Spending less time bug fixing by spending more time unit testing

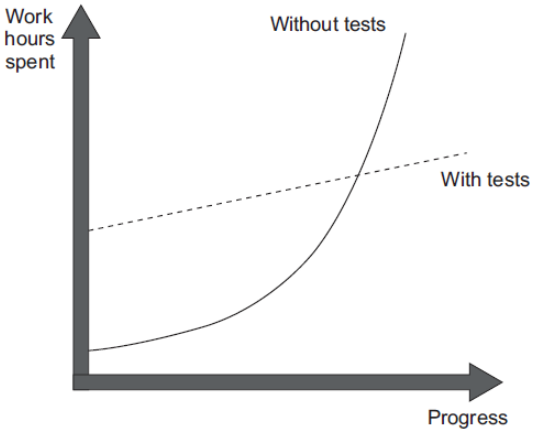
<Name>

There's much more to unit testing than the act of writing tests.

—***Khorikov*, Unit Testing Principles, Practices, and Patterns, *3***

The goal of unit testing

To enable **sustainable** growth of software project.



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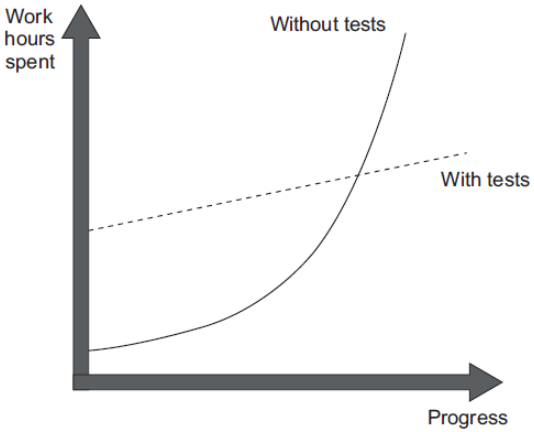

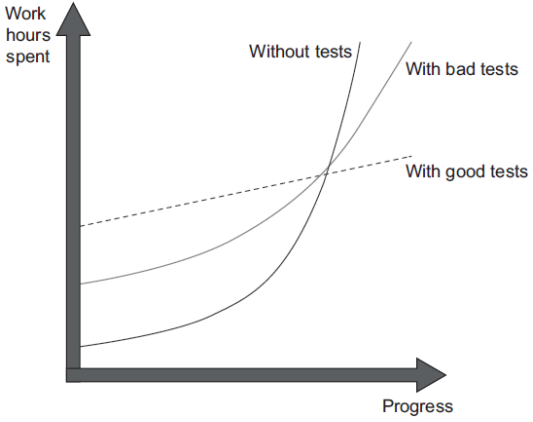

Coverage metrics

Statement vs Branch vs ~~Path~~ vs ~~Condition~~

```
def is_fizzbuzz(num: int) -> bool:
    if num % 3 and num % 5:
        return True
    return some_var

def test_fizzbuzz():
    result = is_fizzbuzz(3)
    assert result
```

$$\frac{\textit{Number of statements executed}}{\textit{Total number of statements}} \approx 67\%$$

Coverage metrics

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```python
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$$\frac{\textit{Number of statements executed}}{\textit{Total number of statements}} = 100\%$$

Coverage metrics

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$$\frac{\textit{Branches traversed}}{\textit{Total number of branches}} = 50\%$$

Coverage metrics

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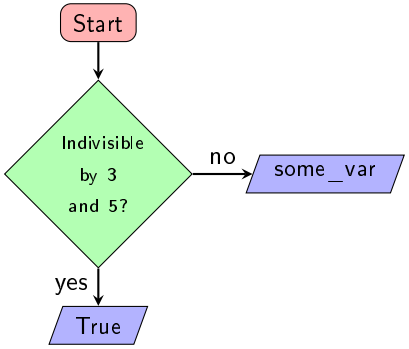
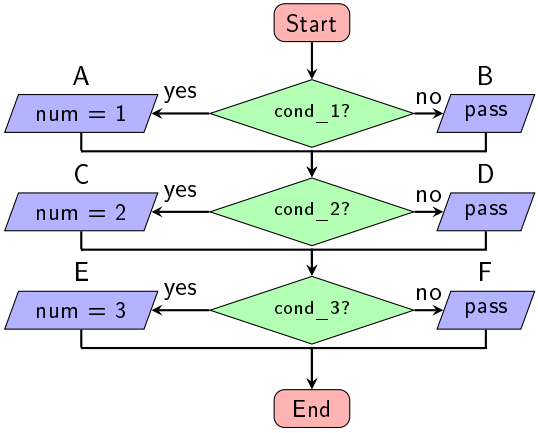


