Unit Testing

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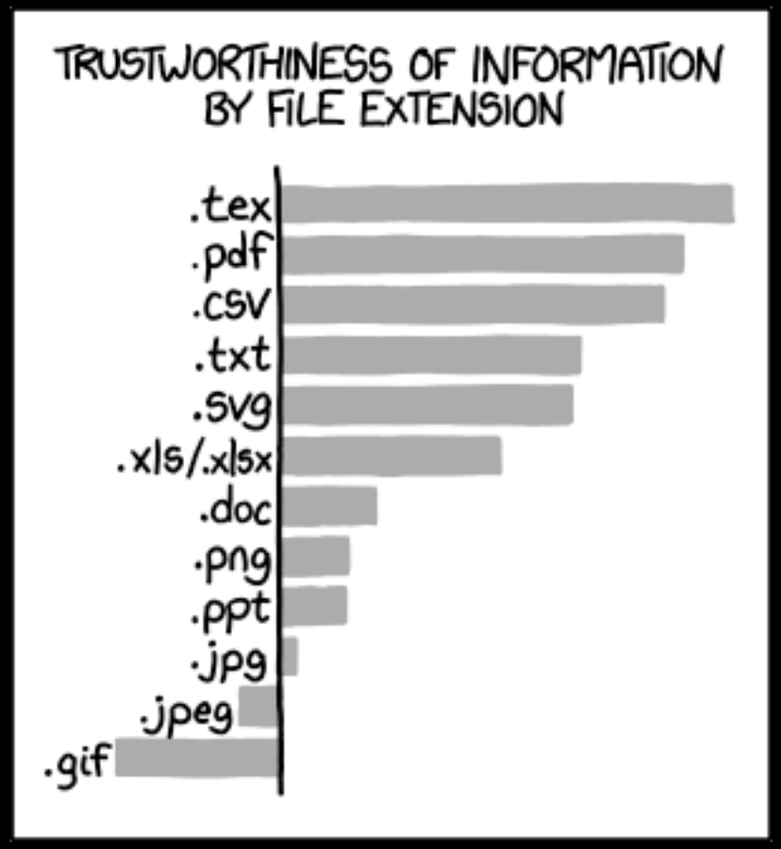
January 8, 2014



http://xkcd.com/1301/

What is unit testing?

"unit" of code:
module, class, function, data file

in isolation!

What is unit testing?

a "unit":

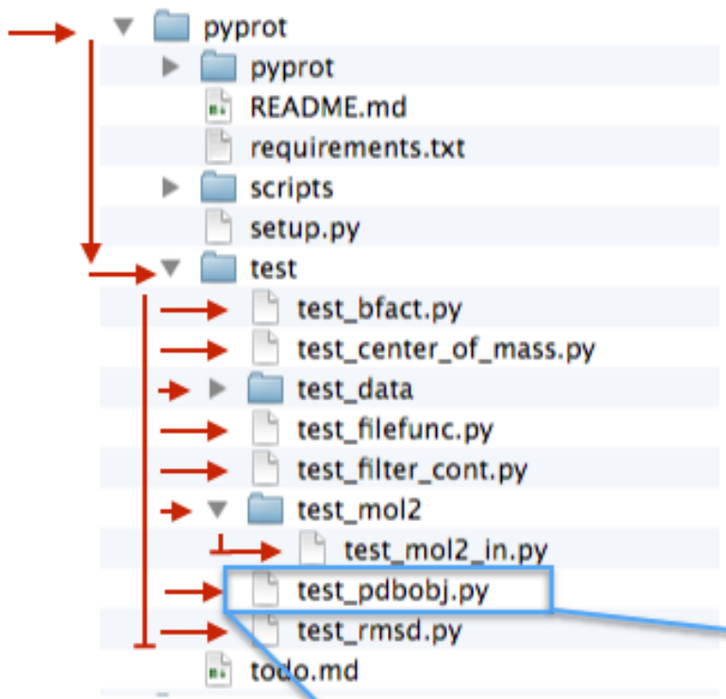
1) fixture (e.g., function)
2) action (e.g., invoking function with particular input)
3) expected result (e.g., return value of a function)
4) actual result (e.g., actual return value of a function
5) report (e.g., success or failure)

Why unit testing?

