().strip()
11	49.742 MiB	0.000 MiB	f.add(word)

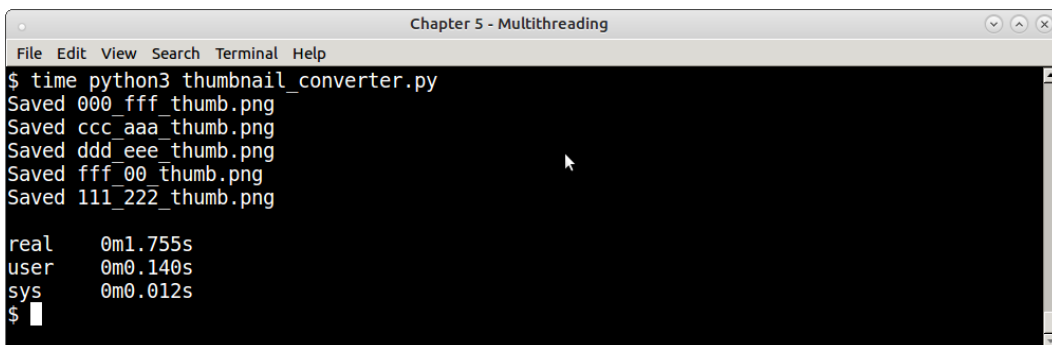
## Chapter 5: Writing Applications That Scale



A terminal window titled "Chapter 5 - Multithreading" showing the execution of a Python script. The script processes five files sequentially. The output shows the filename being saved and a timing summary at the end.

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
$ time python3 thumbnail_converter.py
Saved 000_fff_thumb.png
Saved fff_00_thumb.png
Saved ccc_aaa_thumb.png
Saved ddd_eee_thumb.png
Saved 111_222_thumb.png

real    0m8.446s
user    0m0.184s
sys     0m0.028s
$
```



A terminal window titled "Chapter 5 - Multithreading" showing the execution of the same Python script. The output shows the filename being saved and a timing summary at the end. The real time is significantly lower than in the sequential case.

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
$ time python3 thumbnail_converter.py
Saved 000_fff_thumb.png
Saved ccc_aaa_thumb.png
Saved ddd_eee_thumb.png
Saved fff_00_thumb.png
Saved 111_222_thumb.png

real    0m1.755s
user    0m0.140s
sys     0m0.012s
$
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
Producer Put https://dummyimage.com/240x600/4c8/1d0.jpg
Producer Put https://dummyimage.com/240x240/18d/c05.jpg
Consumer Got https://dummyimage.com/240x600/4c8/1d0.jpg
Consumer Got https://dummyimage.com/240x240/18d/c05.jpg
Producer Put https://dummyimage.com/320x600/e41/58d.jpg
Producer Put https://dummyimage.com/360x720/9c0/b39.jpg
Consumer Saved 1d0_thumb.png
Consumer Got https://dummyimage.com/320x600/e41/58d.jpg
Consumer Saved c05_thumb.png
Consumer Got https://dummyimage.com/360x720/9c0/b39.jpg
Producer Put https://dummyimage.com/600x480/b9d/8e5.jpg
Producer Put https://dummyimage.com/360x600/62a/fc9.jpg
Producer Put https://dummyimage.com/320x240/eb7/c9b.jpg
Producer Put https://dummyimage.com/360x320/a90/340.jpg
Consumer Saved b39_thumb.png
Consumer Got https://dummyimage.com/600x480/b9d/8e5.jpg
Consumer Saved 58d_thumb.png
Consumer Got https://dummyimage.com/360x600/62a/fc9.jpg
Producer Put https://dummyimage.com/240x320/4f7/036.jpg
Producer Put https://dummyimage.com/480x720/8d9/d03.jpg
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
Producer-0df31af3115940039ecae87097c8a4a3 Put https://dummyimage.com/320x320/d4a/53b.jpg
Producer-0161c1559b29422aab98248c07d49e38 Put https://dummyimage.com/720x720/916/325.jpg
Producer-d742b77b5c4149a7adaa34401e51cb54 Put https://dummyimage.com/720x480/d75/f96.jpg
Saved d34_4fc_thumb.png
Count=> 10
Consumer-315c35b4f12347f78efc537d6c438bbe Got https://dummyimage.com/240x360/50c/d58.jpg
Consumer-bfa23685a5fe4a688ee967052ec50293 Set limit reached, quitting
Consumer-f5939f6a840d4e6cb841f381d6c6cbcc Set limit reached, quitting
Consumer-16ad73fe51bd4f9b88afeddcf7b931d9 Set limit reached, quitting
Consumer-315c35b4f12347f78efc537d6c438bbe Set limit reached, quitting
Joined Consumer-16ad73fe51bd4f9b88afeddcf7b931d9
Joined Consumer-315c35b4f12347f78efc537d6c438bbe
Joined Consumer-bfa23685a5fe4a688ee967052ec50293
Joined Consumer-f5939f6a840d4e6cb841f381d6c6cbcc
Producer-0df31af3115940039ecae87097c8a4a3 Put https://dummyimage.com/600x320/d8c/c0d.jpg
Producer-d742b77b5c4149a7adaa34401e51cb54 Put https://dummyimage.com/360x360/795/b30.jpg
Stopped Producer-0161c1559b29422aab98248c07d49e38
Stopped Producer-0df31af3115940039ecae87097c8a4a3
Stopped Producer-d742b77b5c4149a7adaa34401e51cb54
Total number of PNG images 10
$
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
Producer-27f794680560473f939b0bd1fae5166f Put https://dummyimage.com/480x720/372/35f.jpg
Producer-8e2aa45e1ec14693939ec5b87a45429b Put https://dummyimage.com/320x360/e2f/d71.jpg
Producer-0ac969637a5c4b95af4f9d30638b42da Put https://dummyimage.com/720x480/754/e14.jpg
Producer-27f794680560473f939b0bd1fae5166f Put https://dummyimage.com/720x720/815/d3b.jpg
Producer-8e2aa45e1ec14693939ec5b87a45429b Put https://dummyimage.com/320x360/4b5/f02.jpg
Saved da4_fde_thumb.png
Count=> 100
Consumer-2df279565d52400985500148e402da08 Got https://dummyimage.com/600x480/38a/316.jpg
Consumer-71399ff8d7504ef49ac104c6cdab6ec3 Set limit reached, quitting
Consumer-d597bdfebe58452bb84f526ead921b64 Set limit reached, quitting
Joined Consumer-71399ff8d7504ef49ac104c6cdab6ec3
Consumer-c845a8d36fe543fd9945345a7a1e67fb Set limit reached, quitting
Consumer-2df279565d52400985500148e402da08 Set limit reached, quitting
Joined Consumer-c845a8d36fe543fd9945345a7a1e67fb
Joined Consumer-d597bdfebe58452bb84f526ead921b64
Joined Consumer-2df279565d52400985500148e402da08
Stopped Producer-0ac969637a5c4b95af4f9d30638b42da
Stopped Producer-27f794680560473f939b0bd1fae5166f
Stopped Producer-8e2aa45e1ec14693939ec5b87a45429b
Total number of PNG images 100
$
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
Consumer-275279a36ff049c38c77b506c5fa4010 Got https://dummyimage.com/720x360/47e/76b.jpg
Semaphore limit reached, returning False
Consumer-275279a36ff049c38c77b506c5fa4010 Set limit reached, quitting
Producer-cac6092edbbf40fa89ebdb530f1afc40 Put https://dummyimage.com/480x720/172/1fe.jpg
Producer-cc88bd03b49b43348aa3d6128869aea4 Put https://dummyimage.com/320x320/2f1/75c.jpg
Producer-b6fa5b443b8045e792278b4c49c6037f Put https://dummyimage.com/720x360/eab/570.jpg
Saved f96_3d0.png
Consumer-8b3103b9076640b1a4387b6cdc81f7c7 Got https://dummyimage.com/360x320/5be/567.jpg
Semaphore limit reached, returning False
Consumer-8b3103b9076640b1a4387b6cdc81f7c7 Set limit reached, quitting
Joined Consumer-8b3103b9076640b1a4387b6cdc81f7c7
Joined Consumer-275279a36ff049c38c77b506c5fa4010
Joined Consumer-ef6c97e1618744c9af41cc31c70552da
Joined Consumer-92460417f9984080bea7417159a9112b
Producer-cac6092edbbf40fa89ebdb530f1afc40 Put https://dummyimage.com/240x320/4fb/bc5.jpg
Producer-b6fa5b443b8045e792278b4c49c6037f Put https://dummyimage.com/360x320/792/491.jpg
Stopped Producer-cc88bd03b49b43348aa3d6128869aea4
Stopped Producer-cac6092edbbf40fa89ebdb530f1afc40
Stopped Producer-b6fa5b443b8045e792278b4c49c6037f
Total number of PNG images 200
$
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help

$ time python3 thumbnail_limit_lock.py > /dev/null

real    2m44.327s
user    0m1.216s
sys     0m0.196s
$
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help

$ time python3 thumbnail_limit_sema.py > /dev/null

real    0m43.206s
user    0m1.256s
sys     0m0.220s
$
```

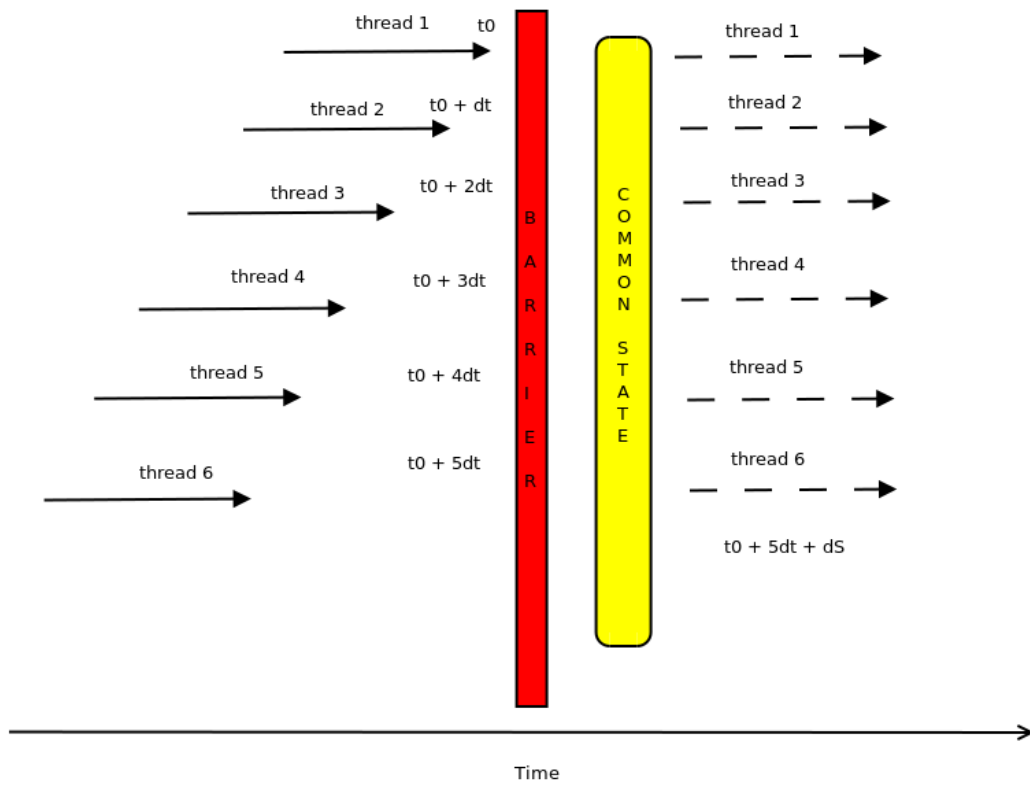
```
Chapter 5 - Multithreading
File Edit View Search Terminal Help

Producer-e16bb20bfec344a397afec7a21b40703 Put https://dummyimage.com/240x600/ac4/732.jpg
Consumer-5e77a6c735cc4011b526fdd30c79ad41 Got https://dummyimage.com/240x600/ac4/732.jpg
Producer-8dbd061f04d64c488fbd48593e9793cd Put https://dummyimage.com/480x360/6a5/dc0.jpg
Producer-bb4afa3358784b25b7bd284fe0060c67 Put https://dummyimage.com/240x240/417/bd1.jpg
Current Rate 340.09723953422684
Controller, rate is high, sleep more by 340.09723953422684 1.6116513307457048
Producer-e16bb20bfec344a397afec7a21b40703 Put https://dummyimage.com/480x480/7e4/fde.jpg
Current Rate 206.21639516208333
Controller, rate is high, sleep more by 206.21639516208333 0.8678688620115741
Producer-8dbd061f04d64c488fbd48593e9793cd Put https://dummyimage.com/360x720/e98/3f9.jpg
Current Rate 233.2954122890928
Controller, rate is high, sleep more by 233.2954122890928 1.0183078460505155
Saved 1af_516.png
Consumer-5acf9e9628f8410eb46b46f494cb0d98 Got https://dummyimage.com/480x360/6a5/dc0.jpg
Saved 0ef_189.png
Consumer-6d91ef9446a64630bf1e440bfd43cb2 Got https://dummyimage.com/240x240/417/bd1.jpg
Saved ac4_732.png
Saved 61f_df6.png
Consumer-8f51be0b029c44cfb0fee4bcbbf87b04 Got https://dummyimage.com/480x480/7e4/fde.jpg
Consumer-5e77a6c735cc4011b526fdd30c79ad41 Got https://dummyimage.com/360x720/e98/3f9.jpg
Saved e98_3f9.png
Saved 6a5_dc0.png
Saved 7e4_fde.png
Saved 417_bd1.png
Producer-e16bb20bfec344a397afec7a21b40703 Put https://dummyimage.com/720x720/f73/430.jpg
```



```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
Consumer-8f51be0b029c44cfb0fee4bcbbf87b04 Got https://dummyimage.com/360x480/b91/ea3.jpg
Saved f73_430.png
Saved f6c_d65.png
Producer-e16bb20bfec344a397afec7a21b40703 Put https://dummyimage.com/480x360/bd9/a3b.jpg
Current Rate 53.89566695203177
Controller, rate is high, sleep more by 53.89566695203177 0.021642594177954264
Consumer-6d91ef9446a64630bfefe440bfd43cb2 Got https://dummyimage.com/480x360/bd9/a3b.jpg
Saved b91_ea3.png
Producer-8dbd061f04d64c488fdb48593e9793cd Put https://dummyimage.com/480x480/5e0/5bc.jpg
Current Rate 55.55763128608805
Controller, rate is high, sleep more by 55.55763128608805 0.030875729367155852
Consumer-5e77a6c735cc4011b526fdd30c79ad41 Got https://dummyimage.com/480x480/5e0/5bc.jpg
Saved bd9_a3b.png
Saved 5e0_5bc.png
Producer-bb4afa3358784b25b7bd284fe0060c67 Put https://dummyimage.com/320x240/3f9/0f6.jpg
Current Rate 53.00755574036437
Controller, rate is high, sleep more by 53.00755574036437 0.01670864300202426
Consumer-5acf9e9628f8410eb46b46f494cb0d98 Got https://dummyimage.com/320x240/3f9/0f6.jpg
Producer-e16bb20bfec344a397afec7a21b40703 Put https://dummyimage.com/360x240/de2/fd8.jpg
Current Rate 51.45704583891241
Consumer-8f51be0b029c44cfb0fee4bcbbf87b04 Got https://dummyimage.com/360x240/de2/fd8.jpg
Controller, rate is high, sleep more by 51.45704583891241 0.008094699105068928
Saved 3f9_0f6.png
Producer-8dbd061f04d64c488fdb48593e9793cd Put https://dummyimage.com/480x720/58b/407.jpg
Current Rate 54.31287546100159
```

```
Chapter 5 - Multithreading
File Edit View Search Terminal Help
Consumer-c2a30ea8d7494631a8203f5c90abea50 Got https://dummyimage.com/320x240/92f/flc.jpg
Semaphore limit reached, returning False
Consumer-c2a30ea8d7494631a8203f5c90abea50 Set limit reached, quitting
Producer-ace34b3fc9644cd0a5760373db9aa0fa Put https://dummyimage.com/720x480/0a1/c69.jpg
Current Rate 50.15528364068437
Consumer-e0c93e3825df407a9d452b993eedd7ca Got https://dummyimage.com/720x480/0a1/c69.jpg
Controller, rate is high, sleep more by 50.15528364068437 0.0008626868926909263
Semaphore limit reached, returning False
Consumer-e0c93e3825df407a9d452b993eedd7ca Set limit reached, quitting
Producer-198415b202dc4b979d68d423c6ba0f16 Put https://dummyimage.com/360x720/7ad/6f4.jpg
Current Rate 50.08487818479042
Controller, rate is high, sleep more by 50.08487818479042 0.00047154547105788446
Consumer-d82287478e0d4a07afa4085b0a666160 Got https://dummyimage.com/360x720/7ad/6f4.jpg
Semaphore limit reached, returning False
Consumer-d82287478e0d4a07afa4085b0a666160 Set limit reached, quitting
Joined Consumer-d82287478e0d4a07afa4085b0a666160
Joined Consumer-1cbb1331c886469abd9892b5219abb9e
Joined Consumer-e0c93e3825df407a9d452b993eedd7ca
Joined Consumer-c2a30ea8d7494631a8203f5c90abea50
Stopping controller
Stopping producers...
Stopped Producer-198415b202dc4b979d68d423c6ba0f16
Stopped Producer-bd2baedf319e45298bc320a1346a46c6
Stopped Producer-ace34b3fc9644cd0a5760373db9aa0fa
Total number of PNG images 200
```



```

Chapter 5 - Multiprocessing
File Edit View Search Terminal Help
$ time python3 prime_thread.py > /dev/null

real    2m12.311s
user    2m12.232s
sys     0m1.128s
$