Coverage metrics

Statement vs Branch vs ~~Path~~ vs ~~Condition~~

```python
def generate_number(
    cond_1: bool = True,
    cond_2: bool = True,
    cond_3: bool = True,
) -> int:
    if cond_1:
        num = 1
    if cond_2:
        num = 2
    if cond_3:
        num = 3
    return num
```

Possible paths:
ACE, ACF, ADE, ADF, BCE, BCF, BDE, BDF



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def is_fizzbuzz(num: int) -> bool:
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```

num % 3	num % 5	num % 3 and num % 5
True	True	True
True	False	False
False	True	False
False	False	False

[C]overage metrics are a good negative indicator, but a bad positive one.

—***Khorikov***, **Unit Testing Principles, Practices, and Patterns**, ***15***

Definition of a unit test

- Verifies a small piece of code,
- Does it quickly, and
- Does it in an isolated manner.

An integration test is a test that doesn't meet one of these criteria. End-to-end tests are a subset of integration tests and usually include more dependencies.

Anatomy of a unit test

The AAA (3A) pattern, also Given-When-Then pattern.

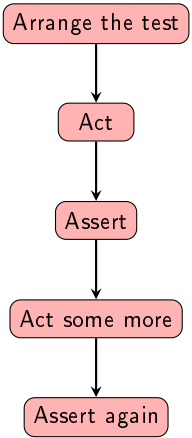
```
# A cohesive set of tests, optional
class TestCalculator:
    # Name of the unit test
    def test_sum_of_two_numbers(self):
        # Arrange
        first = 10
        second = 20
        calculator = Calculator()

        # Act
        result = calculator.sum(first, second)

        # Assert
        assert result == 30
```

- In *Arrange*, bring the system under test (SUT) to the a desired state
- In *Act*, call the method on the SUT, pass the prepared dependencies, and capture the output (if any).
- In *Assert*, verify the outcome. The outcome could be the return value, the final state of the SUT, or the methods the SUT called on its collaborators.

Things to avoid for unit tests



- Avoid multiple arrange, act, and assert sections.

Things to avoid for unit tests

```
def test_node_with_python_updates(self, req_file):
    with TestCase.assertLogs("...logger") as cap:
        assert check_requirements(
            NODE, req_file
        ) == 2
        for i, rec in enumerate(cap.records):
            idx = int(i / 2)
            if i == 4:
                assert "2 packages updated" in rec.getMessage()
            elif i % 2 == 0:
                assert f"{PY_PKGS[idx]} not found" in rec.getMessage()
            else:
                assert f"pip install {PY_PKGS[idx]}" in rec.getMessage()
```

- Avoid multiple arrange, act, and assert sections.
- Avoid `if` statements.

Naming a unit test

```
def test_is_delivery_valid_invalid_date_returns_false():
    sut = DeliveryService()
    past_date = datetime.today() - timedelta(days=1)
    delivery = Delivery(date=past_date)

    is_valid = sut.is_delivery_valid(delivery)

    assert not is_valid
```

- A rigid convention such as `<method>_<scenario>_<expected>` isn't as helpful as plain English

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def test_delivery_with_past_date_should_be_considered_invalid():
    ...
```

- A rigid convention such as `<method>_<scenario>_<expected>` isn't as helpful as plain English
- Should not be too verbose

Naming a unit test

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    assert not is_valid

def test_delivery_with_past_date_should_be_considered_invalid():
    ...

def test_delivery_with_a_past_date_is_invalid():
    ...
```

