Multiply your Testing Effectiveness with Parametrized Testing

Brian Okken

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Code and slides

github.com/okken/pycascades2020

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Brian Okken

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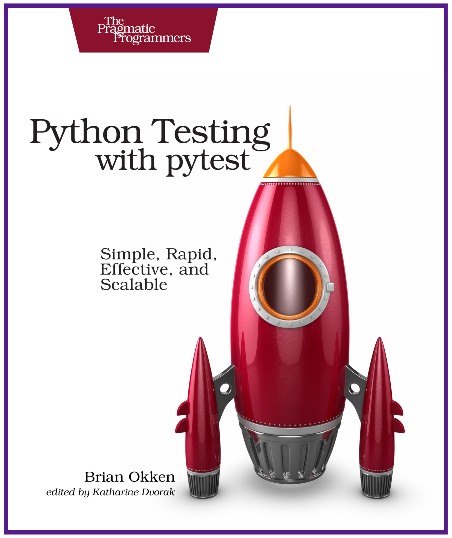

The Pragmatic Programmers
Python Testing with pytest
Simple, Rapid, Effective, and Scalable
Brian Okken
edited by Katharine Dvorak

Value of Tests

A passing test suite means:

- I didn't break anything that used to work.
- Future changes won’t break current features.
- The code is ready for users.
- I can refactor until I'm proud of the code.
- Code reviews can focus on team understanding and ownership.

Only works if:

- New features are tested with new tests.
- **Tests are easy and fast to write.** <- *this is what we're focusing on*

Takeaways

- Why parametrization is useful
- Your choices
  - function
  - fixture
  - pytest_generate_tests
- How to
  - choose a technique
  - run subsets of test cases
  - use pytest.param for ids and markers
  - use indirect to intercept parameters with fixtures

Parametrize vs Parameterize

parameter + ize

- paramet*erize* (US)
- paramet*rize* (UK)

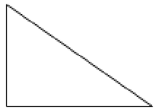
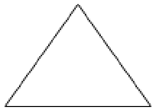
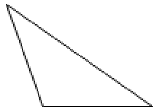
pytest uses parametrize, the UK spelling.

I've tried to get them to change it.
They don't want to.
I've gotten over it.

Something to Test

triangles.py:

```python
def triangle_type(a, b, c):
    """
    Given three angles,
    return 'obtuse', 'acute', 'right', or 'invalid'.
    """
    angles = (a, b, c)
    if 90 in angles:
        return "right"
    if any([a > 90 for a in angles]):
        return "obtuse"
    if all([a < 90 for a in angles]):
        return "acute"
    if sum(angles) != 180:
        return "invalid"
```

Right  , Acute  , Obtuse  ,

without Parametrization

```
def test_right():
    assert triangle_type(90, 60, 30) == "right"

def test_obtuse():
    assert triangle_type(100, 40, 40) == "obtuse"

def test_acute():
    assert triangle_type(60, 60, 60) == "acute"

def test_invalid():
    assert triangle_type(0, 0, 0) == "invalid"
```

```
$ pytest test_1.py
==================== test session starts ====================

test_1.py::test_right PASSED                    [ 25%]
test_1.py::test_obtuse PASSED                   [ 50%]
test_1.py::test_acute PASSED                    [ 75%]
test_1.py::test_invalid FAILED                  [100%]

================ 1 failed, 3 passed in 0.03s ================
```

pytest.ini

I wanted all the examples to include --tb=no, and -v for:

- hide tracebacks
- verbose: show the test names

So those are in a pytest.ini file:

```
[pytest]
addopts = --tb=no -v
markers =
    smoke : smoke tests
```

Moving to one test (don't do this)

```
def test_type():
    many_triangles = [
        (90, 60, 30, "right"),
        (100, 40, 40, "obtuse"),
        (60, 60, 60, "acute"),
        (0, 0, 0, "invalid"),
    ]
    for a, b, c, expected in many_triangles:
        assert triangle_type(a, b, c) == expected
```

```
$ pytest test_2.py
==================== test session starts ====================

test_2.py::test_type FAILED                          [100%]

===================== 1 failed in 0.03s =====================
```