```

```
Chapter 5 - Multiprocessing
File Edit View Search Terminal Help
$ time python3 prime_process.py > /dev/null
real    1m9.633s
user    4m22.372s
sys     0m0.084s
$
```

```
Chapter 5 - Multiprocessing
File Edit View Search Terminal Help
$ python3 -m memory_profiler sort_in_memory.py 1000000
Length of list 10000000
Sorting...
Sorted
Filename: sort_in_memory.py
Line #    Mem usage    Increment    Line Contents
=====
5     31.328 MiB    0.000 MiB    @profile
6
7     31.328 MiB    0.000 MiB    def sort():
8                                all_lists = []
9
9     447.043 MiB  415.715 MiB    for i in range(int(sys.argv[1])):
10    447.043 MiB    0.000 MiB        num_list = map(int, open('numbers/numbers_%d.txt
' % i).readlines())
11    447.043 MiB    0.000 MiB        all_lists += num_list
12
13    447.043 MiB    0.000 MiB    print('Length of list',len(all_lists))
14    447.043 MiB    0.000 MiB    print('Sorting...')
15    456.887 MiB    9.844 MiB    all_lists.sort()
16    465.199 MiB    8.312 MiB    open('sorted_nums.txt','w').writelines('\n'.join(map
(str, all_lists)) + '\n')
17    465.199 MiB    0.000 MiB    print('Sorted')
```

```

Chapter 5 - Multiprocessing
File Edit View Search Terminal Help
$ python3 -m memory_profiler sort_counter.py 100000
Sorting...
Sorted
Filename: sort_counter.py

```

Line #	Mem usage	Increment	Line Contents
7	31.305 MiB	0.000 MiB	@profile
8			def sort():
9			
10	31.305 MiB	0.000 MiB	counter = collections.defaultdict(int)
11			
12	69.836 MiB	38.531 MiB	for i in range(int(sys.argv[1])):
13	69.836 MiB	0.000 MiB	num_list = map(int, open('numbers/numbers_%d.txt' % i
14	69.836 MiB	0.000 MiB	).readlines())
15	69.836 MiB	0.000 MiB	for n in num_list:
16			counter[n] += 1
17			
18	69.836 MiB	0.000 MiB	print('Sorting...')
19	69.836 MiB	0.000 MiB	with open('sorted_nums.txt','w') as fp:
20	69.836 MiB	0.000 MiB	for i in range(1, MAXINT+1):
21	69.836 MiB	0.000 MiB	count = counter.get(i, 0)
22	69.836 MiB	0.000 MiB	if count>0:
23	69.836 MiB	0.000 MiB	fp.write((str(i)+'\n')*count)
24	69.836 MiB	0.000 MiB	print('Sorted')

```

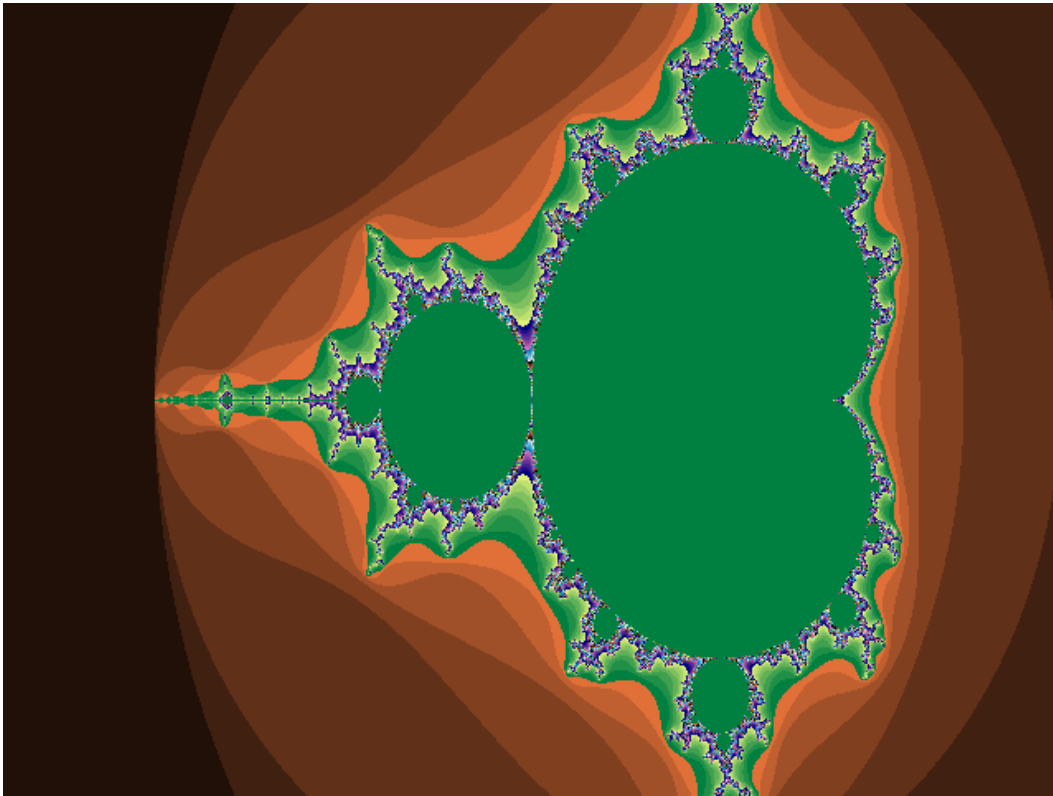
Chapter 5 - Asynchronous Execution
File Edit View Search Terminal Help
$ python3 generator_tasks.py 10
Switching to task square_mapper
Result=> 1
Switching to task prime_filter
Result=> 1
Switching to task square_mapper
Result=> 4
Switching to task prime_filter
Result=> 3
Switching to task square_mapper
Result=> 9
Switching to task prime_filter
Result=> 5
Switching to task square_mapper
Result=> 16
Switching to task prime_filter
Result=> 7
Switching to task square_mapper
Result=> 25
Switching to task prime_filter
Switching to task square_mapper
Result=> 36
Switching to task prime_filter
Switching to task square_mapper
Result=> 49
Switching to task prime_filter
Switching to task square_mapper
Result=> 64
Switching to task prime_filter
Switching to task square_mapper
Result=> 81
Switching to task prime_filter
Switching to task square_mapper
Result=> 100
Switching to task prime_filter
Last prime=> 7
Time taken=> 0.00021399999999999197
$

```



```
Chapter 5 - Asynchronous Execution
File Edit View Search Terminal Help
$ python3 concurrent_factorial.py
Factorial of 10 is 3628800
Factorial of 11 is 39916800
Factorial of 12 is 479001600
Factorial of 13 is 6227020800
Factorial of 14 is 87178291200
Factorial of 15 is 1307674368000
Factorial of 16 is 20922789888000
Factorial of 17 is 355687428096000
Factorial of 18 is 6402373705728000
Factorial of 19 is 121645100408832000
Factorial of 20 is 2432902008176640000
$
```

```
Chapter 5 - Asynchronous Execution
File Edit View Search Terminal Help
$ time python3 concurrent_thumbnail.py > /dev/null
real    0m14.372s
user    0m54.368s
sys     0m1.132s
$ time python3 concurrent_thumbnail.py --process> /dev/null
real    0m14.580s
user    0m55.996s
sys     0m1.076s
$ ls thumbs/* | wc -l
2138
$
```



```
Chapter 5 - Parallel processing
File Edit View Search Terminal Help
$ time python3 mandelbrot.py -W 640 -H 480 -n 1000
Creating mandelbrot set with size 640x480, #iterations=1000
real    0m22.887s
user    0m22.868s
sys     0m0.016s
$
```

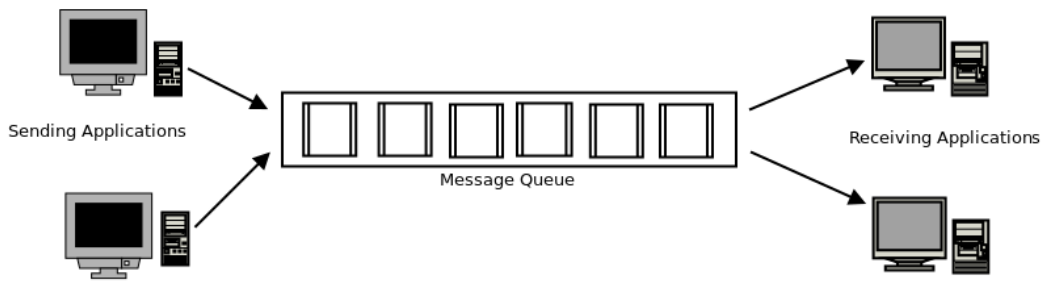
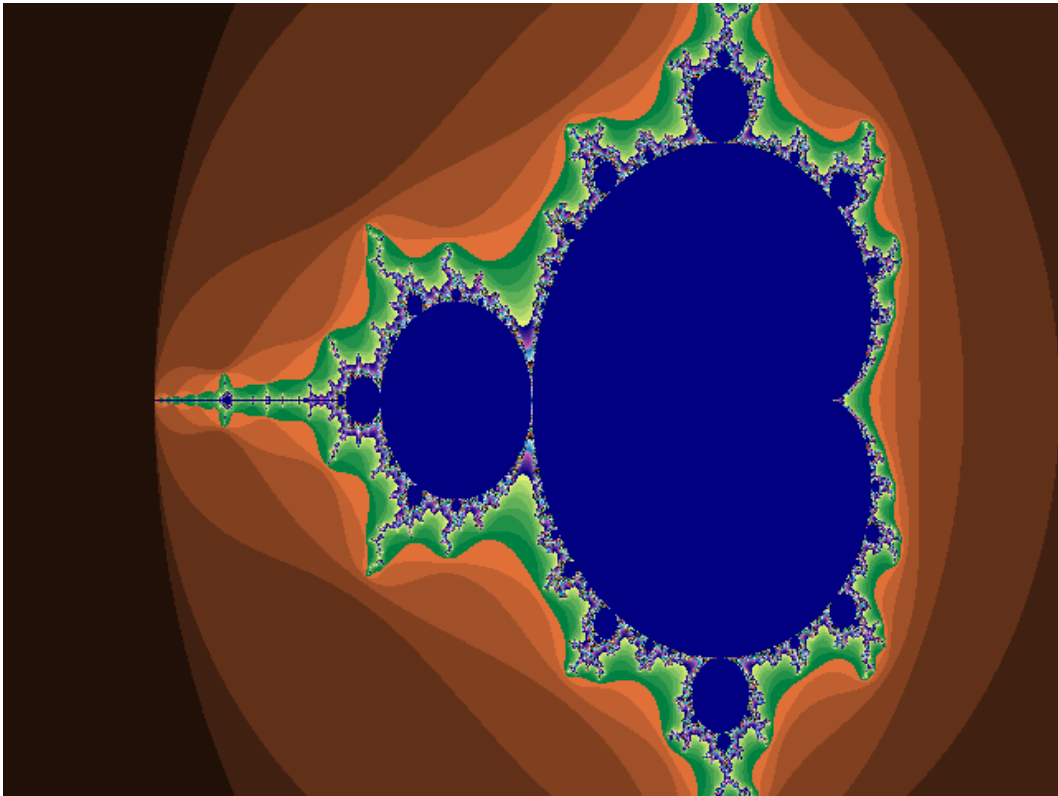
```
Chapter 5 - Parallel processing
File Edit View Search Terminal Help
$ time python3 mandelbrot.py -W 640 -H 480 -n 10000
Creating mandelbrot set with size 640x480, #iterations=10000

real    3m50.876s
user    3m48.876s
sys     0m0.048s
$
```

```
Chapter 5 - Parallel processing
File Edit View Search Terminal Help
$ time python3 mandelbrot_mp.py -W 640 -H 480 -n 10000
Creating mandelbrot set with size 640x480, #iterations=10000
Saved to mandelbrot_mp.png

real    2m20.586s
user    7m17.132s
sys     0m8.036s
$
```





```
Chapter 5 - Parallel processing
File Edit View Search Terminal Tabs Help
Chapter 5 - Parallel processing anand@ubuntu-pro-book: /home/user/programs/chap5
$ celery -A mandelbrot_tasks worker -c 4 --loglevel info

----- celery@ubuntu-pro-book v4.0.2 (latentcall)
----- **** -----
--- * *** * -- Linux-4.4.0-57-generic-x86_64-with-Ubuntu-16.04-xenial 2017-01-17 01:55:05
-- * - **** -----
- ** ----- [config]
- ** ----- .> app: tasks:0x7fee7c7e84e0
- ** ----- .> transport: amqp://guest:**@localhost:5672//
- ** ----- .> results: redis://localhost/
- *** --- * --- .> concurrency: 4 (prefork)
-- ***** --- .> task events: OFF (enable -E to monitor tasks in this worker)
----- ***** -----
----- [queues]
----- .> celery exchange=celery(key=celery)

[tasks]
. mandelbrot_tasks.mandelbrot_calc_row

[2017-01-17 01:55:05,511: INFO/MainProcess] Connected to amqp://guest:**@127.0.0.1:5672//
[2017-01-17 01:55:05,519: INFO/MainProcess] mingle: searching for neighbors
[2017-01-17 01:55:06,540: INFO/MainProcess] mingle: all alone
[2017-01-17 01:55:06,583: INFO/MainProcess] celery@ubuntu-pro-book ready.
```

