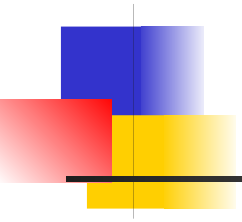


Intro to Unit Testing

James Brucker

Many Kinds of Software Testing

- Test requirements - consistent? unambiguous?
- Test application design - does it satisfy requirements? Consistent with *Vision*? Anything not in requirements?
- Unit Testing - test individual methods and functions
- Integration Testing
- End-to-End or Functional Testing
- Acceptance Testing
- Usability Testing

Why Test?

1. *Saves time!*

   - *Testing is faster than fixing "bugs".*

2. *Testing finds more errors than debugging.*

3. *Prevent re-introduction of old errors (regression errors).*

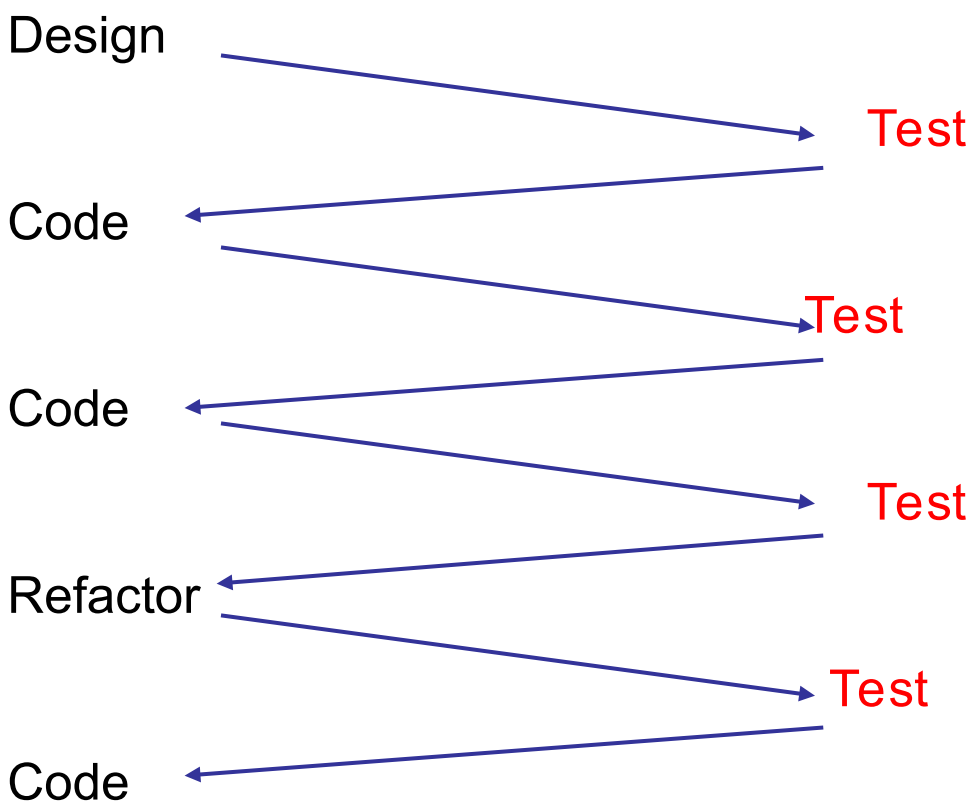
   Programmers often recreate an error that was already fixed when they modify code.

4. *Validate software: does it match the specification?*

Psychological Advantages

- *Keeps you **focused** on current task.*
- *Increase **satisfaction**.*
- ***Confidence** to make changes.*