Function Parametrization

```
@pytest.mark.parametrize( 'a, b, c, expected', [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid")])
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

Function Parametrization

```
@pytest.mark.parametrize( 'a, b, c, expected', [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid")])
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_3.py
=================== test session starts ====================

test_3.py::test_func[90-60-30-right] PASSED        [ 25%]
test_3.py::test_func[100-40-40-obtuse] PASSED      [ 50%]
test_3.py::test_func[60-60-60-acute] PASSED        [ 75%]
test_3.py::test_func[0-0-0-invalid] FAILED         [100%]

=============== 1 failed, 3 passed in 0.03s ===============
```

Function Parametrization

```
many_triangles = [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid")
]

@pytest.mark.parametrize( 'a, b, c, expected', many_triangles)
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

Test cases moved to a variable

Function Parametrization

```
def many_triangles():
    return [ (90, 60, 30, "right"),
             (100, 40, 40, "obtuse"),
             (60, 60, 60, "acute"),
             (0, 0, 0, "invalid") ]

@pytest.mark.parametrize( 'a, b, c, expected', many_triangles())
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

Test cases from a function

Function Parametrization

```
def many_triangles():
    for t in [ (90, 60, 30, "right"),
               (100, 40, 40, "obtuse"),
               (60, 60, 60, "acute"),
               (0, 0, 0, "invalid")]:
        yield t

@pytest.mark.parametrize( 'a, b, c, expected', many_triangles())
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

Test cases from a generator

Back to a List

```
many_triangles = [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid")
]

@pytest.mark.parametrize('a, b, c, expected', many_triangles)
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_7.py
=================== test session starts ====================

test_7.py::test_func[90-60-30-right] PASSED        [ 25%]
test_7.py::test_func[100-40-40-obtuse] PASSED      [ 50%]
test_7.py::test_func[60-60-60-acute] PASSED        [ 75%]
test_7.py::test_func[0-0-0-invalid] FAILED         [100%]

=============== 1 failed, 3 passed in 0.03s ================
```

Run the last failing test case

```
$ pytest --tb=short --lf test_7.py
=================== test session starts ====================
collected 4 items / 3 deselected / 1 selected
run-last-failure: rerun previous 1 failure

test_7.py::test_func[0-0-0-invalid] FAILED          [100%]

======================== FAILURES =========================
_______________ test_func[0-0-0-invalid] _______________
test_7.py:14: in test_func
    assert triangle_type(a, b, c) == expected
E   AssertionError: assert 'acute' == 'invalid'
E     - acute
E     + invalid
============= 1 failed, 3 deselected in 0.03s =============
```

Run test cases with 60 degree angles

```
$ pytest -k 60 test_7.py
==================== test session starts ====================

test_7.py::test_func[90-60-30-right] PASSED        [ 50%]
test_7.py::test_func[60-60-60-acute] PASSED        [100%]

============== 2 passed, 2 deselected in 0.01s ==============
```

Run an individual test case

```
$ pytest test_7.py::test_func[0-0-0-invalid]
=================== test session starts ===================

test_7.py::test_func[0-0-0-invalid] FAILED          [100%]

==================== 1 failed in 0.03s ====================
```

Fixture Parametrization

Function: test_7.py

```
@pytest.mark.parametrize('a, b, c, expected', many_triangles)
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

Fixture test_8.py:

```
@pytest.fixture(params=many_triangles)
def a_triangle(request):
    return request.param

def test_fix(a_triangle):
    a, b, c, expected = a_triangle
    assert triangle_type(a, b, c) == expected
```

Fixture Parametrization

```
many_triangles = [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid")]