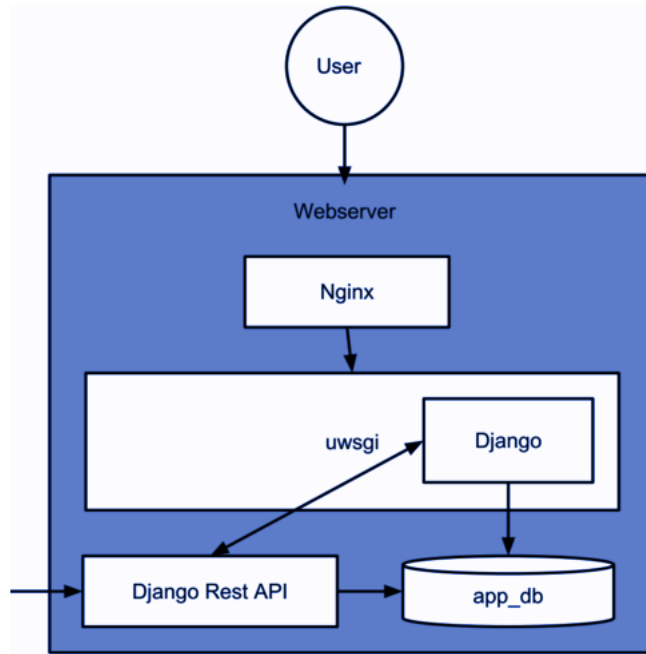
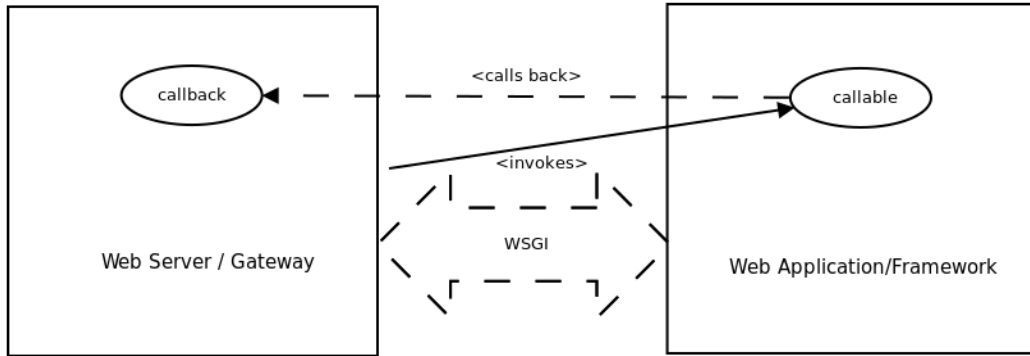
```
Chapter 5 - Parallel Processing
File Edit View Search Terminal Help
$ time python3 celery_mandelbrot.py -W 640 -H 480 -n 1000
Creating mandelbrot set with size 640x480, #iterations=1000
Saved to mandelbrot_celery.png

real    0m14.728s
user    0m2.312s
sys     0m0.140s
$
```

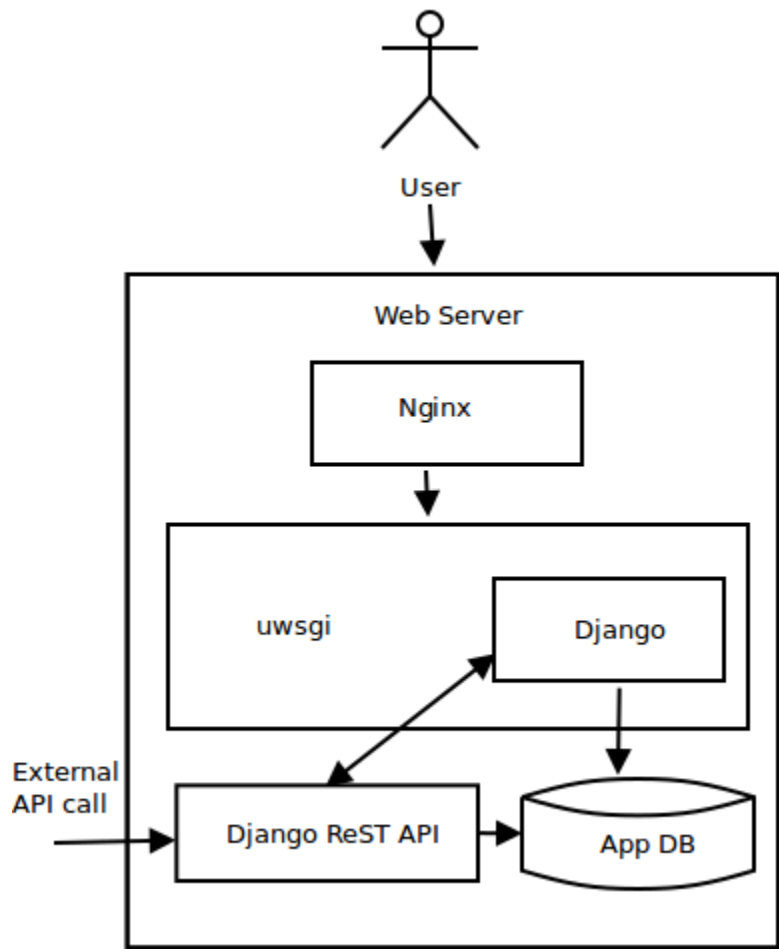
```
Chapter 5 - Parallel processing
File Edit View Search Terminal Tabs Help
Chapter 5 - Parallel processing anand@ubuntu-pro-book: /home/user/programs/chap5
16, 8), 112647: (32, 16, 8), 112648: (32, 16, 8), 112649: (32, 16, 8), 112650: (32, 16, 8), 112651:
(32, 16, 8), 112652: (32, 16, 8), 112653: (32, 16, 8), 112654: (32, 16, 8), 112655: (32, 16, 8), 112
656: (32, 16, 8), 112657: (32, 16, 8), 112658: (32, 16, 8), 112659: (32, 16, 8), 112660: (32, 16, 8)
, 112661: (32, 16, 8), 112662: (32, 16, 8), 112663: (32, 16, 8), 112664: (32, 16, 8), 112665: (32, 1
6, 8), 112666: (32, 16, 8), 112667: (32, 16, 8), 112668: (32, 16, 8), 112669: (32, 16, 8), 112670: (
32, 16, 8), 112671: (32, 16, 8), 112672: (32, 16, 8), 112673: (32, 16, 8), 112674: (32, 16, 8), 1126
75: (32, 16, 8), 112676: (32, 16, 8), 112677: (32, 16, 8), 112678: (32, 16, 8), 112679: (32, 16, 8),
112680: (32, 16, 8), 112681: (32, 16, 8), 112682: (32, 16, 8), 112683: (32, 16, 8), 112684: (32, 16
, 8), 112685: (32, 16, 8), 112686: (32, 16, 8), 112687: (32, 16, 8), 112688: (32, 16, ...)}
[2017-01-17 02:06:04,661: INFO/MainProcess] Received task: mandelbrot_tasks.mandelbrot_calc_row[8ef2
1b12-549e-4950-acba-d688f0130d3e]
[2017-01-17 02:06:04,663: INFO/PoolWorker-1] Task mandelbrot_tasks.mandelbrot_calc_row[f0bc038e-436a
-484c-8dca-5bf642765d5a] succeeded in 0.1549323820072459s: {[113664: (0, 128, 64), 113665: (0, 128, 6
4), 113666: (0, 128, 64), 113667: (0, 128, 64), 113668: (0, 128, 64), 113669: (0, 128, 64), 113670:
(0, 128, 64), 113671: (0, 128, 64), 113672: (0, 128, 64), 113673: (0, 128, 64), 113674: (0, 128, 64)
, 113675: (0, 128, 64), 113676: (0, 128, 64), 113677: (0, 128, 64), 113678: (0, 128, 64), 113679: (0
, 128, 64), 113680: (0, 128, 64), 113681: (0, 128, 64), 113682: (0, 128, 64), 113683: (0, 128, 64),
113684: (0, 128, 64), 113685: (0, 128, 64), 113686: (0, 128, 64), 113687: (0, 128, 64), 113688: (0,
128, 64), 113689: (0, 128, 64), 113690: (0, 128, 64), 113691: (0, 128, 64), 113692: (0, 128, 64), 11
3693: (0, 128, 64), 113694: (0, 128, 64), 113695: (0, 128, 64), 113696: (0, 128, 64), 113697: (0, 12
8, 64), 113698: (0, 128, 64), 113699: (0, 128, 64), 113700: (0, 128, 64), 113701: (0, 128, 64), 1137
02: (0, 128, 64), 113703: (0, 128, 64), 113704: (0, 128, 64), 113705: (0, 128, 64), 113706: (0, 128,
64), 113707: (0, 128, 64), 113708: (0, 128, 64), 113709: (0, 128, 64), 113710: (0, , ...)}
[2017-01-17 02:06:04,665: INFO/MainProcess] Received task: mandelbrot_tasks.mandelbrot_calc_row[9bab
87f4-f3d1-43cb-9698-8e071b810db9]
```

```
Chapter 5 - Parallel Processing
File Edit View Search Terminal Help
$ time python3 celery_mandelbrot.py -W 640 -H 480 -n 10000
Creating mandelbrot set with size 640x480, #iterations=10000
Saved to mandelbrot_celery.png

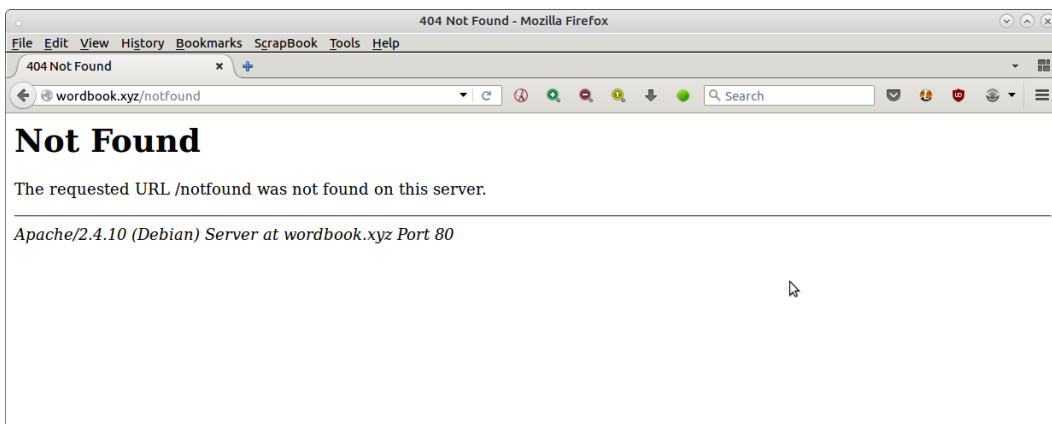
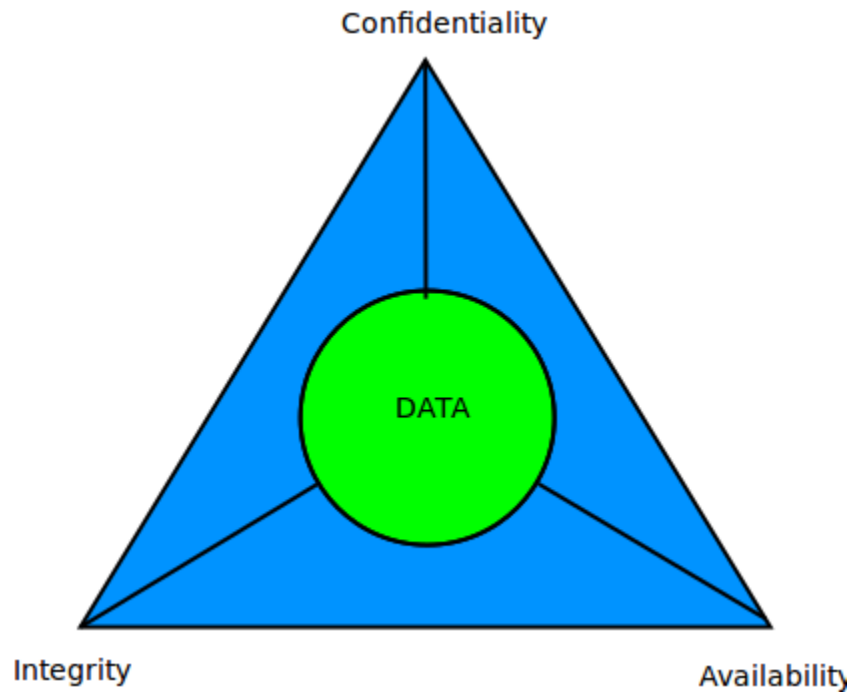
real    1m59.934s
user    0m2.328s
sys     0m0.156s
$
```