Test Often

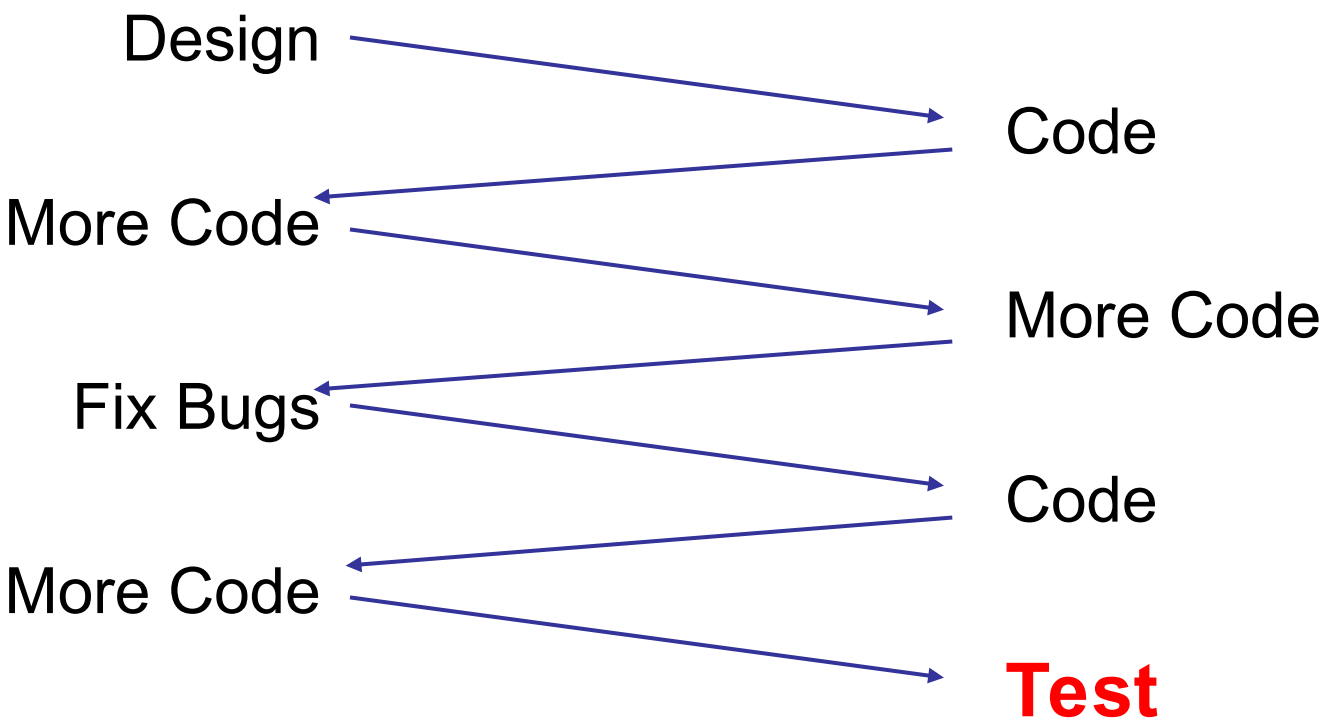


Agile Development

Test early.

Test continually!

Testing Done Wrong



When to Test?

- ***While you are coding.***
- ***Whenever you fix or modify existing code.***
- ***Before & after refactoring.***
- ***When the environment changes*** **-** upgrade a package, "pull" new code, change Python version, change OS, change computer.

The Cost of Fixing "faults"

Discover & fix a defect early is much cheaper (100X) than to fix it after code is integrated.

