Testing in Python, from 0 to 100

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About me

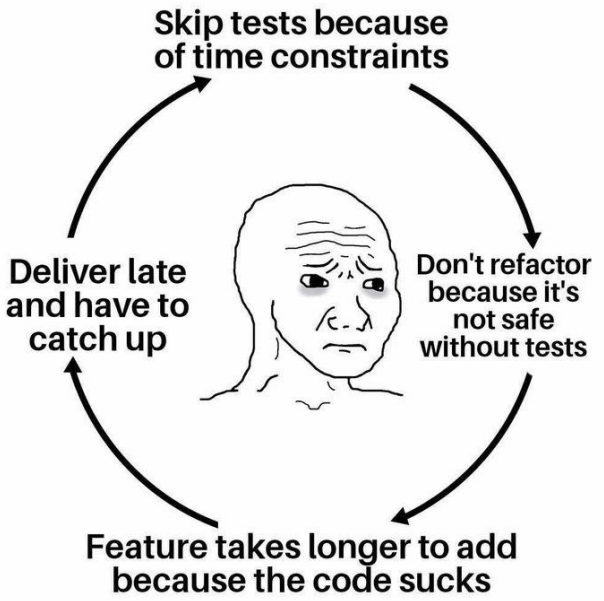
- Developing software since 2001
- Worked in retail, adtech, web, industrial sw
- Find me on Internet: @liopic
- Focus on engineering good practices

Pragmatic approach to Testing

- Do we need tests?
- It depends!
  - **YES** : Team-work, company product, quality work
  - **NO** : PoC, web freelance, one run, pet project?

Why do we need tests?

- **Key point: Maintenance!**
- Tests give lots of benefits to our development
  - (In theory) guarantee code quality
  - Allow **other team members** to **safely** work on the code



Worst team member
is yourself
in the future

What’s testing?

- What’s not testing?
  - Run the script
  - Push a button
  - Display on the browser
  - Do a print

```
class Something:
    def is_testing_do_a_print(self):
        return "NO"

if __name__ == "__main__":
    print(Something().is_testing_do_a_print())
```

- **Develop code that checks/stress your code**

What’s testing?

- In theory “Write tests to validate the functionality of the code”
- **Key: AUTOMATIC!**
  - Continuous Integration: github actions, gitlab, circleCI, travis, jenkins
- Up to Test Driven Development
  - vs Subject Coding + Test coding

What’s a good test?

- One that helps developers/maintainers
  - Safety net
  - Document how to use the code : happy path, edge cases, pitfalls
- Features:
  - Easy to understand: what it does + **what fails if it fails**
  - Test only ONE thing
  - Minimal/concise
    - Given - When - Then


WHAT ABOUT ME?

Tests in Python

- Included:
  - unittest (unittest.TestCase)
  - doctest (X)
- Most used package:
  - pytest

Code Example

```
from datetime import datetime, timedelta
from math import ceil


class MoonLocator:
    moon_on_south = datetime(year=2022, month=11, day=15, hour=6, minute=1, second=12)
    moon_interval = timedelta(days=1, hours=0, minutes=50, seconds=28)

    def next_moon_on_south_from_date(self, from_date: datetime) -> datetime:
        since_moon_on_south = from_date - self.moon_on_south
        cycle = ceil(since_moon_on_south / self.moon_interval)
        return self.moon_on_south + self.moon_interval * cycle
```

Any test idea?

Simplest Test

```
from datetime import datetime, timedelta

from moon import MoonLocator



def test_next_moon_should_be_after_some_given_date():
    date = datetime.now()
    moon_locator = MoonLocator()
    next_moon = moon_locator.next_moon_on_south_from_date(date)
    assert next_moon >= date
```

Another Test Example

```
from datetime import datetime, timedelta

from moon import MoonLocator


def test_date_on_south_a_second_before_should_return_that_date():
    sut = MoonLocator()
    some_moon_on_south = datetime(year=2022, month=11, day=15, hour=6, minute=1, second=12)
    a_moment_before = some_moon_on_south - timedelta(seconds=1)

    next_moon = sut.next_moon_on_south_from_date(a_moment_before)

    assert next_moon == some_moon_on_south
```

Test Example with randomness

```
def test_next_moon_should_be_between_a_date_and_one_day_one_hour_later():
    sut = MoonLocator()
    some_date = datetime(2022, 12, 14, 0, 0, 0) # This could be random!
    one_day_one_hour_later = some_date + timedelta(days=1, hours=1)

    next_moon = sut.next_moon_on_south_from_date(some_date)

    assert next_moon >= some_date
    assert one_day_one_hour_later >= next_moon
```

Snapshot testing?

```
def test_next_moon_on_south():
    sut = MoonLocator()
    some_date = datetime(2022, 12, 14, 0, 0, 0)

    next_moon = sut.next_moon_on_south_from_date(some_date)

    assert next_moon == datetime(2022, 12, 14, 5, 34, 16)
```

Test with fixture

```
@pytest.fixture(scope="module")
def moon_locator():
    return MoonLocator()

@pytest.fixture
def moon_on_south():
    yield datetime(year=2022, month=11, day=15, hour=6, minute=1, second=12)

def test_date_on_south_a_second_before_should_return_that_date(moon_locator, moon_on_south):
    a_moment_before = moon_on_south - timedelta(seconds=1)

    next_moon = moon_locator.next_moon_on_south_from_date(a_moment_before)

    assert next_moon == moon_on_south
```