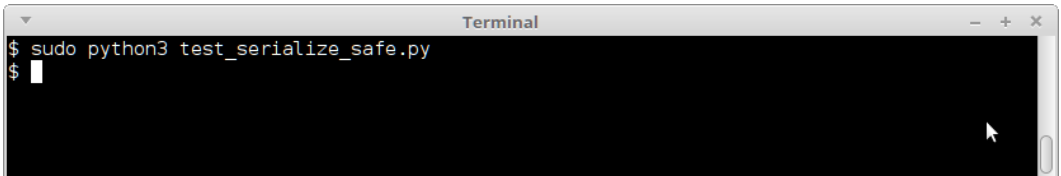
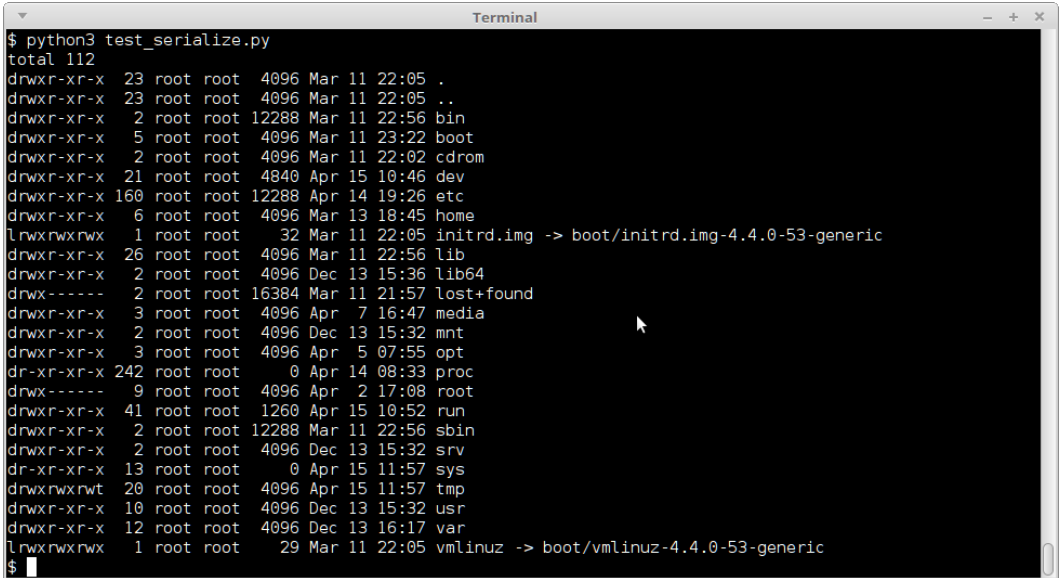
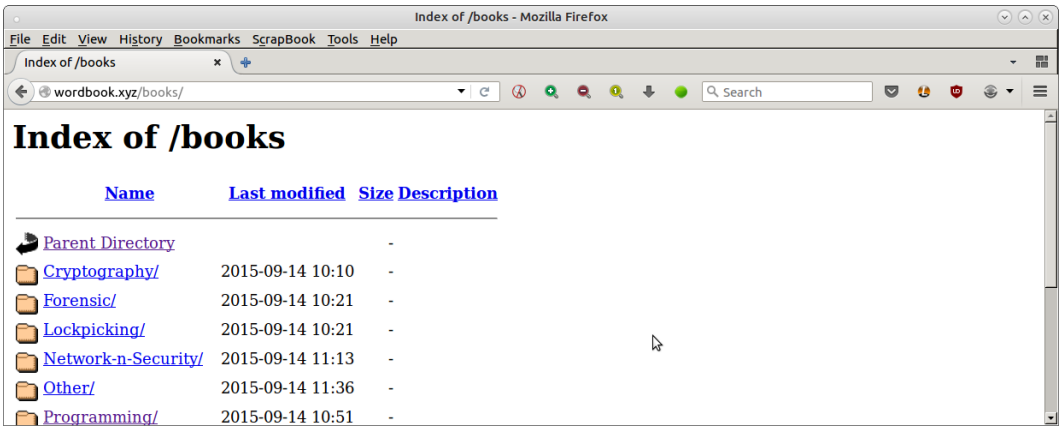


```
Chapter 5 - Asynchronous Execution
(env) anand@mangu-probook:/home/user/programs/chap5$ python3 asyncio_tasks.py
Prime=> 11
Square=> 100
Prime=> 13
Square=> 121
Square=> 144
Prime=> 17
Square=> 169
Prime=> 19
Square=> 196
Square=> 225
Prime=> 23
Square=> 256
Square=> 289
Square=> 324
Prime=> 29
Square=> 361
Prime=> 31
Square=> 400
Square=> 441
Square=> 484
Prime=> 37
Square=> 529
Square=> 576
Prime=> 41
Square=> 625
Prime=> 43
Square=> 676
```



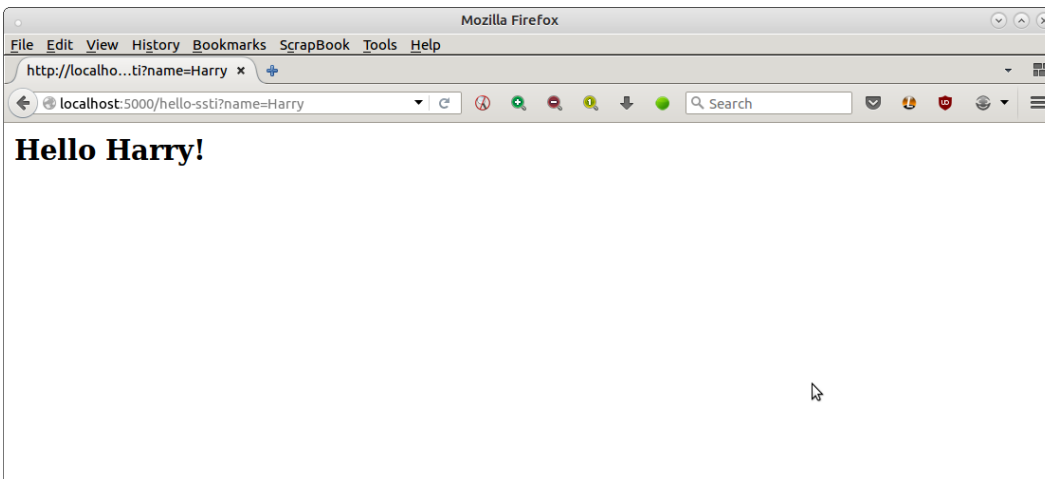
## Chapter 6: Security - Writing Secure Code

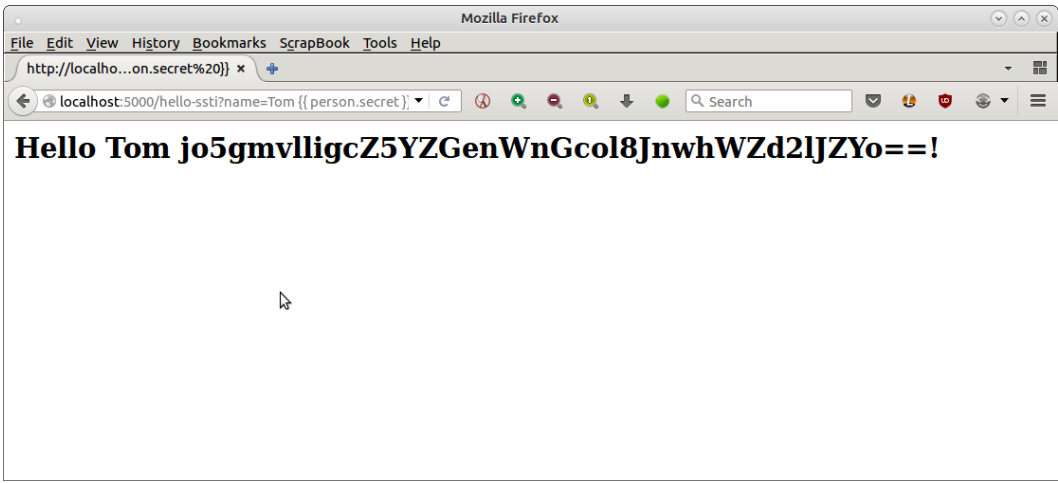


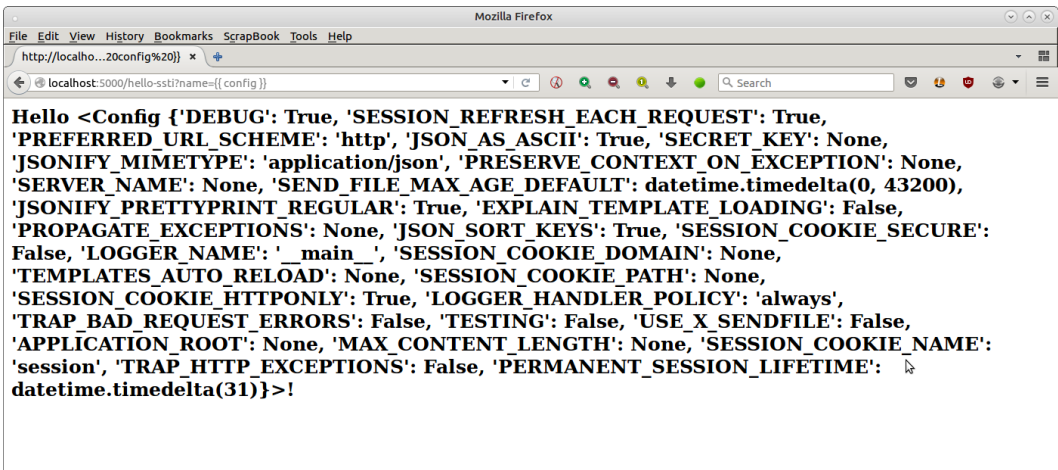


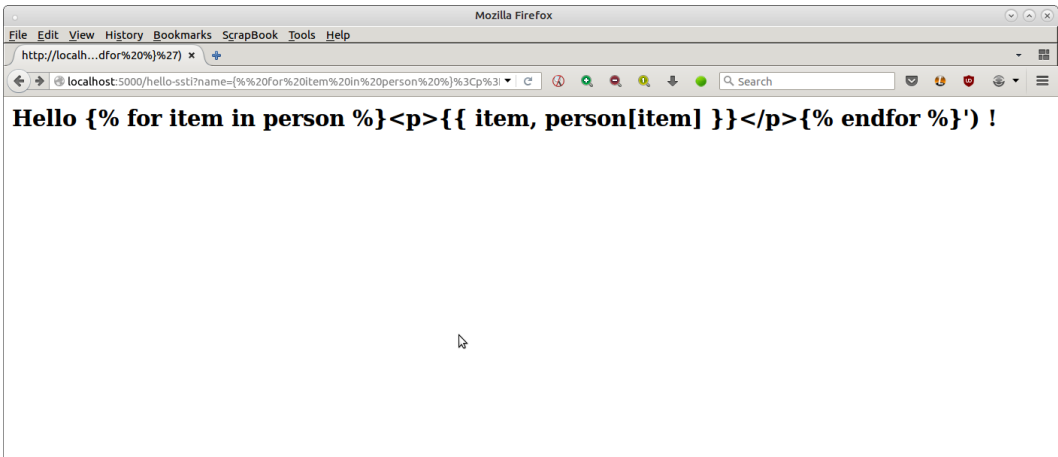


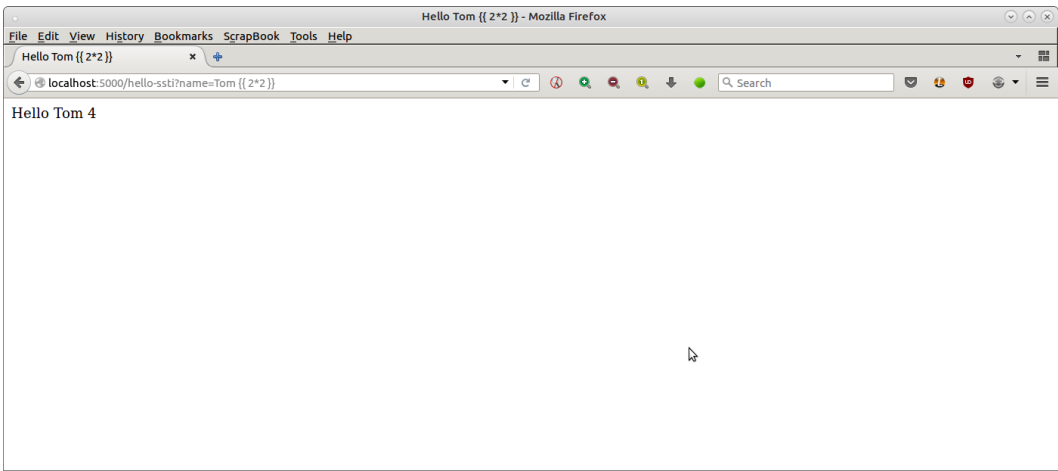
```
Terminal
$ python3 test_serialize_json.py
Traceback (most recent call last):
  File "test_serialize_json.py", line 27, in <module>
    shellcode = serialize()
  File "test_serialize_json.py", line 17, in serialize
    cls=ExploitEncoder)
  File "/usr/lib/python3.5/json/__init__.py", line 237, in dumps
    **kw).encode(obj)
  File "/usr/lib/python3.5/json/encoder.py", line 198, in encode
    chunks = self.iterencode(o, _one_shot=True)
  File "/usr/lib/python3.5/json/encoder.py", line 256, in iterencode
    return _iterencode(o, 0)
ValueError: Circular reference detected
$
```

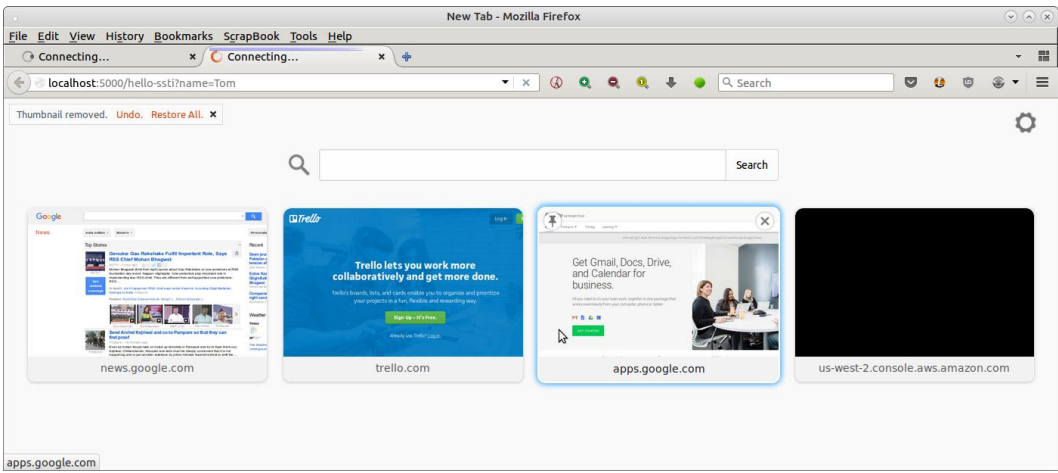
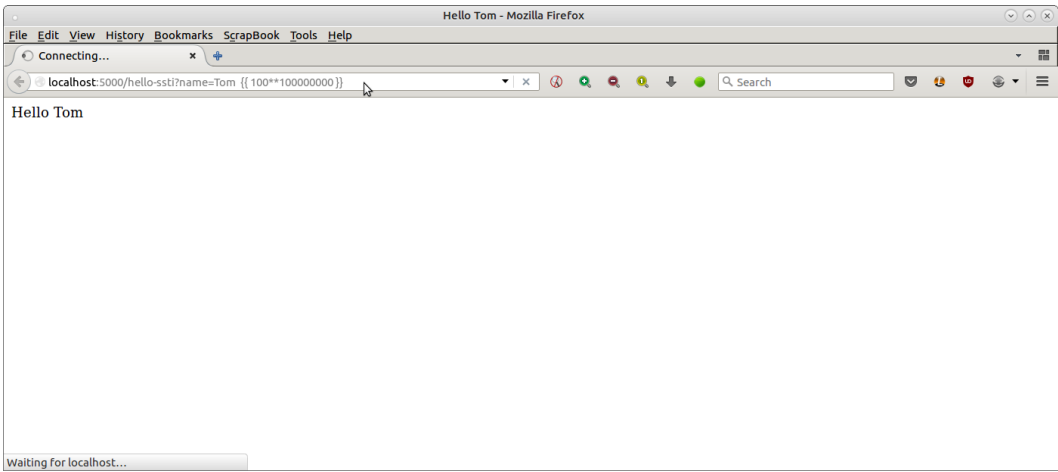


