CS420/520 — Object-oriented Programming

Testing

If it's not in version control, it doesn't exist

If it's not tested, it doesn't work

The only software that won't change is
software that nobody uses

Why Unit Testing?

- *If it is not tested, it does not work*
- Tests represent an *executable specification* of what the methods *ought* to do
  - non-executable specifications gather dust on shelves.

Why Unit Testing (2)

- The more time between coding and testing:
  - More effort is needed to write tests
  - More effort is needed to find bugs
  - Fewer bugs are found
  - Time is wasted working with buggy code
  - Development time increases
  - Quality decreases

Why Unit Testing (3)

- Without unit tests:
  - Code integration is a nightmare
    - Changing code required more courage than I have!

Why Automated Tests?

- What is wrong with:
  - Using print statements?
  - Writing comments that exercise your code?
  - Writing extra methods that exercise your code?
  - Writing small workspace scripts to run code?
  - Running program and testing it by using it?

A testing method should:

- Work with n programmers working for k months (years)
- Help when modifying code 6 months after it was written
- Check impact of code changes on rest of system
- Work in a school project as well as in industry
  - This is probably unrealistic!
- Help to build good habits and skills

We have a QA Team, so why should I write tests?

- How long does it take QA to test your code?
- How much time does your team spend working around bugs before QA tests?
- How easy is it to find & correct the errors after QA finds them?
- Most programmers already have an informal testing process
- With a *little* more work you can develop a useful and *reusable* test suite

When to Write Unit Tests

- *First* write the tests — *T*est *D*riven *D*evelopment
- *Then* write the code to be tested
- Writing tests first saves time!
  - Makes you aware of the interface & functionality of the code
  - Removes temptation to skip tests

SUnit (JUnit, gUnit, …)

- Free frameworks for Unit testing
- SUnit originally written by Kent Beck 1994
- Built into VisualWorks, Squeak, ...
- JUnit written by Kent Beck & Erich Gamma
- gUnit written by Andrew Black, 2012–

Not just for Smalltalk & Grace

- Ports are available in:

Java .NET Ada AppleScript C
C# C++ Curl Delphi
Eiffel Eiffel Flash Forte 4GL
Gemstone/S Haskell HTML Jade
LISP Objective-C Oracle Palm
Perl Php PowerBuilder Python
Ruby Scheme Smalltalk Visual Basic
XML XSLT

The *minitest* dialect

- *minitest* is a Grace dialect that provides a veneer over gUnit.
- It means that you don't have to remember the syntactic details of using "raw" gUnit — what to inherit from, what to define, etc.
- it has essentially the same functionality.
- *minispec* is the same thing, but with BDD language

Don’t let slow tests bog you down

- Michael Feathers (http://tinyurl.com/87nj2) writes:
- A test is not a unit test if:
  - It talks to the database
  - It communicates across the network
  - It touches the file system
  - It can't run at the same time as any of your other unit tests
  - You have to do special things to your environment (such as editing config files) to run it.

Rationale

- Tests that do these things aren't bad. Often they are worth writing, and they can be written in a unit test harness.
- However, it is important to be able to separate them from true unit tests so that we can keep a set of tests that we can run fast whenever we make our changes.

Acceptance Tests *vs.* Unit Tests

- Unit tests:
  - capture one piece of functionality
  - make it easier to identify bugs in that functionality
- Acceptance tests (aka Functional tests)
  - represent a scenario in the larger application
  - Tests that break Feathers' rules may make good acceptance tests.

Acceptance Tests

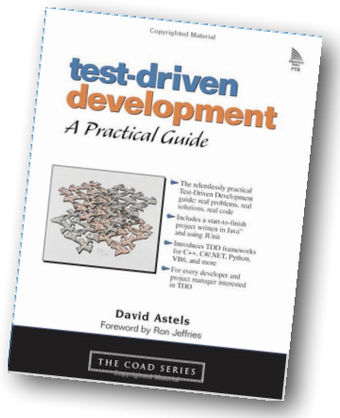
- Example: a compiler
  - one test for each possible source language statement, makes assertions about the emitted code
    - might exercise many classes, read and write from the file system …
- You can put such tests in *x*Unit
  - but separate them from the true unit tests (why?)

How to test a client

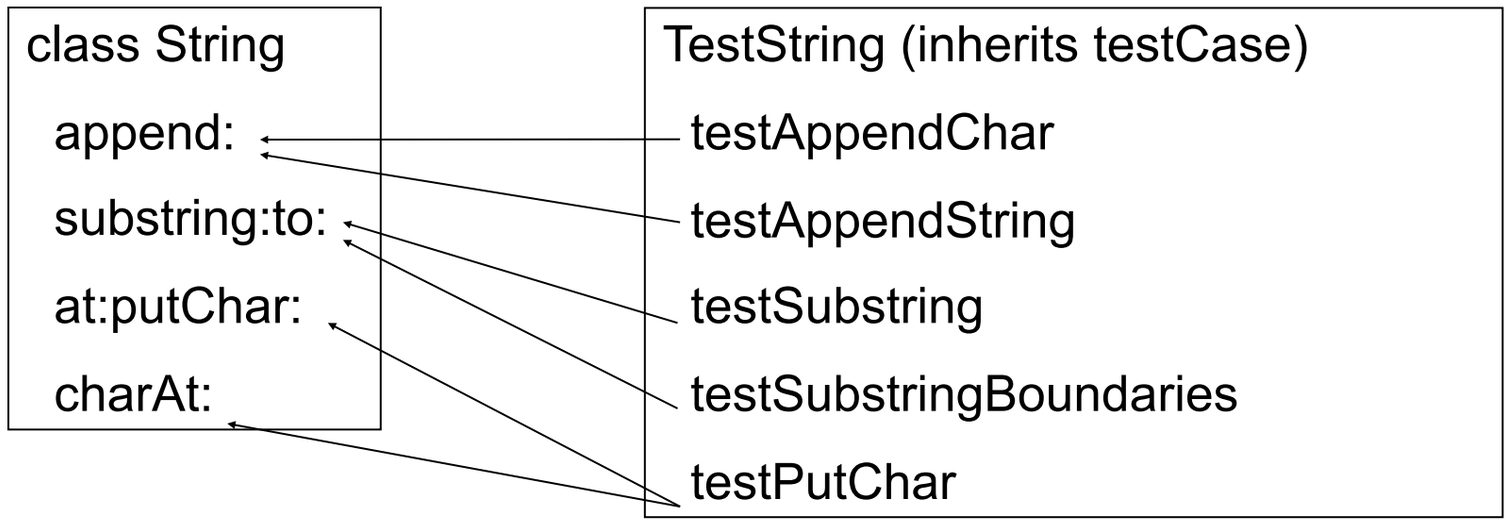
- So, your job is to write a client that interacts with a database. How do you test it?