@pytest.fixture(params=many_triangles)
def a_triangle(request):
    return request.param

def test_fix(a_triangle):
    a, b, c, expected = a_triangle
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_8.py
==================== test session starts ====================
test_8.py::test_fix[a_triangle0] PASSED          [ 25%]
test_8.py::test_fix[a_triangle1] PASSED          [ 50%]
test_8.py::test_fix[a_triangle2] PASSED          [ 75%]
test_8.py::test_fix[a_triangle3] FAILED          [100%]

=============== 1 failed, 3 passed in 0.03s ===============
```

Fixture Parametrization

```
many_triangles = [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid") ]

@pytest.fixture(params=many_triangles,
                ids=['right', 'obtuse', 'acute', 'invalid'])
def a_triangle(request):
    return request.param

def test_fix(a_triangle):
    a, b, c, expected = a_triangle
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_9.py
==================== test session starts ====================
test_9.py::test_fix[right] PASSED                   [ 25%]
test_9.py::test_fix[obtuse] PASSED                  [ 50%]
test_9.py::test_fix[acute] PASSED                   [ 75%]
test_9.py::test_fix[invalid] FAILED                 [100%]
=============== 1 failed, 3 passed in 0.03s ===============
```

Fixture Parametrization

```
many_triangles = [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid") ]

@pytest.fixture(params=many_triangles,
                ids=str)  # or repr
def a_triangle(request):
    return request.param

def test_fix(a_triangle):
    a, b, c, expected = a_triangle
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_10.py
==================== test session starts ====================
test_10.py::test_fix[(90, 60, 30, 'right')] PASSED  [ 25%]
test_10.py::test_fix[(100, 40, 40, 'obtuse')] PASSED [ 50%]
test_10.py::test_fix[(60, 60, 60, 'acute')] PASSED  [ 75%]
test_10.py::test_fix[(0, 0, 0, 'invalid')] FAILED   [100%]
=============== 1 failed, 3 passed in 0.03s ===============
```

Fixture Parametrization

```python
def idfn(a_triangle):
     a, b, c, expected = a_triangle
     return f'{a}-{b}-{c}-{expected}'

@pytest.fixture(params=many_triangles, ids=idfn)
def a_triangle(request):
    return request.param

def test_fix(a_triangle):
    a, b, c, expected = a_triangle
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_11.py
=================== test session starts ===================
test_11.py::test_fix[90-60-30-right] PASSED         [ 25%]
test_11.py::test_fix[100-40-40-obtuse] PASSED       [ 50%]
test_11.py::test_fix[60-60-60-acute] PASSED         [ 75%]
test_11.py::test_fix[0-0-0-invalid] FAILED          [100%]
=============== 1 failed, 3 passed in 0.03s ===============
```

pytest_generate_tests()

```
def pytest_generate_tests(metafunc):
    if "gen_triangle" in metafunc.fixturenames:
        metafunc.parametrize("gen_triangle",
                             many_triangles,
                             ids=idfn)

def test_gen(gen_triangle):
    a, b, c, expected = gen_triangle
    assert triangle_type(a, b, c) == expected
```

```
$ pytest test_12.py
=================== test session starts ===================

test_12.py::test_gen[90-60-30-right] PASSED      [ 25%]
test_12.py::test_gen[100-40-40-obtuse] PASSED    [ 50%]
test_12.py::test_gen[60-60-60-acute] PASSED      [ 75%]
test_12.py::test_gen[0-0-0-invalid] FAILED       [100%]

=============== 1 failed, 3 passed in 0.03s ===============
```

metafunc

From docs.pytest.org/en/latest/reference.html#metafunc

- Metafunc objects are passed to the pytest_generate_tests hook.
- They help to inspect a test function and to generate tests according to
  - test configuration
  - or values specified in the class or module where a test function is defined.

test.param

test_12.py:

```
many_triangles = [
    (90, 60, 30, "right"),
    (100, 40, 40, "obtuse"),
    (60, 60, 60, "acute"),
    (0, 0, 0, "invalid")
]
```

test_13.py:

```
smoke = pytest.mark.smoke

many_triangles = [
    pytest.param(90, 60, 30, "right", marks=smoke),
    pytest.param(100, 40, 40, "obtuse", marks=smoke),
   (90, 60, 30, "right"),
    pytest.param(0, 0, 0, "invalid", id='zeros'),
]
```

test.param

```
smoke = pytest.mark.smoke

many_triangles = [
    pytest.param(90, 60, 30, "right", marks=smoke),
    pytest.param(100, 40, 40, "obtuse", marks=smoke),
    (90, 60, 30, "right"),
    pytest.param(0, 0, 0, "invalid", id='zeros'),
]
```

```
$ pytest -m smoke test_13.py
==================== test session starts ====================
test_13.py::test_func[90-60-30-right] PASSED       [ 50%]
test_13.py::test_func[100-40-40-obtuse] PASSED     [100%]
============= 2 passed, 4 deselected in 0.01s =============
```

```
$ pytest -k zeros test_13.py
==================== test session starts ====================
test_13.py::test_func[zeros] PASSED                [100%]
============= 1 passed, 3 deselected in 0.01s =============
```

indirect parameter

test_14.py:

```
@pytest.fixture()
def expected(request):
    if request.param == 'obtuse':
        print('\nthis is one of the obtuse cases')
    return request.param


@pytest.mark.parametrize('a, b, c, expected', many_triangles,
                         indirect=['expected'])
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

The parameter value goes through a fixture before making it to the test, an "indirect" route.

More test cass

```
many_triangles = [
    (  1, 1, 178, "obtuse"), # big angles
    ( 91, 44, 45, "obtuse"), # just over 90
    (0.01, 0.01, 179.98, "obtuse"), # decimals

    (90, 60, 30, "right"), # check 90 for each angle
    (10, 90, 80, "right"),
    (85,  5, 90, "right"),

    (89, 89,  2, "acute"), # just under 90
    (60, 60, 60, "acute"),

    (0, 0, 0, "invalid"),     # zeros
    (61, 60, 60, "invalid"),  # sum > 180
    (90, 91, -1, "invalid"),  # negative numbers
]
```

For more on test case selection:

- Test & Code 38 : Prioritize software tests with RCRCRC
- Test & Code 39 : equivalence partitioning, boundary value analysis, decision tables

Review

```
@pytest.mark.parametrize('a, b, c, expected', many_triangles)
def test_func(a, b, c, expected):
    assert triangle_type(a, b, c) == expected
```

```
@pytest.fixture(params=many_triangles, ids=idfn)
def a_triangle(request):
    return request.param

def test_fix(a_triangle):
    a, b, c, expected = a_triangle
    assert triangle_type(a, b, c) == expected
```

```
def pytest_generate_tests(metafunc):
    if "gen_triangle" in metafunc.fixturenames:
        metafunc.parametrize("gen_triangle",
                             many_triangles, ids=idfn)

def test_gen(gen_triangle):
    a, b, c, expected = gen_triangle
    assert triangle_type(a, b, c) == expected
```

Choosing a Technique

Guidelines

1. **function parametrization**
   - use this if you can
2. **fixture parametrization**
   - if doing work to set up each fixture value
   - if running multiple test against the same set of "setup states"
3. **pytest_generate_tests()**
   - if list is based on passed in parameters or external resources or other introspection not available to other methods

Combining Techniques

You can have multiple parametrizations for a test function.

- can have multiple @pytest.mark.parametrize() decorators on a test function.
- can parameterize multipe fixtures per test
- can use pytest_generate_tests() to parametrize multiple parameters
- can use a combination of techniques
- can blow up into lots and lots of test cases very fast

Resources

- Python Testing with pytest
  - The fastest way to get super productive with pytest
- pytest docs on
  - parametrization, in general
  - function parametrization
  - fixture parametrization
  - pytest_generate_tests
  - indirect
- podcasts
  - Test & Code
  - Python Bytes
  - Talk Python
- slack community: Test & Code Slack
- Twitter: @brianokken, @testandcode
- This code, and markdown for slides, on github.com/okken/pycascades2020

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