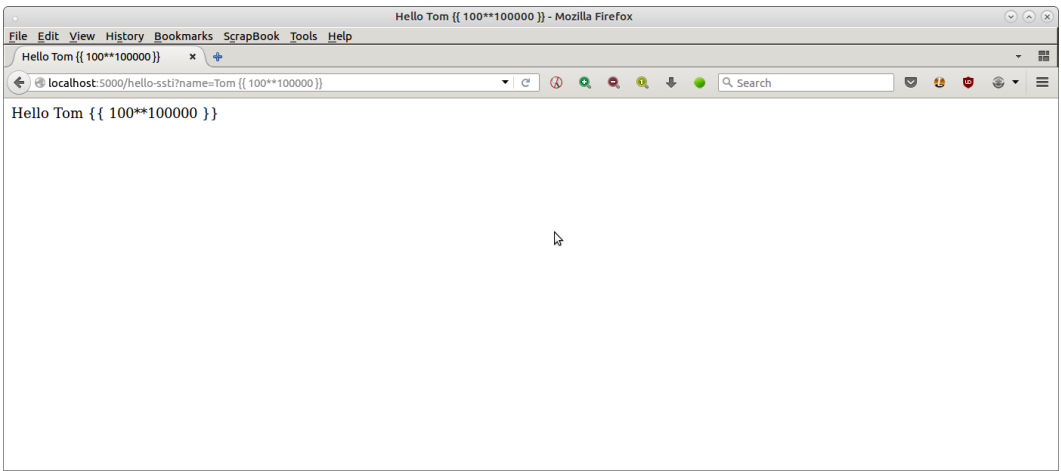
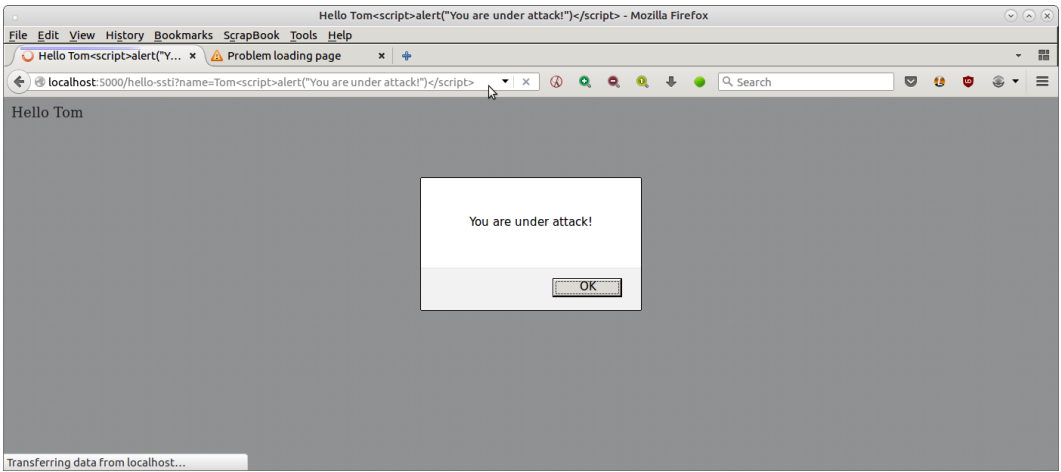


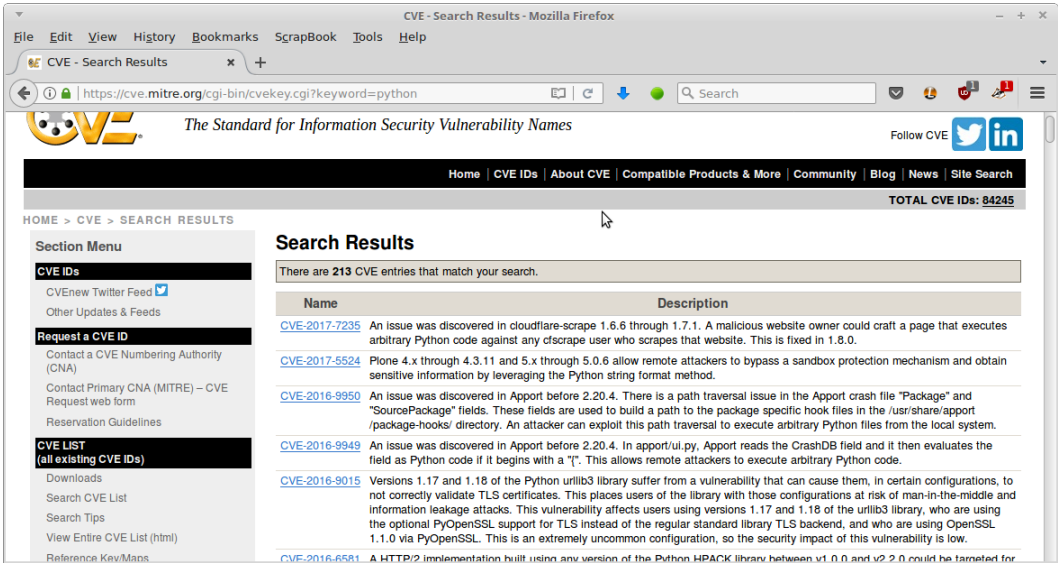
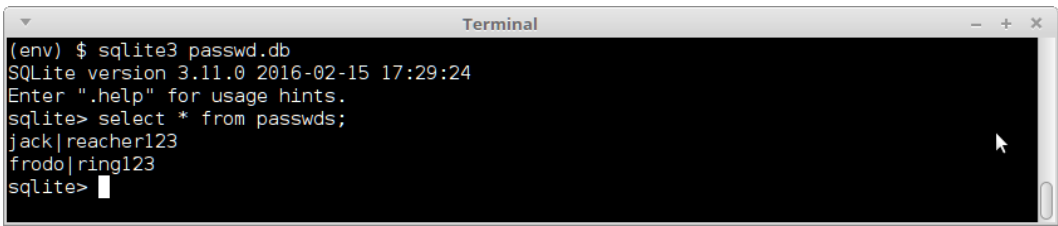
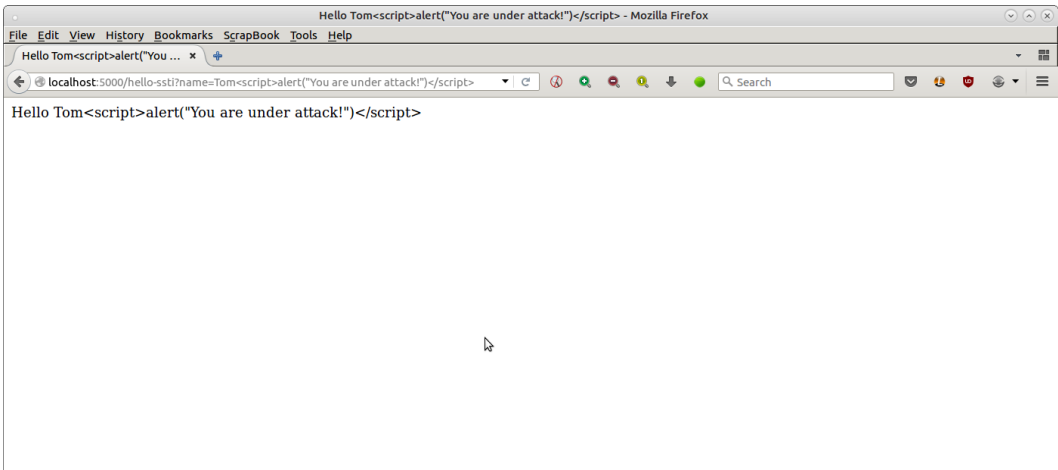














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# OWASP Python Security Project



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Python Security is a free, open source, [OWASP project](#) that aims at creating a hardened version of python that makes it easier for security professionals and developers to write applications more resilient to attacks and manipulations.

The project is designed to explore how web applications can be developed in python by approaching the problem from three different angles:

- o Security in python: white-box analysis, structural and functional analysis
- o Security of python: black-box analysis, identify and address security-related issues
- o Security with python: develop security hardened python suitable for high-risk and high-security environments

This project source code is licensed under the Apache 2.0 license, which has no restriction except for attribution, and allows proprietary

## Chapter 7: Design Patterns in Python

```
anand@ubuntu-pro-book: ~/Documents/ArchitectureBook/code/chap7
File Edit View Search Terminal Help
Help on package compiler:

NAME
  compiler - Package for parsing and compiling Python source code

FILE
  /usr/lib/python2.7/compiler/__init__.py

DESCRIPTION
  There are several functions defined at the top level that are imported
  from modules contained in the package.

  parse(buf, mode="exec") -> AST
    Converts a string containing Python source code to an abstract
    syntax tree (AST). The AST is defined in compiler.ast.

  parseFile(path) -> AST
    The same as parse(open(path))

  walk(ast, visitor, verbose=None)
    Does a pre-order walk over the ast using the visitor instance.
    See compiler.visitor for details.

  compile(source, filename, mode, flags=None, dont_inherit=None)
    Returns a code object. A replacement for the builtin compile() function.

  compileFile(filename)
    Generates a .pyc file by compiling filename.

PACKAGE CONTENTS
  .
```

```
anand@ubuntu-pro-book: ~/Documents/ArchitectureBook/code/chap7
File Edit View Search Terminal Help

parse(buf, mode="exec") -> AST
    Converts a string containing Python source code to an abstract
    syntax tree (AST). The AST is defined in compiler.ast.

parseFile(path) -> AST
    The same as parse(open(path))

walk(ast, visitor, verbose=None)
    Does a pre-order walk over the ast using the visitor instance.
    See compiler.visitor for details.

compile(source, filename, mode, flags=None, dont_inherit=None)
    Returns a code object. A replacement for the builtin compile() function.

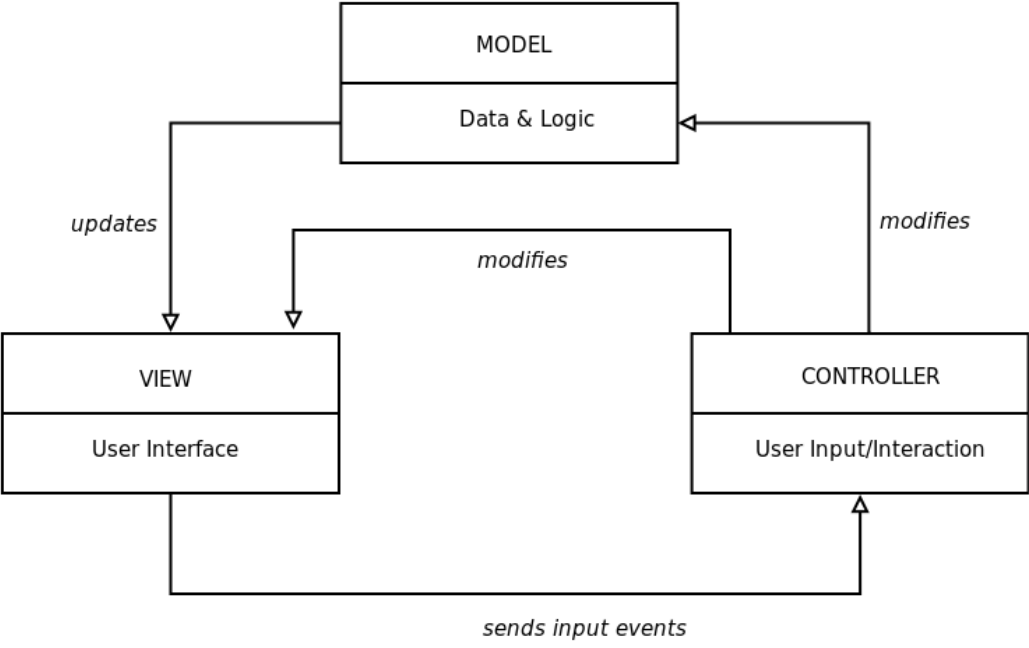
compileFile(filename)
    Generates a .pyc file by compiling filename.

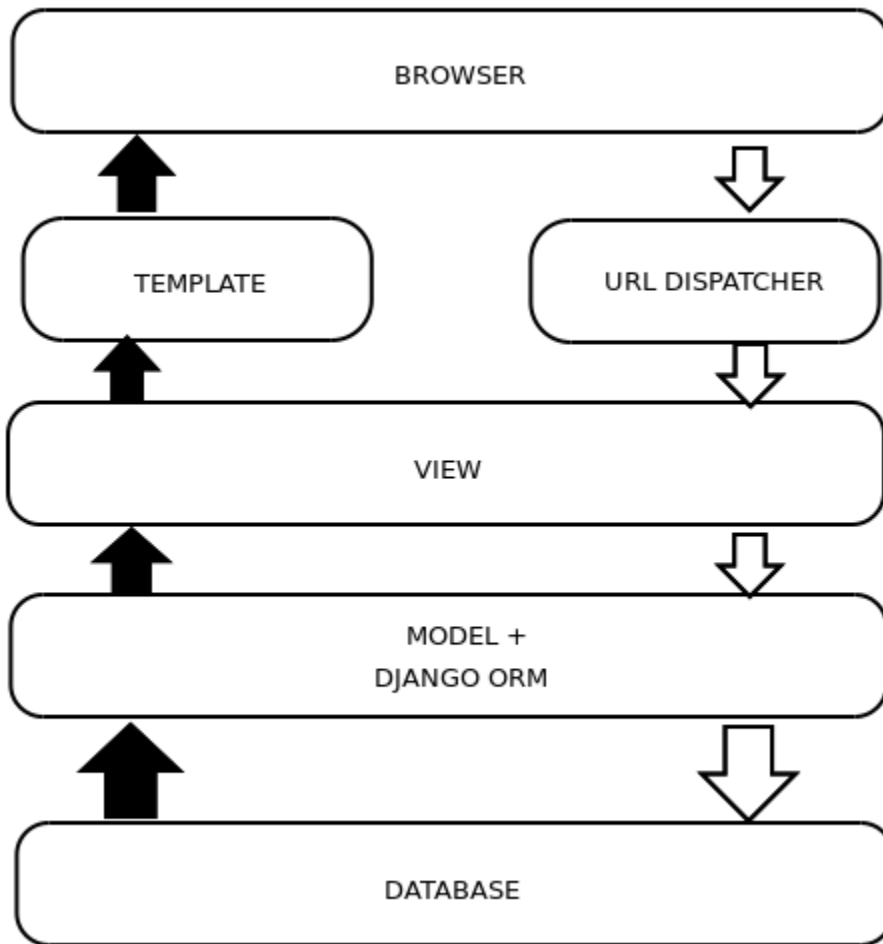
PACKAGE CONTENTS
ast
consts
future
misc
pyassem
pycodegen
symbols
syntax
transformer
visitor

(END)
```

```
Terminal
(env) $ python3 observer_async.py
Notifying <_main_.NewsSubscriber object at 0x7efbf5153f98> on channel india with data=> http://www.business-standard.com/article/current-affairs/mumbai-chennai-and-hyderabad-airports-put-on-hijack-alert-report-117041600183_1.html
Fetching URL http://www.business-standard.com/article/current-affairs/mumbai-chennai-and-hyderabad-airports-put-on-hijack-alert-report-117041600183_1.html ...
Response from <_main_.NewsSubscriber object at 0x7efbf5153f98> for channel india => <aiohttp.client._SessionRequestContextManager object at 0x7efbf53ded38>
Notifying <_main_.NewsSubscriber object at 0x7efbf691d2e8> on channel sports with data=> http://www.cricbuzz.com/cricket-news/94018/collective-dd-show-hands-massive-loss-to-kings-xi-punjab
Fetching URL http://www.cricbuzz.com/cricket-news/94018/collective-dd-show-hands-massive-loss-to-kings-xi-punjab ...
Response from <_main_.NewsSubscriber object at 0x7efbf691d2e8> for channel sports => <aiohttp.client._SessionRequestContextManager object at 0x7efbf4c68318>
Notifying <_main_.NewsSubscriber object at 0x7efbf5153f98> on channel india with data=> http://timesofindia.indiatimes.com/india/pakistan-to-submit-new-dossier-on-jadhav-to-un-report/articleshow/58204955.cms
Fetching URL http://timesofindia.indiatimes.com/india/pakistan-to-submit-new-dossier-on-jadhav-to-un-report/articleshow/58204955.cms ...
Response from <_main_.NewsSubscriber object at 0x7efbf5153f98> for channel india => <aiohttp.client._SessionRequestContextManager object at 0x7efbf39e0ca8>
Notifying <_main_.NewsSubscriber object at 0x7efbf691d2e8> on channel sports with data=> https://sports.ndtv.com/indian-premier-league-2017/ipl-2017-this-is-how-virat-kohli-recovered-from-the-loss-against-mumbai-indians-1681955
Fetching URL https://sports.ndtv.com/indian-premier-league-2017/ipl-2017-this-is-how-virat-kohli-recovered-from-the-loss-against-mumbai-indians-1681955 ...
Response from <_main_.NewsSubscriber object at 0x7efbf691d2e8> for channel sports => <aiohttp.client._SessionRequestContextManager object at 0x7efbf39e05e8>
<_main_.NewsSubscriber object at 0x7efbf691d2e8> Got data for URL http://www.cricbuzz.com/cricket-news/94018/collective-dd-show-hands-massive-loss-to-kings-xi-punjab length: 66230
<_main_.NewsSubscriber object at 0x7efbf691d2e8> Got data for URL https://sports.ndtv.com/indian-premier-league-2017/ipl-2017-this-is-how-virat-kohli-recovered-from-the-loss-against-mumbai-indians-1681
```