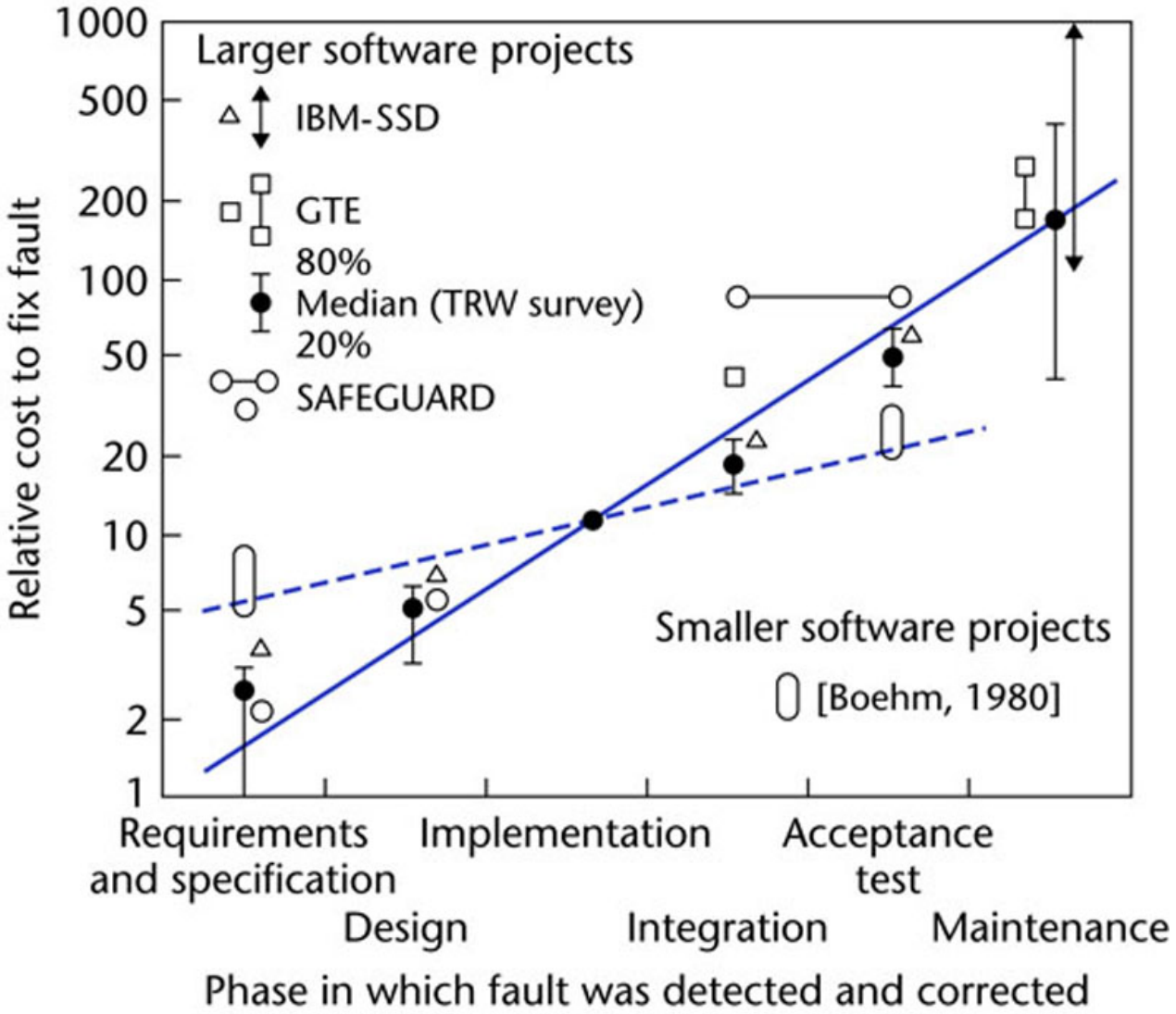


Figure 1.5

What to Test?

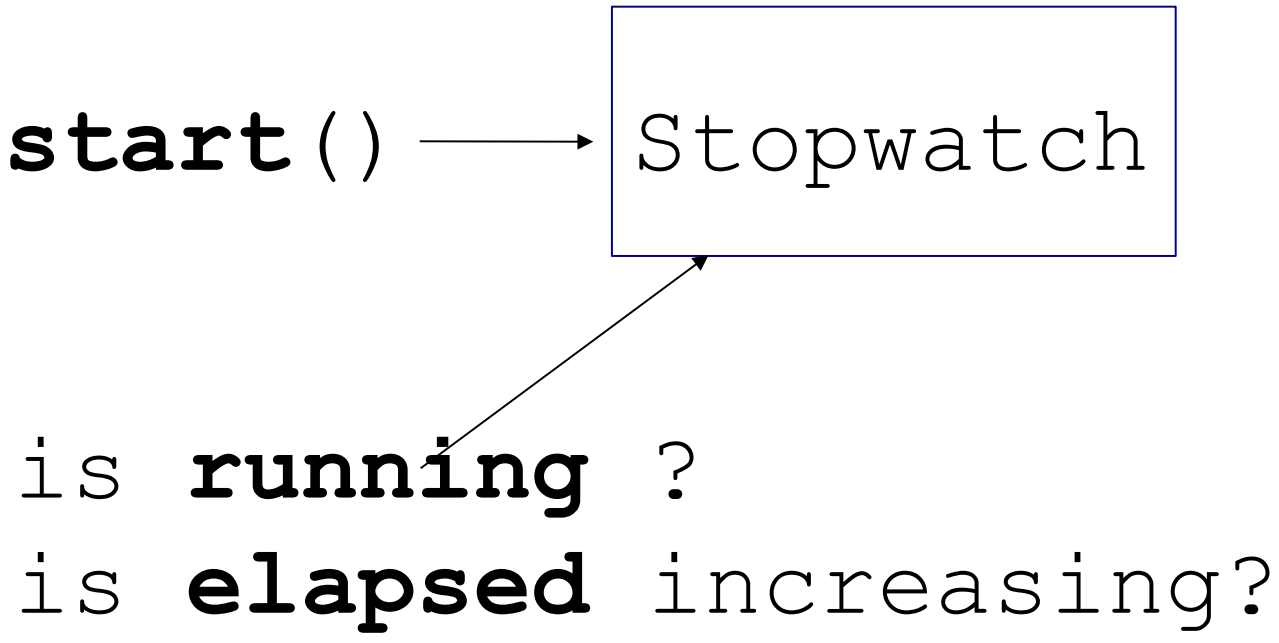
In unit testing, we test functions or methods.

