

Testing

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Overview

1 Introduction

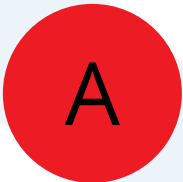
2 Testing

- Unit testing
- Integration testing
- System testing
- Acceptance testing

3 How to...

- Unit test
- Automate

Bugs



How many bugs in a 1000 line program?

Bugs

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How many bugs in a 1000 line program?

- Industry average 15-85 per KLOC.
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How many lines of code in something like Office?

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How many make it through to the customer?

- 0.5-3 per KLOC.
- How do we get it so low?
 - Testing.

Bugless

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Your code will have bugs.

- The gold standard for perfect code belongs to.....

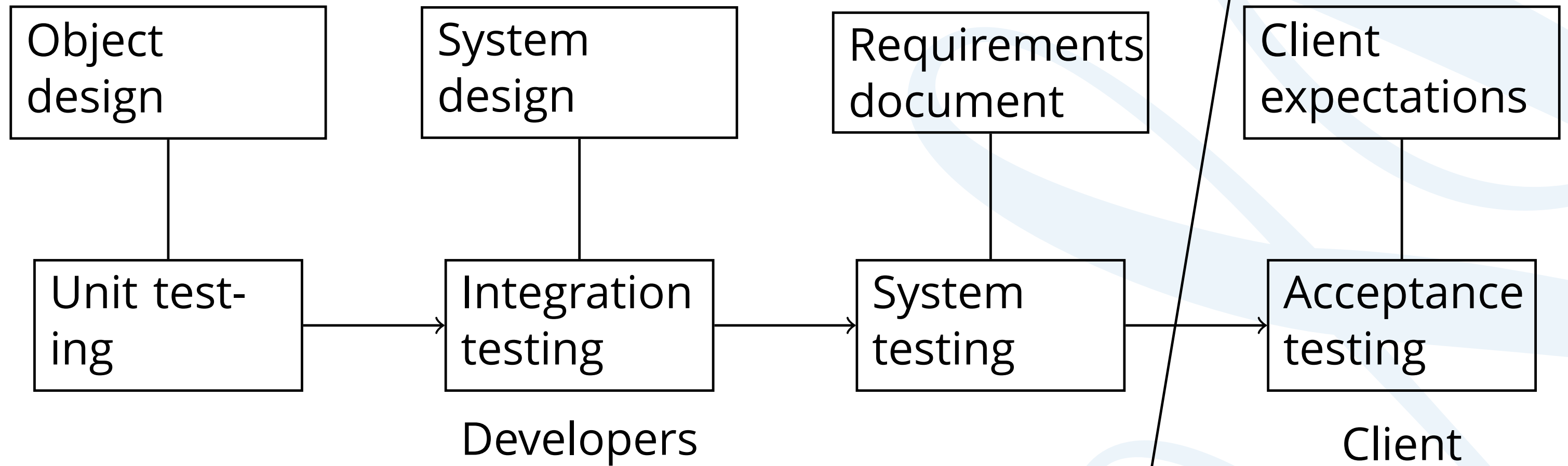
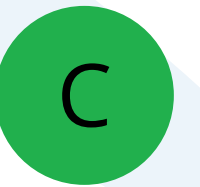
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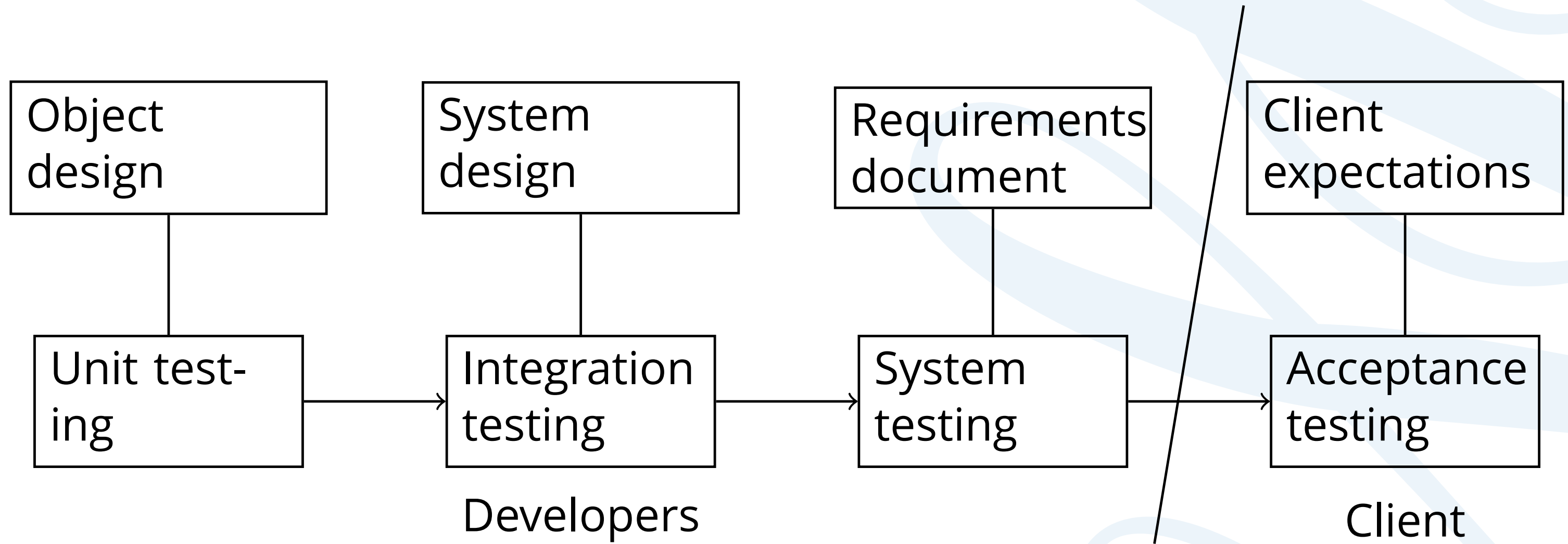
–Every programmer ever