## **Chapter 8: Python - Architectural Patterns**





Add glossary term | Django site admin - Mozilla Firefox - (Current Session: Application Architectures)



Add glossary term | Dja... x

eiil.eu/admin/glossary/glossaryterm/add/

Django administration Welcome, **admin**. [View site](#) / [Change password](#) / [Log out](#)

[Home](#) > [Glossary](#) > [Glossary terms](#) > Add glossary term

### Add glossary term

Term:	<input type="text"/>
Meaning:	<input type="text"/>
Meaning with HTML markup:	<input type="text"/>
Example:	<input type="text"/>
Domains:	<input type="text"/>
Notes:	<input type="text"/>
URL:	<input type="text"/>
Source:	<input type="text"/>  

Chapter 8: Architecture Patterns

```
File Edit View Search Terminal Help
$ python3 chatserver.py
Listening to port 3490 ...
chatserver: got connection 4 from ('127.0.0.1', 45914)
chatserver: got connection 5 from ('127.0.0.1', 45916)
chatserver: 4 hung up
chatserver: 5 hung up
```

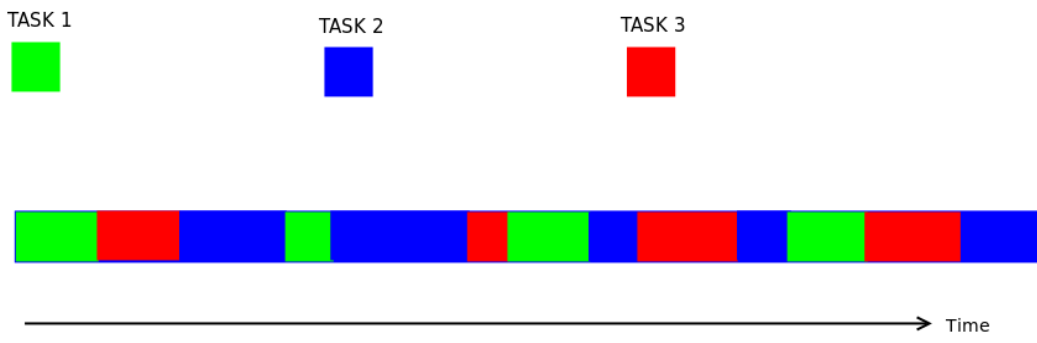
```
Chapter 8: Architecture Patterns
File Edit View Search Terminal Help

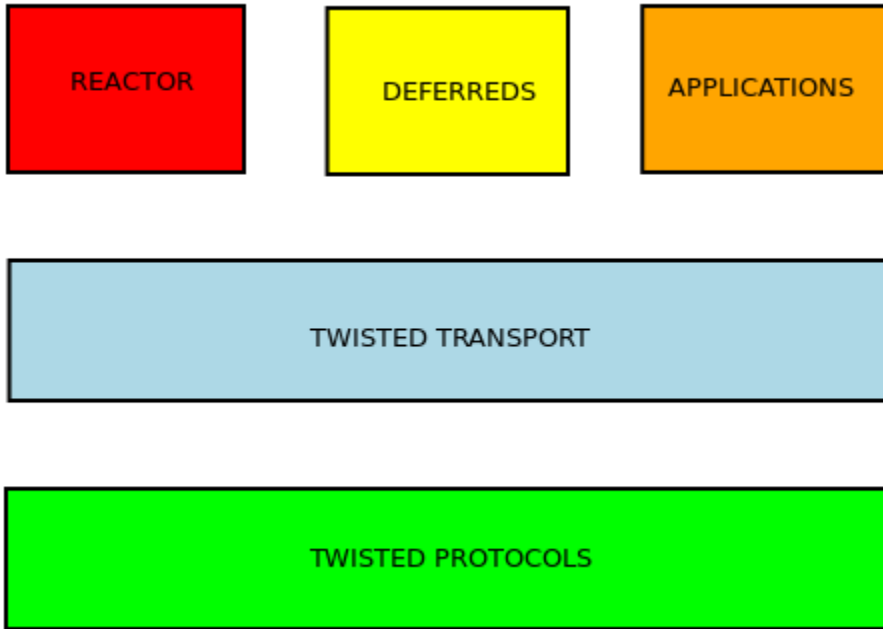
$ python3 chatclient.py andy localhost 3490
Connected to chat server@3490
[andy@127.0.0.1]>
(Connected: New client (2) from betty@127.0.0.1)
[andy@127.0.0.1]> hi betty
[andy@127.0.0.1]>
#[betty@127.0.0.1]>> hello andy!
[andy@127.0.0.1]> how are you ?
[andy@127.0.0.1]>
#[betty@127.0.0.1]>> I am good, and you ?
[andy@127.0.0.1]> I am fine.
[andy@127.0.0.1]>
#[betty@127.0.0.1]>> Thats nice
[andy@127.0.0.1]>
#[betty@127.0.0.1]>> Ok, see you. Bye
[andy@127.0.0.1]> Bbye.
[andy@127.0.0.1]>
[andy@127.0.0.1]> ^CInterrupted.
$
```

```
Chapter 8: Architecture Patterns
File Edit View Search Terminal Help

$ python3 chatclient.py betty localhost 3490
Connected to chat server@3490
[betty@127.0.0.1]>
#[andy@127.0.0.1]>> hi betty
[betty@127.0.0.1]> hello andy!
[betty@127.0.0.1]>
#[andy@127.0.0.1]>> how are you ?
[betty@127.0.0.1]> I am good, and you ?
[betty@127.0.0.1]>
#[andy@127.0.0.1]>> I am fine.
[betty@127.0.0.1]> Thats nice
[betty@127.0.0.1]> Ok, see you. Bye
[betty@127.0.0.1]>
#[andy@127.0.0.1]>> Bbye.
[betty@127.0.0.1]>
(Hung up: Client from andy@127.0.0.1)
[betty@127.0.0.1]> ^CInterrupted.
$
```

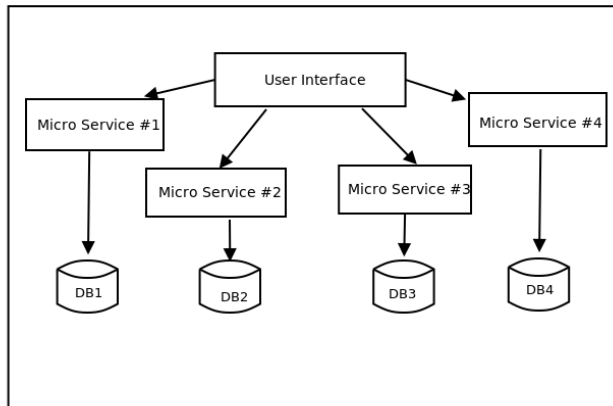
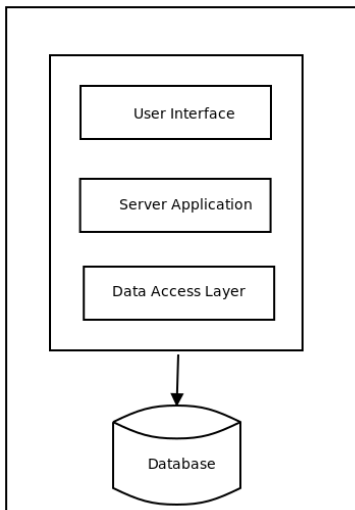


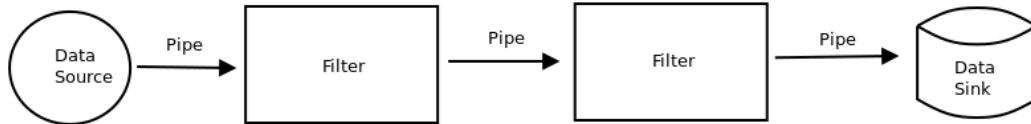
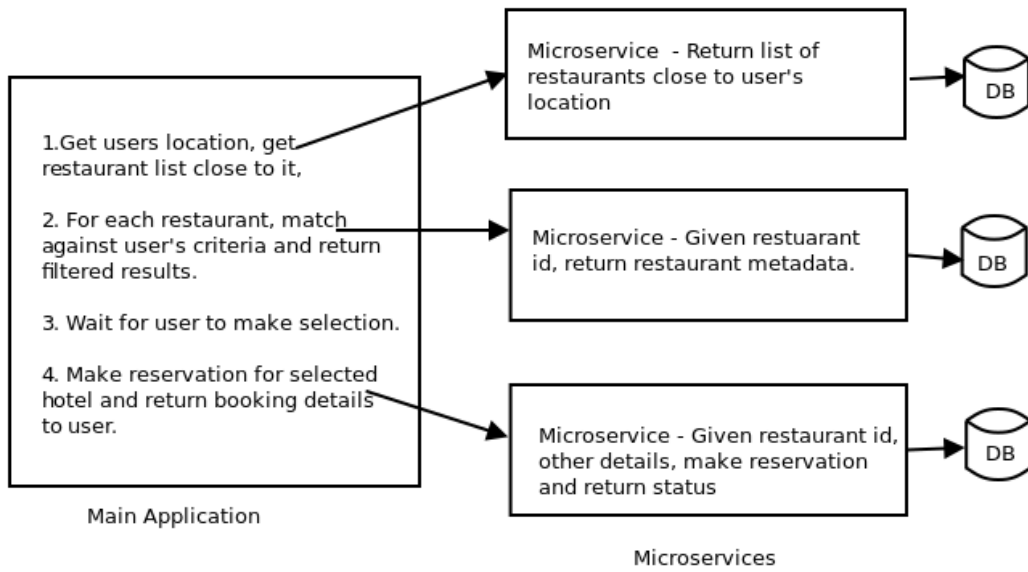




```
Terminal
anand@mangu-probook:/home/user/programs/chap8$ python2 twisted_chat_client.py andy
Connection made
Connected to server
[andy@mangu-probook]>
(User betty connected from IPv4Address(TCP, '127.0.0.1', 39252))
[andy@mangu-probook]> hello betty
[andy@mangu-probook]>
#[betty]>>> hi andy
[andy@mangu-probook]> how are you ?
[andy@mangu-probook]>
#[betty]>>> I am good, and you ?
[andy@mangu-probook]> I am pretty fine
[andy@mangu-probook]>
#[betty]>>> Ok
[andy@mangu-probook]>
#[betty]>>> How about the dinner plan today ?
[andy@mangu-probook]> All good
[andy@mangu-probook]>
#[betty]>>> See you at 8 then
[andy@mangu-probook]> Sure, see you then
[andy@mangu-probook]>
#[betty]>>> bye andy
[andy@mangu-probook]> bye betty
anand@mangu-probook:/home/user/programs/chap8$
anand@mangu-probook:/home/user/programs/chap8$
```

```
Terminal
anand@mangu-probook:/home/user/programs/chap8$ python twisted_chat_client.py betty
Connection made
Connected to server
[betty@mangu-probook]>
#[andy]>>> hello betty
[betty@mangu-probook]> hi andy
[betty@mangu-probook]>
#[andy]>>> how are you ?
[betty@mangu-probook]> I am good, and you ?
[betty@mangu-probook]>
#[andy]>>> I am pretty fine
[betty@mangu-probook]> Ok
[betty@mangu-probook]> How about the dinner plan today ?
[betty@mangu-probook]>
#[andy]>>> All good
[betty@mangu-probook]> See you at 8 then
[betty@mangu-probook]>
#[andy]>>> Sure, see you then
[betty@mangu-probook]> bye andy
[betty@mangu-probook]>
#[andy]>>> bye betty
[betty@mangu-probook]>
#[andy]>>> (User andy disconnected)
anand@mangu-probook:/home/user/programs/chap8$
anand@mangu-probook:/home/user/programs/chap8$
```





```

Chapter 8: Architecture Patterns
File Edit View Search Terminal Help
$ cat pipe_words.py | wc -w
64
$ python pipe_words.py pipe_words.py
('Words', 64)
$