- testing functionality (incl. edge cases)
- alter your code and make sure that you didn't break anything
- debugging
- trust your code
- save time in the long run
- trust code from collaborators
- credibility for publication

unit testing frameworks in python

- unittest
- nose
- py.test



nose descending the directory tree looking for prefix "`test`"

test_pdbobj.py (~/Github/pyprot/test) – VIM

```
import pyprot.pdb as ppdb

pdb1 = ppdb.PdbObj("./test/test_data/3EIY.pdb")
pdb2 = ppdb.PdbObj("./test/test_data/small_3EIY.pdb")


def test_constructor():
    assert len(pdb1.cont) == 2147
    assert len(pdb1.atom) == 1330
    assert len(pdb1.hetatm) == 151
    assert len(pdb1.conect) == 54

def test_calpha():
    atom = [
    'ATOM      2  CA  SER A   2       3.259  54.783  -0.368  1.00 52.54           C',
    'ATOM      8  CA  PHE A   3       4.261  51.413   1.102  1.00 48.73           C',
    'ATOM     19  CA  SER A   4       4.593  49.745  -2.323  1.00 47.00           C',
    'ATOM     25  CA  ASN A   5       7.351  52.145  -3.480  1.00 41.42           C',
    'ATOM     33  CA  VAL A   6       9.636  51.959  -0.457  1.00 32.41           C'
    ]
    assert atom == pdb2.calpha()
```

Terminal

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```
[bash]~/Gits/Github/pyprot >nosetests
............
----------------------------------------------------------------------
Ran 12 tests in 0.143s

OK
[bash]~/Gits/Github/pyprot >
```

- pyprot
  - pyprot
  - README.md
  - requirements.txt
  - scripts
  - setup.py
  - test
    - test_bfact.py
    - test_center_of_mass.py
    - test_data
    - test_filefunc.py
    - test_filter_cont.py
    - test_mol2
      - test_mol2_in.py
    - test_pdbobj.py
    - test_rmsd.py
  - todo.md

test_pdbobj.py (~/Github/pyprot/test) – VIM

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import pyprot.pdb as ppdb

pdb1 = ppdb.PdbObj("./test/test_data/3EIY.pdb")
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    assert atom == pdb2.calpha()
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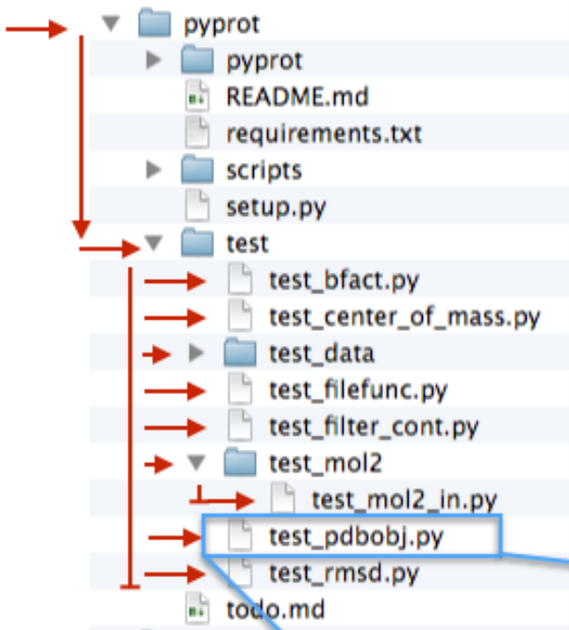

Terminal

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```
[bash]~/Gits/Github/pyprot >nosetests -v
test_bfact.test_get_bfactor ... ok
test_bfact.test_median_bfactor ... ok
test_bfact.test_mean_bfactor ... ok
test_center_of_mass.test_center_of_mass ... ok
test_filefunc.test_open_file ... ok
test_filter_cont.test_filter_column_match ... ok
test_filter_cont.test_filter_col_match_exclude ... ok
test_mol2_in.test_multi_mol2list ... ok
test_pdbobj.test_constructor ... ok
test_pdbobj.test_calpha ... ok
test_pdbobj.test_main_chain ... ok
test_rmsd.test_rmsd ... ok

----------------------------------------------------------------------
Ran 12 tests in 0.128s

OK
[bash]~/Gits/Github/pyprot >
```