Example with dependency

```
def reference_date_for_year(year) -> datetime:
    if year >= 2022:
        return datetime(2022, 11, 15, 6, 1, 12)
    else:
        return datetime(2010, 1, 2, 2, 32, 4)

class MoonLocator:
    moon_interval = timedelta(days=1, hours=0, minutes=50, seconds=28)

    def next_moon_on_south_from_date(self, from_date: datetime) -> datetime:
        moon_on_south = reference_date_for_year(from_date.year)
        since_moon_on_south = from_date - moon_on_south
        cycle = ceil(since_moon_on_south / self.moon_interval)
        return moon_on_south + self.moon_interval * cycle
```

Test with mock

```
from unittest import mock

from moon_locator import MoonLocator

namespace = "moon_locator"
@mock.patch(f"{namespace}.reference_date_for_year", return_value=datetime(2020, 2, 1))
def test_date_on_south_a_second_before_should_return_that_date(mock_reference, moon_locator):
    some_moon = datetime(year=2020, month=2, day=1)
    a_moment_before = some_moon - timedelta(seconds=1)

    next_moon = moon_locator.next_moon_on_south_from_date(a_moment_before)

    assert next_moon == some_moon
    mock_reference.assert_any_call(2020)
```

Advanced testing

- Quality of tests
  - Test coverage (pytest-cov)
  - Mutant testing (mutmut)
- Other ways to do tests
  - Property-based testing (hypothesis)
  - BDD testing (behave)

Test coverage

- Do your tests cover all the code?
  - Lines of code
  - Paths of execution
- pytest-cov gives you statement-based reports

```
count = 0
if some_thing:
    count += 1
if other_thing:
    count += 10
```

Coverage for **moon.py**: 91%

11 statements | 10 run | 1 missing | 0 excluded

 coverage.py v6.5.0, created at 2022-12-10 20:49 +0100

```
1  from datetime import datetime, timedelta
2  from math import ceil
3
4
5  class MoonLocator:
6      moon_on_south = datetime(year=2022, month=11, day=15, hour=6, minute=1, second=12)
7      moon_interval = timedelta(days=1, hours=0, minutes=50, seconds=28)
8
9      def next_moon_on_south_from_date(self, from_date: datetime) -> datetime:
10         since_moon_on_south = from_date - self.moon_on_south
11         cycle = ceil(since_moon_on_south / self.moon_interval)
12         return self.moon_on_south + self.moon_interval * cycle
13
14     def other_untested_function() -> int:
15         0
```

Mutant testing (mutmut)

- Test your tests
- Mutate the original code...
  - Add 1 to numbers
  - Change < to <=
  - ... other changes
- ... and execute the tests

Mutant testing (mutmut)

🎉 *Killed mutants.* *The goal is for everything to end up in this bucket.*

⏰ *Timeout.* *Test suite took 10 times as long as the baseline so were killed.*

🤔 *Suspicious.* *Tests took a long time, but not long enough to be fatal.*

😕 *Survived.* *This means your tests needs to be expanded.*

🔇 *Skipped.* *Skipped.*

1. Running tests without mutations

⠸ Running...Done

2. Checking mutants

⠼ 136/136 🎉 90 ⏰ 0 🤔 0 😕 46 🔇 0

Mutant testing (mutmut)

- Good vs Bad
  - + Captures edge cases
  - + “Clever coverage”
  - - Make tests not flexible
  - - Slow
- Recommendation: just pieces of code with complexity

Key Ideas

- Create the simplest test first
- Execute your test, **automatically (CI)**
- Iterate: add more tests + more types of testing

THANK YOU!

Extra testing methods...

Property-based testing (hypothesis)

```
imfrom hypothesis import given, settings
import hypothesis.strategies as st

from moon_locator import MoonLocator

datetimes = st.datetimes(max_value=datetime(2100, 1, 1))

@given(datetimes)
@settings(max_examples=5000)
def test_next_moon_should_be_after_some_given_date(date):
   moon_locator = MoonLocator()
   assert date <= moon_locator.next_moon_on_south_from_date(date)
```

Property-based testing (hypothesis)

- Good vs Bad
  - + Finds unexpected cases
  - + hypothesis can find the minimum error
  - - Force the developer to stop and fix unrelated code
- Recommendation: Build random stubs (Faker)

BDD testing (behave)

- An interface with product/stakeholders

```
Feature: next moon calculation

  Scenario: next moon in December
    Given we set last moon to "2022-11-15 19:00:00"
     When we ask for the next moon on South from today
     Then the next moon on South should be in the future
```

BDD testing (behave)

```
@given('we set last moon on South to "{date}"')
def step_impl(context, date):
    last_south = datetime.strptime(date, '%Y-%m-%d %H:%M:%S')
    context.moon_locator = MoonLocator()
    context.moon_locator.default_moon = last_south

@when('we ask for the next moon on South from today')
def step_impl(context):
    context.today = datetime.now()
    context.next_moon = context.moon_locator.next_moon_on_south_from_date(context.today)

@then('the next moon on South should be in the future')
def step_impl(context):
    assert context.today <= context.next_moon
```

BDD testing (behave)

- Good vs Bad
  - + Text is highly configurable
  - + High level testing
  - - You need a diligent product team
- Recommendation: try it with easy-to-implement features