- A rigid convention such as `<method>_<scenario>_<expected>` isn't as helpful as plain English
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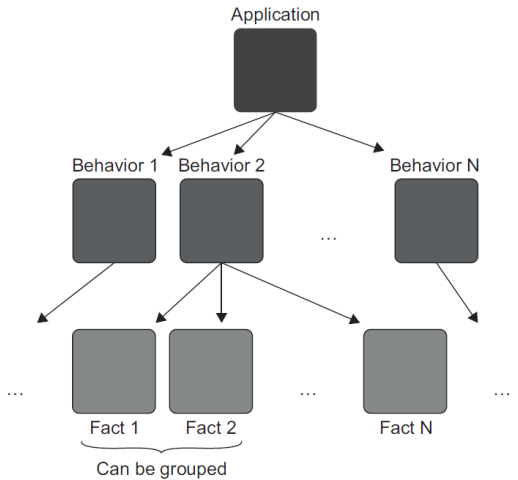
Parametrizing tests

Parametrization, also spelled parameterization, parametrisation or parameterisation, is the process of defining or choosing parameters. — Wikipedia



- The number of tests can become unmanageable if each component/behavior of the application is tested with its own test.
- Some (similar) behaviors can be grouped into a single test using parametrization.

Parametrizing tests

Behavior: The soonest allowed delivery date is two days from now.

In addition to `test_delivery_with_a_past_date_is_invalid`, we need to add three more:

```
def test_delivery_for_today_is_invalid():
    ...

def test_delivery_for_tomorrow_is_invalid():
    ...

def test_the_soonest_delivery_date_is_two_days_from_now():
    ...
```

This would result in four test methods, with the only difference between them being the delivery date.

Parametrizing tests

Behavior: The soonest allowed delivery date is two days from now.

```
@pytest.mark.parametrize(
    "days_from_now,expected",
    [(-1, False), (0, False), (1, False), (2, True)],
)
def test_can_detect_an_invalid_delivery_date(
    days_from_now, expected
):
    sut = DeliveryService()
    delivery_date = datetime.today() + timedelta(days=days_from_now)
    delivery = Delivery(date=delivery_date)

    is_valid = sut.is_delivery_valid(delivery)

    assert is_valid == expected
```

- Significantly reduce the amount of test code

Parametrizing tests (meaningfully)

Behavior: The soonest allowed delivery date is two days from now.

```python
@pytest.mark.parametrize("days_from_now", [-1, 0, 1])
def test_detects_an_invalid_delivery_date(days_from_now):
    ...

    assert not is_valid


def test_the_soonest_delivery_date_is_two_days_from_now():
    ...

    assert is_valid
```

- Significantly reduce the amount of test code
- Do not "over parametrize" if the scenarios are complicated

Using an assertion library (optional)

An assertion library like `assertpy` can improve test readability by making the assert section read like plain English.

```python
def test_sum_of_two_numbers():
    ...

    assert result == 30
```

```python
def test_sum_of_two_numbers():
    ...

    assert_that(result).is_equal_to(30)
```

- Introduces additional dependencies

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```

- Introduces additional dependencies

Bonus: `Chai` assertion library

```
describe("Calculator", () => {
    it("computes the sum of two number", () => {
        const calculator = new Calculator();

        const result calculator.sum(10, 20);

        expect(result).to.be.equal(30);
    });
});
```

Recognizing a good unit test

The four pillars of a good unit test

- Protection against regression
  - Amount of code executed during the test
  - Complexity of that code
  - The code's domain significance
- Resistance against refactoring
- Fast feedback
  - "Fast enough"
  - Can be run more often to detect regressions
- Maintainability
  - How hard is it to understand the test: Test code quality matters as much as production code
  - How hard is it to run the test

The second pillar: Resistance to refactoring

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Scenario: You developed a new feature and everything works great. The feature is working as intended and all the tests are passing.

You decide to clean up the code before submitting the PR. Some refactoring here and there, and the code ends up looking better than before.

Except one thing — the tests are failing. But the feature is still working perfectly, just as before. Turns out the tests are written in such a way that they fail with any modifications to the underlying code.

This situation is a *false positive*.

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Why is this so important that it deserves its own slide?

- Enable sustainable project growth
- Provide early warning to regressions
- Give confidence that code changes won't lead to regressions

How to avoid false positives?