test_pdbobj.py (~/Github/pyprot/test) – VIM

```
import pyprot.pdb as ppdb

pdb1 = ppdb.PdbObj("./test/test_data/3EIY.pdb")
pdb2 = ppdb.PdbObj("./test/test_data/small_3EIY.pdb")


def test_constructor():
    assert len(pdb1.cont) == 2147
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    assert len(pdb1.hetatm) == 151
    assert len(pdb1.conect) == 54

def test_calpha():
    atom = [
    'ATOM      2  CA  SER A   2       3.259  54.783  -0.368  1.00 52.54           C',
    'ATOM      8  CA  PHE A   3       4.261  51.413   1.102  1.00 48.73           C',
    'ATOM     19  CA  SER A   4       4.593  49.745  -2.323  1.00 47.00           C',
    'ATOM     25  CA  ASN A   5       7.351  52.145  -3.480  1.00 41.42           C',
    'ATOM     33  CA  VAL A   6       9.636  51.959  -0.457  1.00 32.41           C'
    ]
    assert atom == pdb2.calpha()
```

Example: Testing a simple function

factor_three.py

```python
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num % 3 == 0:
        is_fact = True
    return is_fact


def filter_factor_of_three(numbers):
    """Return all even numbers in list *numbers*."""
    return [n for n in numbers if factor_of_three(n)]
```

Example: Unit test for our function

factor_three.py

```python
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num % 3 == 0:
        is_fact = True
    return is_fact


def filter_factor_of_three(numbers):
    """Return all even numbers in list *numbers*."""
    return [n for n in numbers if factor_of_three(n)]
```

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
```

Example: Unit test for our function

factor_three.py

```python
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num % 3 == 0:
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    return is_fact


def filter_factor_of_three(numbers):
    """Return all even numbers in list *numbers*."""
    return [n for n in numbers if factor_of_three(n)]
```

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
```

Terminal

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```
[bash]~/Desktop >nosetests
.
----------------------------------------------------------------------
Ran 1 test in 0.009s

OK
[bash]~/Desktop >
```

Example: Testing edge cases

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
    assert factor_of_three(0) == False
```

Example: Testing edge cases

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
    assert factor_of_three(0) == False
```

```
[bash]~/Desktop >nosetests
F
======================================================================
FAIL: test_factor_three.test_factor_of_three
----------------------------------------------------------------------
Traceback (most recent call last):
  File "/soft/linux64/python/3.3.3--GCC-4.4.7/lib/python3.3/site-packages/nos
.3.0-py3.3.egg/nose/case.py", line 198, in runTest
    self.test(*self.arg)
  File "/home/raschkas/Desktop/test_factor_three.py", line 9, in test_factor_
three
    assert factor_of_three(0) == False
AssertionError

----------------------------------------------------------------------
Ran 1 test in 0.010s

FAILED (failures=1)
[bash]~/Desktop >
```

Example: Fixing the code

*factor_three.py test_factor_three.py

```
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num != 0 and num % 3 == 0:
        is_fact = True
    return is_fact


def filter_factor_of_three(numbers):
    """Return all even numbers in list *numbers*."""
    return [n for n in numbers if factor_of_three(n)]
```

Example: Fixing the code

*factor_three.py test_factor_three.py

```python
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num != 0 and num % 3 == 0:
        is_fact = True
    return is_fact


def filter_factor_of_three(numbers):
    """Return all even numbers in list *numbers*."""
    return [n for n in numbers if factor_of_three(n)]
```

```
[bash]~/Desktop >nosetests
.
----------------------------------------------------------------------
Ran 1 test in 0.009s

OK
[bash]~/Desktop >
```

Example: Testing more edge cases

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
    assert factor_of_three(0) == False
    assert factor_of_three(3.0) == True
    assert factor_of_three(6.6) == False
    assert factor_of_three(3.00000001) == False
    assert factor_of_three(6*1000) == True
    assert factor_of_three(-9) == False
```