Your code will have bugs.

- The gold standard for perfect code belongs to....The Space Shuttle.
- 420,000 lines of code.
 - Expect between 210 and 720 bugs.
- In 1996 the previous 3 versions had one known bug each.
 - 0.0024 per KLOC.

Testing types





- Ad-hoc
- Acceptance
- Accessibility
- Agile
- API
- Automated
- All Pairs
- Beta
- Black Box
- Backward Compatibility
- Boundary Value

- Bottom up Integration
- Branch
- Compatibility
- Component
- Condition Coverage
- Dynamic
- Decision Coverage
- End-to-end
- Exploratory
- Equivalence Partitioning
- Functional

- GUI
- Glass box
- Gorilla
- Happy path
- Integration
- Interface
- Internationalization
- Keyword-driven
- Load
- Localization
- Negative

- Pair
- Performance
- Penetration
- Regression
- Risk based
- Smoke
- Security
- Sanity
- Scalability
- Stability
- Static

- System
- Soak
- System Integration
- Unit
- Usability
- User Acceptance
- Volume
- Vulnerability
- White box

More than bugfixing

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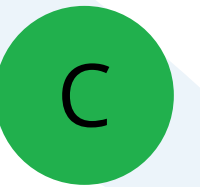
Testing is not just about code.

- Testing expectations, documentation.
- Testing assumptions.

Absence of evidence is not evidence of absence.

- Just because you can't find the bugs doesn't mean they aren't there.

- Formal verification is the exception.
 - Mathematically proof of correctness.
 - Mathematical model of an algorithms.
 - Can still mess up the code.



Once you've written your code, what is the most important step?

- Testing happens continuously during development.
 - Code compiles/runs/works?

Once you've written your code, what is the most important step?

- Testing happens continuously during development.
 - Code compiles/runs/works?
- Important to do formal testing
 - Just checking it runs as you code is not enough.
 - Make sure you've not missed anything
 - In depth, comprehensive testing.
- Extra attention to edge cases.
 - I.e. if code expects number between 0 and 100 make sure to test -1, 0, 1, 99, 100 and 101.
- Every return path.
 - I.e. every if-else.

