



Intro to Testing

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Many Kinds of Software Testing

Software testing is critical!

- ❑ Test **requirements** - consistent? unambiguous?
- ❑ Test **software specification** - is it consistent with the requirements? Satisfy all the 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?*

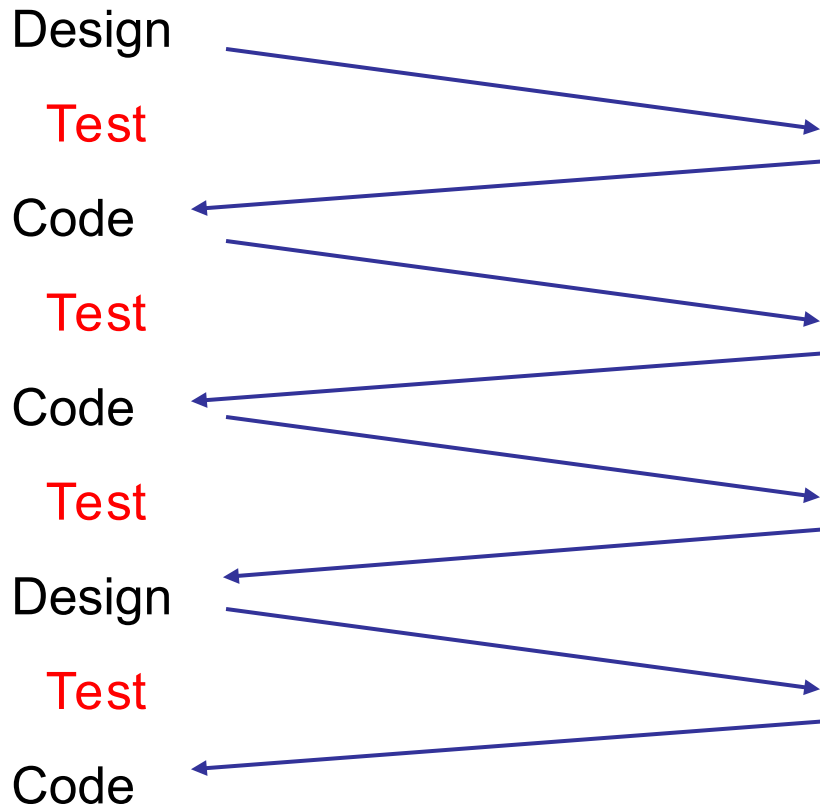
Psychological Advantages

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

Testing is part of development

Agile Development Practices

- *Test early.*
- *Test continually!*



When To Test?

- Test **while** you are writing the source code
- **Retest** whenever you modify the source code

Test-Driven Development (TDD)

*Write the **tests first** ... what the code should do.*

***Then** write code that passes the tests.*

The Cost of Fixing "faults"