```

```
Chapter 8: Architecture Patterns
File Edit View Search Terminal Help
$ python3 pipe_words_gen.py
('twisted_chat.py', 70)
('twisted_client.py', 170)
('gevent_chat.py', 124)
('select_echoserver.py', 146)
('twisted_chatclient.py', 21)
('twisted_fetcher.py', 162)
('chatserver.py', 331)
('eventlet_chat.py', 124)
('communication.py', 71)
('eventlet_fetch.py', 42)
('select_chatserver.py', 331)
('pipe_example.py', 64)
('twisted_chat_server.py', 66)
('select_chatclient.py', 198)
('chatclient.py', 202)
('twisted_chat_client.py', 168)
('pipe_words.py', 64)
('twisted_fetch_url.py', 46)
('pipe_words_gen.py', 75)
('pipe_example_gen.py', 75)
$
```

```
Chapter 8: Architecture Patterns
File Edit View Search Terminal Help
-rw-rw-r-- 1 anand anand 870 Mar  2 09:55 pipe_recent_gen.py

```

```
Chapter 8: Architecture Patterns
File Edit View Search Terminal Help
-rw-rw-r-- 1 anand anand 0 Mar  2 10:02 example.py

```

## Chapter 9: Deploying Python Applications

```
Chap 9 - Deployment
File Edit View Search Terminal Help
$ wget https://bootstrap.pypa.io/get-pip.py
--2017-01-29 20:20:38-- https://bootstrap.pypa.io/get-pip.py
Resolving bootstrap.pypa.io (bootstrap.pypa.io)... 151.101.120.175
Connecting to bootstrap.pypa.io (bootstrap.pypa.io)|151.101.120.175|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1595408 (1.5M) [text/x-python]
Saving to: 'get-pip.py'

get-pip.py          100%[=====>]  1.52M  642KB/s  in 2.4s
2017-01-29 20:20:41 (642 KB/s) - 'get-pip.py' saved [1595408/1595408]

$ sudo python3 get-pip.py
The directory '/home/anand/.cache/pip/http' or its parent directory is not owned by the
current user and the cache has been disabled. Please check the permissions and owner of
that directory. If executing pip with sudo, you may want sudo's -H flag.
The directory '/home/anand/.cache/pip' or its parent directory is not owned by the curre
nt user and caching wheels has been disabled. check the permissions and owner of that di
rectory. If executing pip with sudo, you may want sudo's -H flag.
Collecting pip
  Downloading pip-9.0.1-py2.py3-none-any.whl (1.3MB)
  100% |#####| 1.3MB 646KB/s
Installing collected packages: pip
  Found existing installation: pip 8.1.1
  Uninstalling pip-8.1.1:
    Successfully uninstalled pip-8.1.1
Successfully installed pip-9.0.1
$
```

```
Chap 9 - Deployment
File Edit View Search Terminal Help
$ pip3 --version
pip 9.0.1 from /usr/local/lib/python3.5/dist-packages (python 3.5)
$
```

```
Chap 9 - Deployment
File Edit View Search Terminal Help
$ sudo -H pip3 install numpy
Collecting numpy
  Downloading numpy-1.12.0-cp35-cp35m-manylinux1_x86_64.whl (16.8MB)
    100% |████████████████████████████████████████| 16.8MB 38kB/s
Installing collected packages: numpy
Successfully installed numpy-1.12.0
$
```

```
Chap 9 - Deployment
File Edit View Search Terminal Help
$ virtualenv appenv
Running virtualenv with interpreter /usr/bin/python2
New python executable in /home/user/appenv/bin/python2
Also creating executable in /home/user/appenv/bin/python
Installing setuptools, pkg_resources, pip, wheel...done.
$ source appenv/bin/activate
(appenv) $ which python
/home/user/appenv/bin/python
(appenv) $ which pip
/home/user/appenv/bin/pip
(appenv) $ pip install numpy
Collecting numpy
  Downloading numpy-1.12.0-cp27-cp27mu-manylinux1_x86_64.whl (16.5MB)
    100% |████████████████████████████████████████| 16.5MB 24kB/s
Installing collected packages: numpy
Successfully installed numpy-1.12.0
(appenv) $ pip --version
pip 9.0.1 from /home/user/appenv/local/lib/python2.7/site-packages (python 2.7)
(appenv) $ python --version
Python 2.7.12
(appenv) $ █
```

```
Chap 9 - Deployment
File Edit View Search Terminal Help
$ python3 -m venv /home/user/env3
$ source env3/bin/activate
(env3) $ pip3 --version
pip 8.1.1 from /home/user/env3/lib/python3.5/site-packages (python 3.5)
(env3) $ python --version
Python 3.5.2
(env3) $ which python
/home/user/env3/bin/python
(env3) $ pip3 install requests
Collecting requests
  Using cached requests-2.13.0-py2.py3-none-any.whl
Installing collected packages: requests
Successfully installed requests-2.13.0
You are using pip version 8.1.1, however version 9.0.1 is available.
You should consider upgrading via the 'pip install --upgrade pip' command.
(env3) $ pip3 install --upgrade pip
Collecting pip
  Using cached pip-9.0.1-py2.py3-none-any.whl
Installing collected packages: pip
  Found existing installation: pip 8.1.1
  Uninstalling pip-8.1.1:
    Successfully uninstalled pip-8.1.1
Successfully installed pip-9.0.1
(env3) $
```

```
Chap 9 - Deployment
File Edit View Search Terminal Help
(appenv) $ pip freeze | tee requirements.txt
appdirs==1.4.0
backports-abc==0.5
certifi==2017.1.23
numpy==1.12.0
packaging==16.8
pkg-resources==0.0.0
pyparsing==2.1.10
requests==2.13.0
singledispatch==3.4.0.3
six==1.10.0
tornado==4.4.2
(appenv) $
```



```
Chap 9 - Deployment
File Edit View Search Terminal Help
(env3) $ pip3 install -r requirements.txt
Collecting appdirs==1.4.0 (from -r requirements.txt (line 1))
  Using cached appdirs-1.4.0-py2.py3-none-any.whl
Collecting backports-abc==0.5 (from -r requirements.txt (line 2))
  Using cached backports-abc-0.5-py2.py3-none-any.whl
Collecting certifi==2017.1.23 (from -r requirements.txt (line 3))
  Using cached certifi-2017.1.23-py2.py3-none-any.whl
Collecting numpy==1.12.0 (from -r requirements.txt (line 4))
  Downloading numpy-1.12.0-cp35-cp35m-manylinux1_x86_64.whl (16.8MB)
    100% |#####| 16.8MB 25kB/s
Collecting packaging==16.8 (from -r requirements.txt (line 5))
  Using cached packaging-16.8-py2.py3-none-any.whl
Requirement already satisfied: pkg-resources==0.0.0 in ./env3/lib/python3.5/site-packages (from -r requirements.txt (line 6))
Collecting pyparsing==2.1.10 (from -r requirements.txt (line 7))
  Using cached pyparsing-2.1.10-py2.py3-none-any.whl
Requirement already satisfied: requests==2.13.0 in ./env3/lib/python3.5/site-packages (from -r requirements.txt (line 8))
Collecting singledispatch==3.4.0.3 (from -r requirements.txt (line 9))
  Using cached singledispatch-3.4.0.3-py2.py3-none-any.whl
Collecting six==1.10.0 (from -r requirements.txt (line 10))
  Using cached six-1.10.0-py2.py3-none-any.whl
Collecting tornado==4.4.2 (from -r requirements.txt (line 11))
  Using cached tornado-4.4.2.tar.gz
Installing collected packages: appdirs, backports-abc, certifi, numpy, pyparsing, six, packaging, singledispatch, tornado
  Running setup.py install for tornado ... done
Successfully installed appdirs-1.4.0 backports-abc-0.5 certifi-2017.1.23 numpy-1.12.0 packaging-16.8 pyparsing-2.1.10 singledispatch-3.4.0.3 six-1.10.0 tornado-4.4.2
(env3) $
```

```
Chap 9 - Deployment
File Edit View Search Terminal Help
$ virtualenv lenv
Running virtualenv with interpreter /usr/bin/python2
New python executable in /home/user/lenv/bin/python2
Also creating executable in /home/user/lenv/bin/python
Installing setuptools, pkg_resources, pip, wheel...done.
$ virtualenv --relocatable lenv
Running virtualenv with interpreter /usr/bin/python2
Making script /home/user/lenv/bin/python-config relative
Making script /home/user/lenv/bin/pip2.7 relative
Making script /home/user/lenv/bin/easy_install relative
Making script /home/user/lenv/bin/pip relative
Making script /home/user/lenv/bin/wheel relative
Making script /home/user/lenv/bin/pip2 relative
Making script /home/user/lenv/bin/easy_install-2.7 relative
$ cd lenv
$ ls
bin include lib local pip-selfcheck.json share
$ source bin/activate
```

PyPI - the Python Package Index : Python Package Index - Mozilla Firefox

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PyPI - the Python Package... x

Python Software Foundation (US) https://pypi.python.org/pypi

python™ search

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## PyPI - the Python Package Index

The Python Package Index is a repository of software for the Python programming language. There are currently **97553** packages here.

To contact the PyPI admins, please use the [Support](#) or [Bug reports](#) links.

**Not Logged In**

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**Status**

Nothing to report

**Get Packages**

To use a package from this index either "pip install package" (get pip) or download, unpack and "python setup.py install" it.

**Package Authors**

Submit packages with "python setup.py upload". The index [hosts package docs](#). You may also use the [web form](#). You must [register](#). Testing? Use [testpypi](#).

**Infrastructure**

To interoperate with the index use the [JSON](#), [OAuth](#), [XML-RPC](#) or [HTTP](#) interfaces. Use [local mirroring](#) or [caching](#) to make installation more robust.

Updated	Package	Description
2017-01-29	PyMCDP 3.0.7	PyMCDP is an interpreter and solver for Monotone Co-Design Problems
2017-01-29	gitfaces 0.1.2	fetch contributor avatars for a GitHub repository
2017-01-29	aiocassandra 1.0.1	Simple threaded cassandra wrapper for asyncio
2017-01-29	zc.buildout 2.6.0	System for managing development buildouts

Chap 9: Deployment

File Edit View Search Terminal Help

```
$ pwd
/home/user/programs/chap9/mandelbrot
$ tree .
.
├── mandelbrot
│   ├── __init__.py
│   ├── mp
│   │   ├── __init__.py
│   │   └── mandelbrot.py
│   └── simple
│       ├── __init__.py
│       └── mandelbrot.py
├── README
└── setup.py
3 directories, 7 files
$
```

```
Chap 9: Deployment
File Edit View Search Terminal Help
(env3) $ python setup.py install
running install
running bdist_egg
running egg_info
creating mandelbrot.egg-info
writing top-level names to mandelbrot.egg-info/top_level.txt
writing entry points to mandelbrot.egg-info/entry_points.txt
writing requirements to mandelbrot.egg-info/requires.txt
writing mandelbrot.egg-info/PKG-INFO
writing dependency links to mandelbrot.egg-info/dependency_links.txt
writing manifest file 'mandelbrot.egg-info/SOURCES.txt'
reading manifest file 'mandelbrot.egg-info/SOURCES.txt'
writing manifest file 'mandelbrot.egg-info/SOURCES.txt'
installing library code to build/bdist.linux-x86_64/egg
running install_lib
running build_py
creating build
creating build/lib
creating build/lib/mandelbrot
copying mandelbrot/__init__.py -> build/lib/mandelbrot
creating build/lib/mandelbrot/mp
copying mandelbrot/mp/mandelbrot.py -> build/lib/mandelbrot/mp
copying mandelbrot/mp/__init__.py -> build/lib/mandelbrot/mp
creating build/lib/mandelbrot/simple
copying mandelbrot/simple/mandelbrot.py -> build/lib/mandelbrot/simple
copying mandelbrot/simple/__init__.py -> build/lib/mandelbrot/simple
```

```
Chap 9: Deployment
File Edit View Search Terminal Help
(env3) $ python
Python 3.5.2 (default, Nov 17 2016, 17:05:23)
[GCC 5.4.0 20160609] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import mandelbrot
>>> mandelbrot.__file__
'/home/user/programs/chap9/mandelbrot/mandelbrot/__init__.py'
>>> from mandelbrot.simple import mandelbrot
>>> mandelbrot.__file__
'/home/user/programs/chap9/mandelbrot/mandelbrot/simple/mandelbrot.py'
>>> dir(mandelbrot)
['Image', '__builtins__', '__cached__', '__doc__', '__file__', '__loader__', '__name__', '__package__', '__spec__', 'argparse', 'main', 'mandelbrot_calc_row', 'mandelbrot_calc_set', 'sys']
>>> mandelbrot.main()
Creating mandelbrot set with size 640x480, #iterations=1000
>>> from mandelbrot.mp import mandelbrot
>>> # Calling the mandelbrot_calc_set directly with options
...
>>> mandelbrot.mandelbrot_calc_set(1280, 720, 5000, 'mandelbrot_big.png')
Saved to mandelbrot_big.png
>>> █
```

```
Chap 9: Deployment
File Edit View Search Terminal Help
(env3) $ mandelbrot -h
usage: mandelbrot [-h] [-W WIDTH] [-H HEIGHT] [-n NITER] [-o OUTPUT]

Mandelbrot fractal generator

optional arguments:
  -h, --help            show this help message and exit
  -W WIDTH, --width WIDTH
                        Width of the image
  -H HEIGHT, --height HEIGHT
                        Height of the image
  -n NITER, --niter NITER
                        Number of iterations
  -o OUTPUT, --output OUTPUT
                        Name of output image file
(env3) $ mandelbrot -H 240 -W 320 -n 500 -o mandelbrot_small.png
Creating mandelbrot set with size 320x240, #iterations=500
(env3) $ ls -lh mandelbrot_small.png
-rw-rw-r-- 1 anand anand 15K Feb  6 16:12 mandelbrot_small.png
(env3) $
```

```
Chap 9: Deployment
File Edit View Search Terminal Help
(env3) $ mandelbrot_mp -h
usage: mandelbrot [-h] [-W WIDTH] [-H HEIGHT] [-n NITER] [-o OUTPUT]

Mandelbrot fractal generator (parallel version)

optional arguments:
  -h, --help            show this help message and exit
  -W WIDTH, --width WIDTH
                        Width of the image
  -H HEIGHT, --height HEIGHT
                        Height of the image
  -n NITER, --niter NITER
                        Number of iterations
  -o OUTPUT, --output OUTPUT
                        Name of output image file
(env3) $ mandelbrot_mp -H 960 -W 1280 -n 2000 -o mandelbrot_large.png
Creating mandelbrot set with size 1280x960, #iterations=2000
Saved to mandelbrot_large.png
(env3) $ ls -lh mandelbrot_large.png
-rw-rw-r-- 1 anand anand 138K Feb  6 16:17 mandelbrot_large.png
(env3) $
```

```
.pypirc - emacs@ubuntu-pro-book
File Edit Options Buffers Tools Help
[distutils]
index-servers=
  pypi

[pypi]
repository:https://pypi.python.org/pypi
username:anandpillai
password:*****

-:--- .pypirc      All (1,0)      (Fundamental) [100.0%]4:58PM 0.16
```

```
Chap 9: Deployment
File Edit View Search Terminal Help
(env3) $ python setup.py register
running register
running egg_info
writing entry points to mandelbrot.egg-info/entry_points.txt
writing top-level names to mandelbrot.egg-info/top_level.txt
writing mandelbrot.egg-info/PKG-INFO
writing requirements to mandelbrot.egg-info/requirements.txt
writing dependency links to mandelbrot.egg-info/dependency_links.txt
reading manifest file 'mandelbrot.egg-info/SOURCES.txt'
writing manifest file 'mandelbrot.egg-info/SOURCES.txt'
running check
Registering mandelbrot to https://pypi.python.org/pypi
Server response (200): OK
(env3) $
```

```
Chap 9: Deployment
File Edit View Search Terminal Help
(env3) $ python setup.py sdist upload
running sdist
running egg_info
writing mandelbrot.egg-info/PKG-INFO
writing dependency links to mandelbrot.egg-info/dependency_links.txt
writing entry points to mandelbrot.egg-info/entry_points.txt
writing top-level names to mandelbrot.egg-info/top_level.txt
writing requirements to mandelbrot.egg-info/requirements.txt
reading manifest file 'mandelbrot.egg-info/SOURCES.txt'
writing manifest file 'mandelbrot.egg-info/SOURCES.txt'
running check
creating mandelbrot-0.1
creating mandelbrot-0.1/mandelbrot
creating mandelbrot-0.1/mandelbrot.egg-info
creating mandelbrot-0.1/mandelbrot/mp
creating mandelbrot-0.1/mandelbrot/simple
making hard links in mandelbrot-0.1...
hard linking README -> mandelbrot-0.1
hard linking setup.py -> mandelbrot-0.1
hard linking mandelbrot/__init__.py -> mandelbrot-0.1/mandelbrot
hard linking mandelbrot.egg-info/PKG-INFO -> mandelbrot-0.1/mandelbrot.egg-info
hard linking mandelbrot.egg-info/SOURCES.txt -> mandelbrot-0.1/mandelbrot.egg-info
```