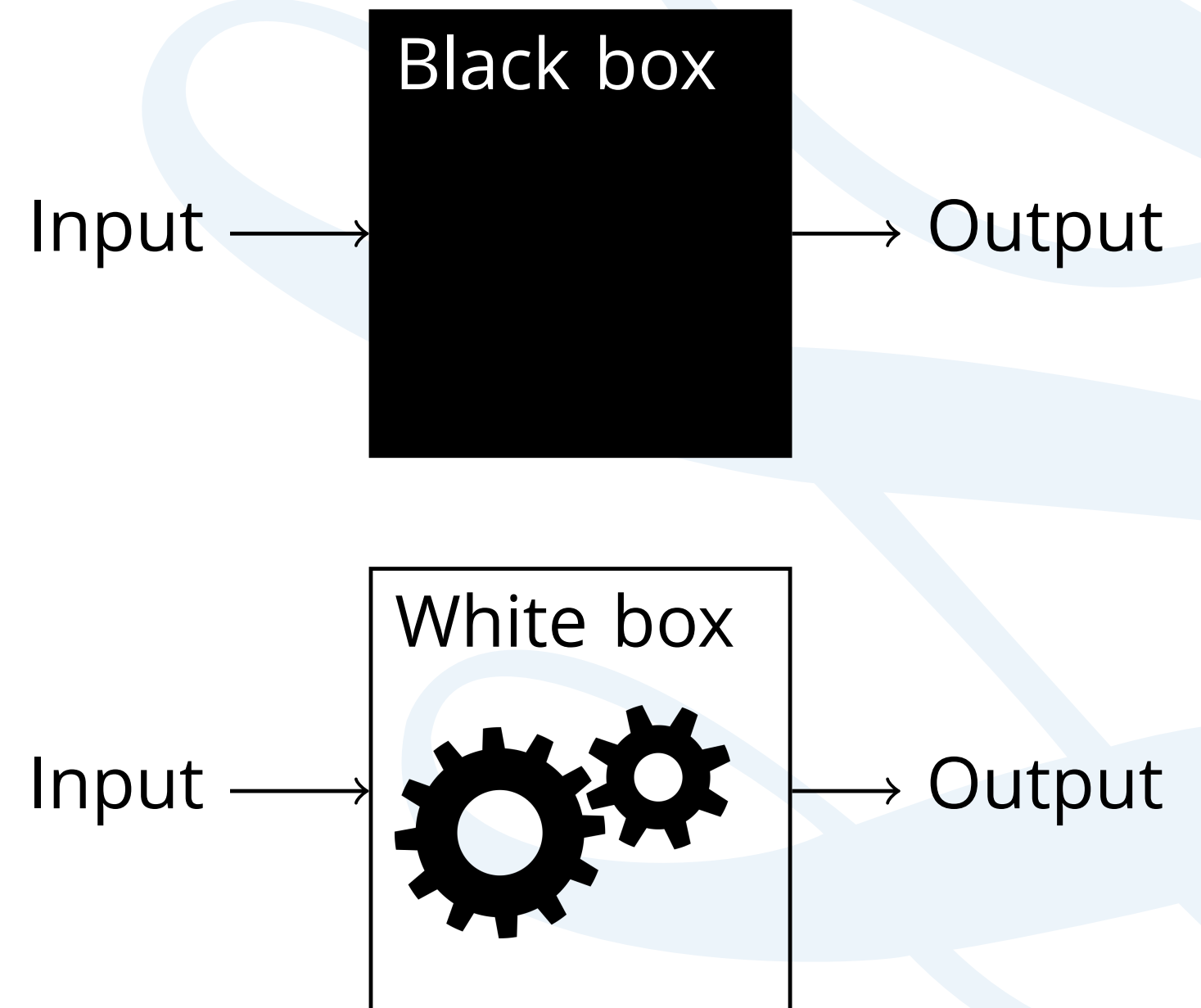
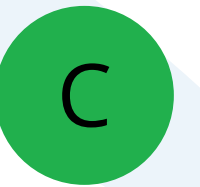
Test each individual 'unit' of your program.