Test that inputs produce the expected results.

Test **State**, Too

Many operations change the state of an object or component.

You should test the expected state, too.



How to Test?

We can not test all possible inputs & outputs.

- Divide input into categories or sets.
- Discover "rules" that apply to different sets of input.
- Test a few samples from each set, category, or class.
  - Test boundary values.
  - Test "typical" values.
  - Test "extreme" values.
  - Test impossible values.
  - Try to make the code fail.

Example: gcd(a,b)

`gcd(a:int, b:int)` = greatest common divisor

`gcd(24,30)` -> 6

`gcd(3, 7)` -> 1 (no common factors)

Rule: gcd is always positive

`gcd(80,-15)` -> 5

`gcd(-7,-3)` -> 1

Rule: gcd involving zero is positive

`gcd(8,0)` -> 8

`gcd(0,-8)` -> 8

Edge Case: something the may go wrong

`gcd(0,0)` -> 1

Defining Test Cases

Test Case	Example Arguments
Two positive ints with common factor	(30, 35), (48, 20), (36, 999)
Two int with no common factor	(1, 50), (50, 3), (370, 999), (1,1)
One or both args are negative	(-30,45), (72,-27), (-1,-2)
One or both args are zero	(99, 0), (0, 7), (0, -7), (0, 0)
Extreme case to test algorithm efficiently terminates	(123*123457890123, 123*789012345890)

Don't Rely on Manual Tests

Automate

Automate

Automate

Why?

Python Unit Test Libraries

Doctest - tests in code provide documentation

Unittest - the standard, based on JUnit

Pytest - simple yet powerful package for concise tests. Can execute doctests & unittests, too.

Tools to Enhance Testing:

Mock objects - "fake" objects for external components

Hamcrest - declarative rules of "intent" to help write readable, powerful matching rules for tests.

Python unittest

```
import unittest

class TestGcd(unittest.TestCase):

    def test_gcd_positive_values(self):
        """Should return positive gcd."""
        self.assertEqual(5, gcd(30, 35))
        self.assertEqual(4, gcd(48, 20))

    def test_gcd_no_common_factors(self):
        """gcd of relatively primes values is 1."""
        self.assertEqual(1, gcd(30, 49))
        self.assertEqual(1, gcd(27, 29))
        self.assertEqual(1, gcd(44, 1))
```

Doctest

```
def gcd(a: int, b: int):
    """Return the greatest common divisor two ints.

    Examples:
    >>> gcd(24, 30)
    6
    >>> gcd(24, -36)
    12
    >>> gcd(24, 49)
    1
    >>> gcd(0, 15)
    15
    """
```

Provides documentation.

Each test is a different category of input.

Pytest

```
import pytest

def test_gcd_positive_values():
    """Should return positive gcd."""
    assert 5 == gcd(30, 35)
    assert 4 == gcd(48, 20)

def test_gcd_no_common_factors():
    """gcd of relatively primes values is 1."""
    assert 1 == gcd(30, 49)
    assert 1 == gcd(27, 29)
    assert 1 == gcd(44, 1)
```

Run: `pytest -v`

`pytest -v test_file_name.py`

Parameterize: reuse test code

```
import pytest

@pytest.mark.parametrize( #"parametrize" is not typo
        "a, b, expected",
        [   (30, 35, 5),
            (48, 20, 4),
            (27, 29, 1),
        ])
def test_gcd_positive_values(a, b, expected):
    assert expected == gcd(a, b)
```

Run a test with multiple sets of values.

unittest has parameterized tests, too.

FIRST guide for good tests

Fast

Independent - can run any subset of tests in any order

Repeatable - always get same result

Self-checking - test knows if it passed or failed

Timely - written at same time as the code to test

Prepare for Quiz

On a quiz, you will not have time to stumble around searching for how to perform some test.

You should learn and memorize in advance

- what "asserts" are available and how to quickly find them in the unittest docs (points deducted for nonspecific assert)
- how & when to use `setUp`, `setUpClass`, and `tearDown`
- how to test for exceptions
- parameterized tests
- how to test Django views, models, & templates. How to use django.test.TestCase and Client classes.

References

`unittest` in Python Library (search for "unittest")

- Learn the many "assert" methods
- Learn to use setUp, tearDown, setUpClass
- Parameterized testing

Getting Started with Testing in Python

Article on using unittest. Includes testing of web API and web applications.

`https://realpython.com/python-testing/`