mandelbrot 0.1 : Python Package Index - Mozilla Firefox

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mandelbrot 0.1 : Python P... x

Python Software Foundation (US) https://pypi.python.org/pypi/mandelbrot/0.1

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» Package Index > mandelbrot > 0.1

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## mandelbrot 0.1

A program for generating Mandelbrot fractal images

Package: [roles](#) | [releases](#) | [view](#) | [edit](#) | [files](#) | [PKG-INFO](#)

[Download mandelbrot-0.1.tar.gz](#)

This is a program which generates the Mandelbrot fractal set of a given width and height for a given number of iterations.

It uses Pillow, the Python Imaging Library fork to render the image and save it to a file.

Sample Usage.

To see all command line arguments, pass -h to the program.

\$ mandelbrot -h usage: mandelbrot [-h] [-W WIDTH] [-H HEIGHT] [-n NITER] [-o OUTPUT]

Mandelbrot fractal generator

optional arguments:

- h, --help show this help message and exit
- W WIDTH, --width WIDTH Width of the image
- H HEIGHT, --height HEIGHT

**Welcome anandpillai**

Your details (Logout)

Your packages:

- HarvestMan
- mandelbrot

**Status**

Nothing to report

Chap 9: Deployment

File Edit View Search Terminal Help

```
(env3) $ fab remote install:mandelbrot -H mylinode
[mylinode] Executing task 'remote_install'
Installing mandelbrot
[mylinode] run: sudo pip install mandelbrot
[mylinode] out: Downloading/unpacking mandelbrot
[mylinode] out: Downloading mandelbrot-0.1.tar.gz
[mylinode] out: Running setup.py (path:/tmp/pip-build-3RuBh1/mandelbrot/setup.py) egg_info for package m
[mylinode] out: Requirement already satisfied (use --upgrade to upgrade): Pillow>=3.1.2 in /usr/local/lib/
dist-packages (from mandelbrot)
[mylinode] out: Requirement already satisfied (use --upgrade to upgrade): pypm-pypi>=0.3.1 in /usr/local/l
.7/dist-packages (from mandelbrot)
[mylinode] out: Requirement already satisfied (use --upgrade to upgrade): olefile in /usr/local/lib/python
ackages (from Pillow>=3.1.2->mandelbrot)
[mylinode] out: Installing collected packages: mandelbrot
[mylinode] out: Running setup.py install for mandelbrot
[mylinode] out: Installing mandelbrot mp script to /usr/local/bin
[mylinode] out: Installing mandelbrot script to /usr/local/bin
[mylinode] out: Could not find .egg-info directory in install record for mandelbrot
[mylinode] out: Successfully installed mandelbrot
[mylinode] out: Cleaning up...
[mylinode] out:

Done.
Disconnecting from mylinode... done.
(env3) $
```

## Chapter 10: Techniques for Debugging

```
IPython: user/programs
File Edit View Search Terminal Help
warn("Attempting to work in a virtualenv. If you encounter problems, please ")
> /home/user/programs/maxsubarray.py(6)max_subarray()
4
5     max_ending_here = max_so_far = 0
----> 6     for x in sequence
7         max_ending_here = max(0, max_ending_here + x)
8         max_so_far = max(max_so_far, max_ending_here)

ipdb> max_so_far
20
ipdb> r
> /home/user/programs/maxsubarray.py(6)max_subarray()
4
5     max_ending_here = max_so_far = 0
----> 6     for x in sequence
7         max_ending_here = max(0, max_ending_here + x)
8         max_so_far = max(max_so_far, max_ending_here)

ipdb> max_so_far
20
ipdb> l
1
2 def max_subarray(sequence):
3     """ Maximum subarray - optimized version """
4
5     max_ending_here = max_so_far = 0
----> 6     for x in sequence
7         max_ending_here = max(0, max_ending_here + x)
8         max_so_far = max(max_so_far, max_ending_here)
```

```
IPython: user/programs
File Edit View Search Terminal Help
1
2 def max_subarray(sequence):
3     """ Maximum subarray - optimized version """
4
5     max_ending_here = max_so_far = 0
----> 6     for x in sequence
7         max_ending_here = max(0, max_ending_here + x)
8         max_so_far = max(max_so_far, max_ending_here)
9         import ipdb, ipdb.set_trace()
10
11     return max_so_far

ipdb> w
/home/user/programs/maxsubarray.py(14)<module>()
10
11     return max_so_far
12
13 if __name__ == "__main__":
----> 14     print max_subarray([20, 5, -10, 30, 10])

> /home/user/programs/maxsubarray.py(6)max_subarray()
4
5     max_ending_here = max_so_far = 0
----> 6     for x in sequence
7         max_ending_here = max(0, max_ending_here + x)
8         max_so_far = max(max_so_far, max_ending_here)

ipdb> █
```

```
IPython: user/programs
File Edit View Search Terminal Help
-> print(max_subarray([20, -5, -10, 30, 10]))
[1] > /home/user/programs/maxsubarray.py(6)max_subarray()
-> for x in sequence:
(Pdb++) max
max          max_ending_here  max_so_far    max_subarray
(Pdb++) max_so_far
20
(Pdb++) c
[1] > /home/user/programs/maxsubarray.py(6)max_subarray()
-> for x in sequence:
(Pdb++) c
[1] > /home/user/programs/maxsubarray.py(6)max_subarray()
-> for x in sequence:
(Pdb++) x
-10
(Pdb++) c
[1] > /home/user/programs/maxsubarray.py(6)max_subarray()
-> for x in sequence:
(Pdb++) max_s
max_so_far    max_subarray
(Pdb++) max_so_far
35
(Pdb++) c
[1] > /home/user/programs/maxsubarray.py(6)max_subarray()
-> for x in sequence:
(Pdb++) c=x
(Pdb++) c
10
(Pdb++)
```

```
IPython: user/programs
File Edit View Search Terminal Help
$ python3 -m trace --trace maxsubarray.py
--- modulename: maxsubarray, funcname: <module>
maxsubarray.py(2): def max_subarray(sequence):
maxsubarray.py(12): if __name__ == "__main__":
maxsubarray.py(13):     print(max_subarray([20, -5, -10, 30, 10]))
--- modulename: maxsubarray, funcname: max_subarray
maxsubarray.py(5):     max_ending_here = max_so_far = 0
maxsubarray.py(6):     for x in sequence:
maxsubarray.py(7):         max_ending_here = max(0, max_ending_here + x)
maxsubarray.py(8):         max_so_far = max(max_so_far, max_ending_here)
maxsubarray.py(6):     for x in sequence:
maxsubarray.py(7):         max_ending_here = max(0, max_ending_here + x)
maxsubarray.py(8):         max_so_far = max(max_so_far, max_ending_here)
maxsubarray.py(6):     for x in sequence:
maxsubarray.py(7):         max_ending_here = max(0, max_ending_here + x)
maxsubarray.py(8):         max_so_far = max(max_so_far, max_ending_here)
maxsubarray.py(6):     for x in sequence:
maxsubarray.py(7):         max_ending_here = max(0, max_ending_here + x)
maxsubarray.py(8):         max_so_far = max(max_so_far, max_ending_here)
maxsubarray.py(6):     for x in sequence:
maxsubarray.py(10):     return max_so_far
45
--- modulename: trace, funcname: unsettrace
trace.py(77):     sys.settrace(None)
$
```





```
anand@ubuntu-pro-book: /home/user/programs
File Edit View Search Terminal Help
$ sudo lptrace -p 9766
runUntilCurrent (/usr/local/lib/python2.7/dist-packages/twisted/internet/base.py:790)
  _insertNewDelayedCalls (/usr/local/lib/python2.7/dist-packages/twisted/internet/base.py:750)
  timeout (/usr/local/lib/python2.7/dist-packages/twisted/internet/base.py:760)
  _insertNewDelayedCalls (/usr/local/lib/python2.7/dist-packages/twisted/internet/base.py:750)
doPoll (/usr/local/lib/python2.7/dist-packages/twisted/internet/epollreactor.py:206)
```

```
anand@ubuntu-pro-book: /home/user/programs
File Edit View Search Terminal Help
logPrefix (/usr/local/lib/python2.7/dist-packages/twisted/internet/tcp.py:1129)
qual (/usr/local/lib/python2.7/dist-packages/twisted/python/reflect.py:355)
callWithContext (/usr/local/lib/python2.7/dist-packages/twisted/python/log.py:83)
getContext (/usr/local/lib/python2.7/dist-packages/twisted/python/context.py:120)
currentContext (/usr/local/lib/python2.7/dist-packages/twisted/python/context.py:110)
getContext (/usr/local/lib/python2.7/dist-packages/twisted/python/context.py:86)
callWithContext (/usr/local/lib/python2.7/dist-packages/twisted/python/context.py:117)
currentContext (/usr/local/lib/python2.7/dist-packages/twisted/python/context.py:110)
callWithContext (/usr/local/lib/python2.7/dist-packages/twisted/python/context.py:61)
  _doReadOrWrite (/usr/local/lib/python2.7/dist-packages/twisted/internet/posixbase.py:555)
meth (/usr/lib/python2.7/socket.py:227)
doRead (/usr/local/lib/python2.7/dist-packages/twisted/internet/tcp.py:1015)
accept (/usr/lib/python2.7/socket.py:205)
  __init__ (/usr/lib/python2.7/socket.py:189)
meth (/usr/lib/python2.7/socket.py:227)
```

```
anand@ubuntu-pro-book: /home/user/programs
File Edit View Search Terminal Help
$ sudo strace -p 10499
strace: Process 10499 attached
epoll_wait(4,
```

```
anand@ubuntu-pro-book: /home/user/programs
File Edit View Search Terminal Help
[[EPOLLIN, {u32=3, u64=14887175234342879235}]], 4, -1) = 1
accept(3, {sa_family=AF_INET, sin_port=htons(44874), sin_addr=inet_addr("127.0.0.1")}, [16]) = 10
fcntl(10, F_GETFD) = 0
fcntl(10, F_SETFD, FD_CLOEXEC) = 0
fcntl(10, F_GETFL) = 0x2 (flags O_RDWR)
fcntl(10, F_SETFL, O_RDWR|O_NONBLOCK) = 0
epoll_ctl(4, EPOLL_CTL_ADD, 10, {EPOLLIN, {u32=10, u64=14887175234342879242}}) = 0
accept(3, 0x7ffd17f2acd0, 0x7ffd17f2accc) = -1 EAGAIN (Resource temporarily unavailable)
epoll_wait(4, [{EPOLLIN, {u32=11, u64=14887175234342879243}}], 5, -1) = 1
recvfrom(11, "", 65536, 0, NULL, NULL) = 0
epoll_ctl(4, EPOLL_CTL_DEL, 11, 0x7ffd17f2aa60) = 0
shutdown(11, SHUT_RDWR) = 0
close(11) = 0
epoll_wait(4,
```

```
anand@ubuntu-pro-book: /home/user/programs
File Edit View Search Terminal Help
[{{EPOLLIN, {u32=10, u64=14887175234342879242}}}, 4, -1) = 1
recvfrom(10, "Hello", 65536, 0, NULL, NULL) = 5
epoll_ctl(4, EPOLL_CTL_MOD, 10, {{EPOLLIN|EPOLLOUT, {u32=10, u64=14887175234342879242}}}) =
0
epoll_wait(4, {{EPOLLOUT, {u32=10, u64=14887175234342879242}}}, 4, -1) = 1
sendto(10, "Hello", 5, 0, NULL, 0) = 5
epoll_ctl(4, EPOLL_CTL_MOD, 10, {{EPOLLIN, {u32=10, u64=14887175234342879242}}}) = 0
epoll_wait(4,
```