- Python/C++ lets you break your code into modules
 - import/include modules
- Test each module separately
 - Everything module can do
 - Works correctly.
 - Fails correctly.
- Can be white or black box.
 - White box - know/care how module works inside.
 - Black box - don't know/care how module works inside.
- Version control is great help here.
 - Multiple programmers working on separate units.
 - Commit code only if it passes unit testing.

Black and white box testing

- Black box.
 - Don't see/know what's going on inside.
 - Just supply inputs, test outputs.
- White box.
 - Do see/know what's going on inside.
 - Test internal states/variables.

Black box White box



Integration testing

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Test how multiple modules/units work together when combined.

- Individual modules treated as black boxes.
 - Don't care how they work.
 - Just care what they do.
- Make sure everyone is following agreed interfaces.
 - Function names/parameters etc.
 - Behaviour hasn't changed.
- Continuous integration.
 - Bring together everyone's latest code several times a day.

System testing



Test system meets the specifications.

- Test the whole system works together.
- Black box testing.
- Ideally done by someone other than the developer/s.

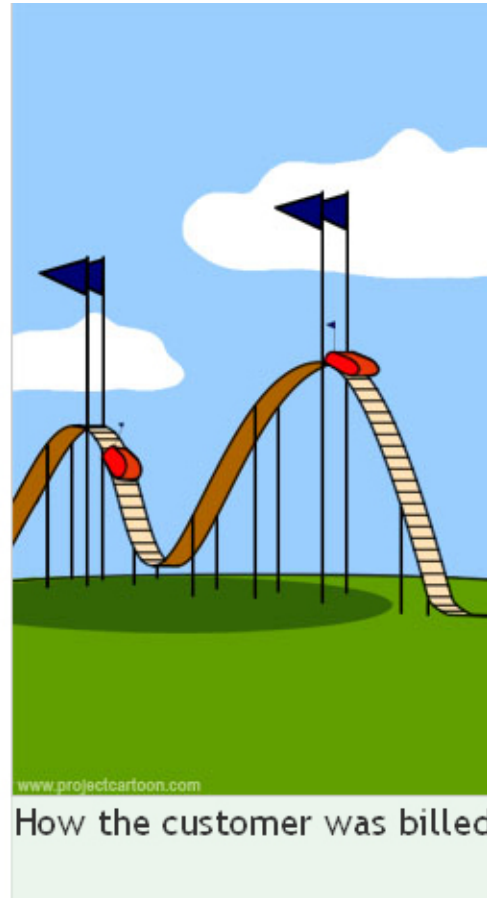
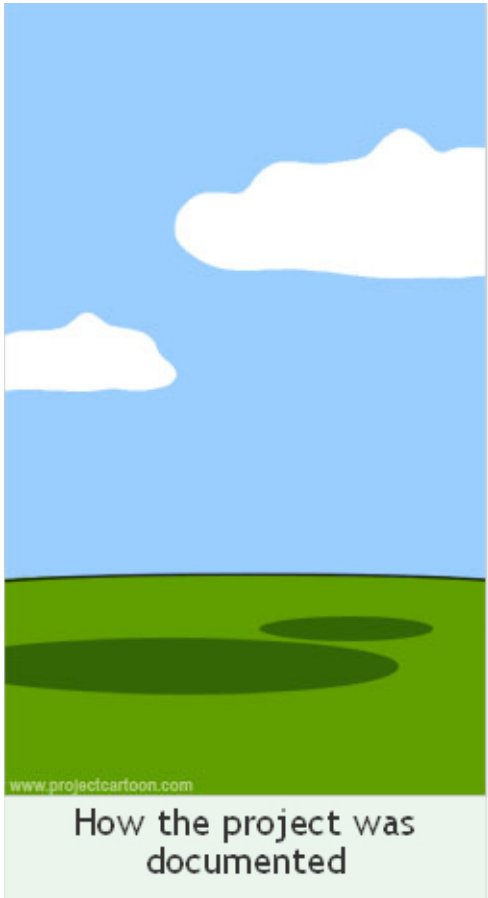
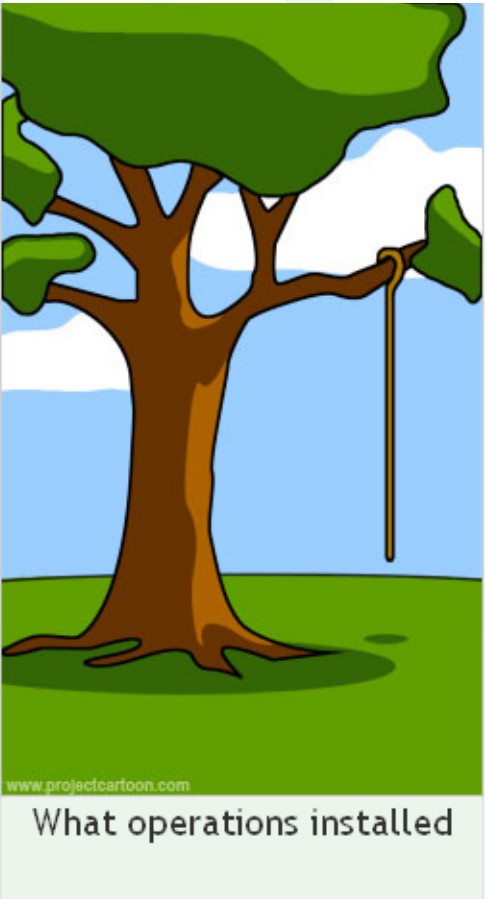
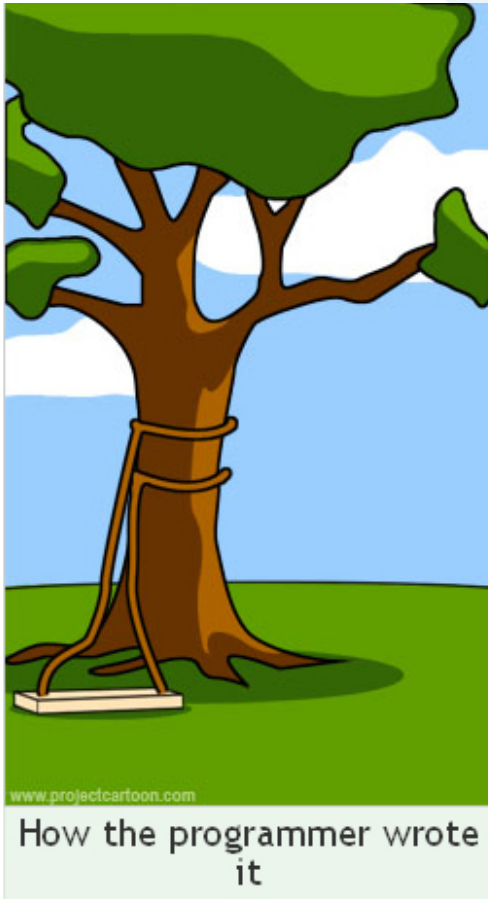
Acceptance testing