Example: Testing more edge cases

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_
    assert factor_
    assert factor
    assert factor_
    assert factor_
    assert factor_
    assert factor_
```

Desktop — bash — 59×26

```
==================== test session starts ====================
platform darwin -- Python 3.3.3 -- pytest-2.5.0
collected 1 items

test_factor_three.py F

======================== FAILURES ========================
_________________ test_factor_of_three _________________

    def test_factor_of_three():
        assert factor_of_three(3) == True
        assert factor_of_three(4) == False
        assert factor_of_three(5) == False
        assert factor_of_three(6) == True
        assert factor_of_three(0) == False
        assert factor_of_three(3.0) == True
        assert factor_of_three(6.6) == False
        assert factor_of_three(3.00000001) == False
        assert factor_of_three(6*1000) == True
>       assert factor_of_three(-9) == False
E       assert True == False
E        +  where True = factor_of_three(-9)

test_factor_three.py:14: AssertionError
================ 1 failed in 0.04 seconds =================
sebastian ~/Desktop>
```

Example: Fixing the code again

*factor_three.py | test_factor_three.py

```
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num != 0 and num % 3 == 0:
        is_fact = True
    return is_fact


def filter_factor_of_three(
    """Return all even numb
    return [n for n in numb
```

*factor_three.py | test_factor_three.py

```
def factor_of_three(num):
    """Return True if 'num' is a factor of 3."""
    is_fact = False
    if num > 0 and num % 3 == 0:
        is_fact = True
    return is_fact


def filter_factor_of_three(numbers):
    """Return all even numbers in list *numbers*."""
    return [n for n in numbers if factor_of_three(n)]
```

Example: Moving on to the next unit

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
    assert factor_of_three(0) == False
    assert factor_of_three(3.0) == True
    assert factor_of_three(6.6) == False
    assert factor_of_three(3.00000001) == False
    assert factor_of_three(6*1000) == True
    assert factor_of_three(-9) == False

def test_filter_factor_of_three():
    in1 = [1,2,3,4,5,6,7,8,9]
    out1 = [3,6,9]
    in2 = [-2,-1,33,99]
    out2 = [33,99]
    print(filter_factor_of_three(in2))
    assert (filter_factor_of_three(in1)) == out1
    assert (filter_factor_of_three(in2)) == out2
```

Example: Moving on to the next unit

factor_three.py | *test_factor_three.py

```python
from factor_three import factor_of_three
from factor_three import filter_factor_of_three

def test_factor_of_three():
    assert factor_of_three(3) == True
    assert factor_of_three(4) == False
    assert factor_of_three(5) == False
    assert factor_of_three(6) == True
    assert factor_of_three(0) == False
    assert factor_of_three(3.0) == True
    assert factor_of_three(6.6) == False
    assert factor_of_three(3.00000001) == False
    assert factor_of_three(6*1000) == True
    assert factor_of_three(-9) == False

def test_filter_factor_of_three():
    in1 = [1,2,3,4,5,6,7,8,9]
    out1 = [3,6,9]
    in2 = [-2,-1,33,99]
    out2 = [33,99]
    print(filter_factor_of_three(in2))
    assert (filter_factor_of_three(in1)) == out1
    assert (filter_factor_of_three(in2)) == out2
```

Terminal

File Edit View Search Terminal Help

```
[bash]~/Desktop/nose_unittest >nosetests -v
test_factor_three.test_factor_of_three ... ok
test_factor_three.test_filter_factor_of_three ... ok

----------------------------------------------------------------------
Ran 2 tests in 0.008s

OK
[bash]~/Desktop/nose_unittest >
```

More Resources

- Titus' tutorial: An Extended Introduction to the nose Unit Testing Framework
  http://ivory.idyll.org/articles/nose-intro.html

- Software Carpentry Video Tutorial: Unit Testing (nose)
  http://software-carpentry.org/v4/test/unit.html

- Jeff Knupp's Tutorial (unittest)
  http://www.jeffknupp.com/blog/2013/12/09/improve-your-python-understanding-unit-testing/