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

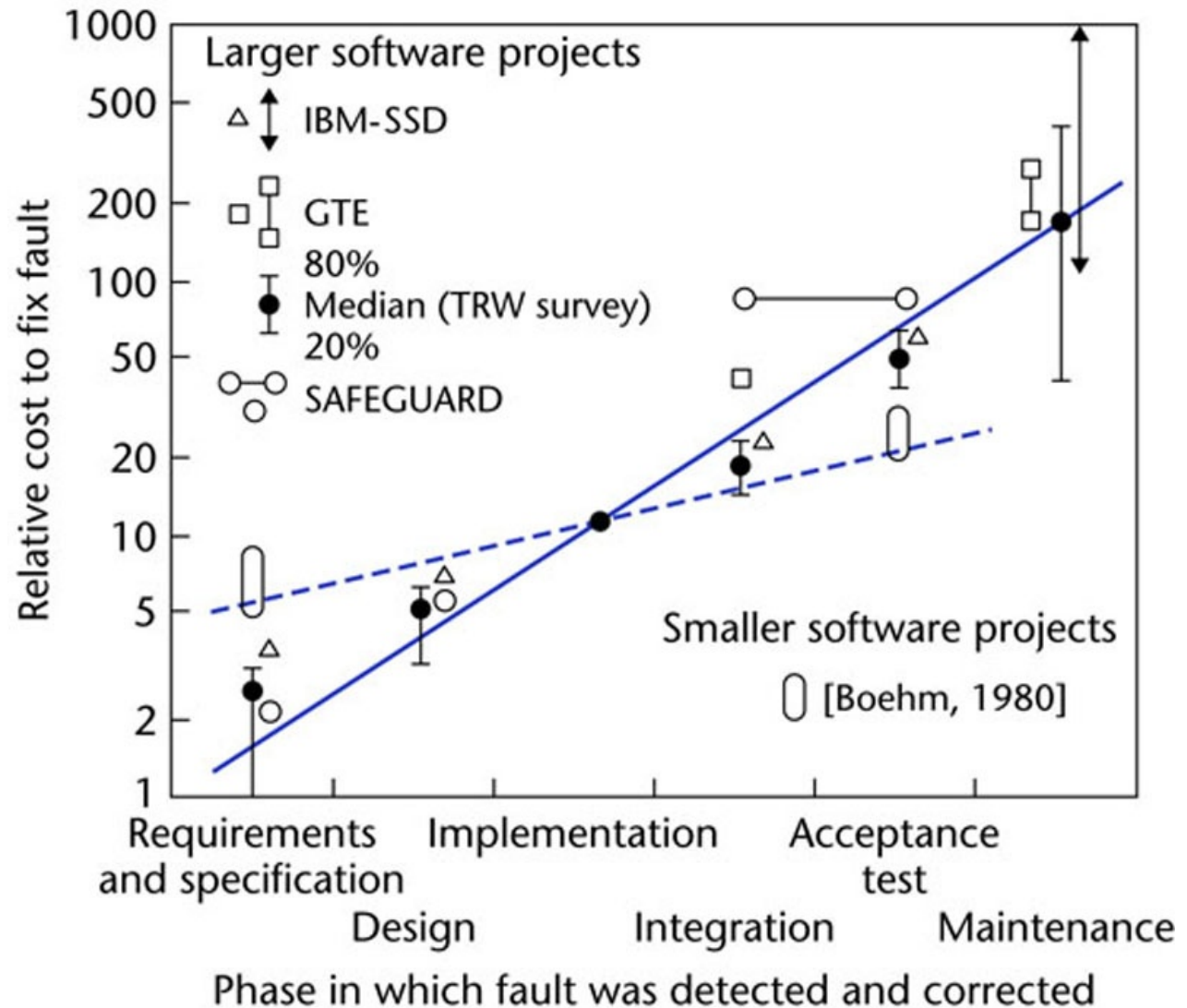
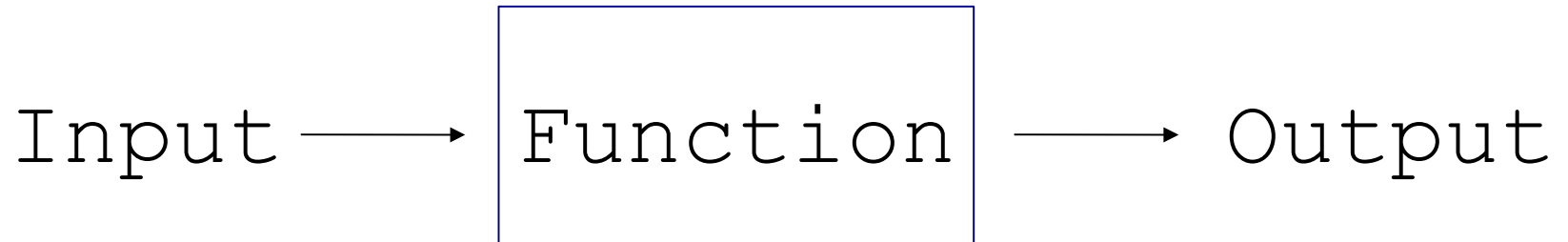


Figure 1.5

What to Test?

In unit testing, we test functions or methods.

Test that inputs produce the expected results.



How to Test?

We can not test all possible input / output.

- 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 of a & b

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

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 zero	(99, 0), (0,-33), (0,0)
Extreme case to test algorithm efficiently terminates	(123*123457890123, 123*789012345890)

Python unittest

```
import unittest
```

```
class TestGcd(unittest.TestCase):  
    def test_gcd_positive_values(self):  
        self.assertEqual(6, gcd(30,36))  
        self.assertEqual(4, gcd(48,20))  
  
    def test_gcd_involving_zero(self):  
        self.assertEqual(1, gcd(0,0))  
        self.assertEqual(99, gcd(0,99))  
        self.assertEqual(1, gcd(1,0) )
```

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

References

`unittest` in Python Library

- Search for "`unittest`" on main page of Library
- You should have Library **installed on your computer**

Hitchhiker's Guide to Python Testing

Short introduction to several testing tools

<https://docs.python-guide.org/writing/tests/>

Test-Driven Development in Python, 2E

"The TDD book" for Python. Uses Django.