Not testing code directly.

- Testing expectations.
- Does the whole thing work as expected?
 - Were specifications correct?
 - Were specifications complete?

Expectations



How to Unit test your Dragon I



Just looking at unit testing in 122COM.

Good unit testing is very time consuming.

- Should be testing before committing any changes.

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Why bother??

- Debugging is simpler, know where bugs are.
- Bugs stay dead (or detected).
 - Spot new bugs.
- Every 3 bugs solved creates 1 new one (Glenford Myers - Art of Software Testing).

How to Unit test your Dragon II



Basic unit testing.

- Grab your spreadsheet.
- Example - testing your stack code from data structures week.

ID	Description	Test	Expected	Success	Why
1a	Push to empty stack	.push('A')	.size() =1, .top() = 'A'	Pass	
1b	Push to full stack	.push('Z')	StackFull exception	Pass	
1c	Push to !full !empty stack	.push('Q')	.size() += 1, .top() = 'Q'	Pass	
2a	Pop from empty stack	.pop()	StackEmpty excep- tion	Fail	No exception raised
2b	Pop from full stack	.pop()	.size() -= 1, .top() = el- ement at .size()-1	Pass	
2c	Pop from !full !empty stack	.pop()	.size() -= 1, .top() = el- ement at .size()-1	Pass	

I don't wanna



Running unit tests manually is a massive time sink.

■ Solution?

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- Solution?



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Running unit tests manually is a massive time sink.

- Solution?
 - Automate our testing.
 - Write code to test our code.



Automated unit testing

C

Already encountered this idea in this module.

- C++ intro, searching, pointers, data structures and sorting labs.
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Automated unit testing

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Advantages.

- Fully tested your code.
 - Every time.
- Quickly tested your code

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Disadvantages.

- Messy, confusing testing code.
- Results not clear.

Automated unit testing libraries

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Solution?

- Unit testing libraries.
- Available for every significant language I can think of.
 - Multiple libraries per language.
- Same concept
 - Write small test functions.
 - Run them all.
 - Report what failed and summary.

Using unittest module.

- Built in.
- Test ways things are correct.
- Test that things go wrong.
 - Test for expected exceptions.

```
import unittest

class Tests(unittest.TestCase):
    def test_bigger(self):
        self.assertTrue( 1 < 0 )

    def test_equals(self):
        self.assertEqual( 1+1, 2 )

    def test_div(self):
        with self.assertRaises(ZeroDivisionError):
            1 / 0

if __name__ == '__main__':
    unittest.main()
```

lec_unittest.py

Python testing results

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F..

=====

FAIL: test_bigger (__main__.Tests)

Traceback (most recent call last):

File "lec_unittest.py", line 5, in test_bigger

self.assertTrue(1 < 0)

AssertionError: False is not true

Ran 3 tests in 0.000s

FAILED (failures=1)

Using cxxtest.

- Very similar to Python unittest.
- Slightly more complicated to run.
- Header file, .h file.

```
#include <cxxtest/TestSuite.h>

class SomeTests : public CxxTest::TestSuite
{
public:
    void test_bigger()
    { TS_ASSERT( 1 < 0 );
    }

    void test_equals()
    { TS_ASSERT_EQUALS( 1+1, 2 );
    }

    void test_except()
    { TS_ASSERT_THROWS_ANYTHING( throw 1 );
    }
};
```

lec_unittest.h

C++ testing results



```
Running cxxtest tests (3 tests)
In SomeTests::test_bigger:
lec_unittest.h:8: Error: Assertion failed: 1 < 0
..
Failed 1 and Skipped 0 of 3 tests
Success rate: 66%
```


Running the tests

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Python

- Just run it.

```
>> python3 -m unittest TESTCASES.py
```

If you have `unittest.main()`

```
>> python3 TESTCASES.py
```

C++

- Generate a 'runner' that will actually run the tests.

```
>> cxxtestgen --error-printer TESTCASES.h -o runner.cpp
```

- Compile the runner.

```
>> g++ --std=c++11 runner.cpp -o runner
```

- Run the runner.

```
>> ./runner
```

putUp, tearDown

1

Running multiple tests.

- Will have lots of commonalities.
- Each test run on fresh structure.
 - I.e. testing stack/queue
- Have to create/clean up structure for every test.
 - Is hassle.
- Built in feature to do it for you.
 - `setUp()`
 - `tearDown()`

putUp, tearDown II

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```
from lab_stack import *
import unittest

class StackTest(unittest.TestCase):
    def setUp(self):
        self.testvalues = 'abcde'
        self.s = Stack( len(self.testvalues) )

    def tearDown(self):
        pass

    def test_size(self):
        """ test that stack reports the correct number of things
        on the stack """
```

Can be integrated into projects in many ways.

- Build scripts - every time you compile, tests run automatically.
- Commit tests - every time you try and commit a new version, tests run automatically.
- Reports - automatically generate reports on current bugs, track progress.

Quiz

Recap

- Unit test - test individual 'units' of code.
 - Functions, classes etc.
- Integration test
 - Test multiple units work correctly when combined.
- System test.
 - Test the whole thing matches what the user said they wanted.
- Acceptance test.
 - User/s test what they said they wanted is what they actually wanted.
- Automated unit testing.
 - What is it?
 - Why do it?
 - How to do it.

The End