- Use *Fake Objects* to simulate the database

— http://www.mockobjects.com
Test Driven Development, A
— *Practical Guide* by David Astels



Coverage


class String
append:
substring:to:
at:putChar:
charAt:
TestString (inherits testCase)
testAppendChar
testAppendString
testSubstring
testSubstringBoundaries
testPutChar

Asserting more things

- `assert() description`
  takes what you expect to be true
- `deny()description`
  takes what you expect to be false
- `assert{}shouldRaise`
  takes a block and the kind of error it should raise
- `assert()hasType`
  asserts that the expression has all of the methods of the type

Unit Tests: More Details

- The `setUp` method happens before each test*X* method (the framework ensures this)
- The `tearDown` method happens after

Best Practices

- Test everything that you want to work
- More test methods in your TestCase than in the class you are testing
- Tests should be as fine grained as possible
- Tests should be independent
- Should not take long to run (a few seconds)
- Easy to understand: tests read like a specification

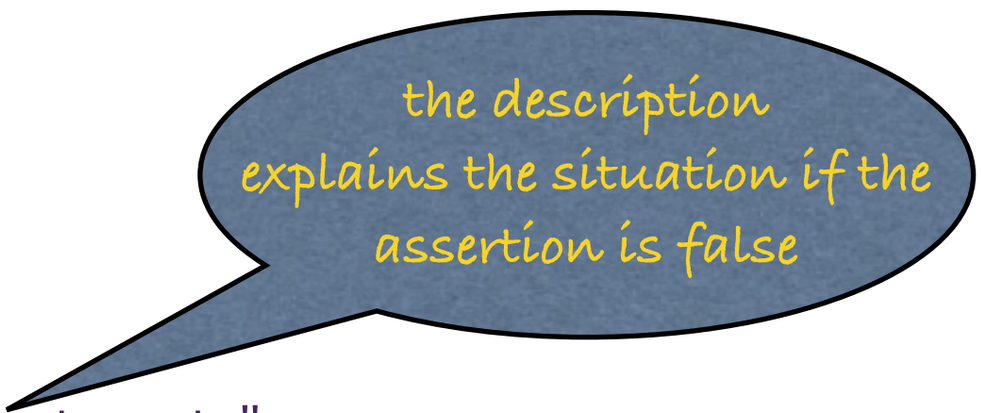
Black's rule of testing

- Clearly:
  - For every important property, there should be a test
- Not so obvious:
  - For every test, there should be a property, such that when the test passes, your confidence in the property increases
  - Multiple tests of same property are bad (why?)

Have a property in mind
when you write a test

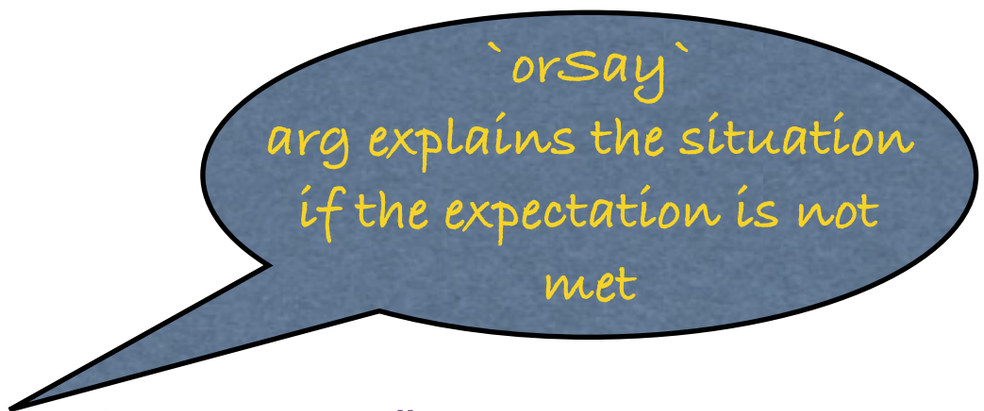
Tests as Specification

```
dialect "minitest"

testSuiteNamed "set tests" with {
    test "a new set is empty" by {
        def newSet = set [ ]
        assert (newSet.isEmpty) description "a new set is not empty"
    }
    test "sets don't contain duplicates" by {
        def s = set ["one"]
        assert (s.size) shouldBe 1
        s.add "one"
        assert (s.size) shouldBe 1
    }
    test "even if an element has been added twice, it's in the set just once" by {
        def s = set ["one"]
        s.add "one"
        s.remove "one"
        assert (s.isEmpty) description "after removing its single element, set is not empty"
    }
}
```



BDD makes Specification View Clear

```
dialect "minispec"

describe "set tests" with {
    specify "a new set is empty" by {
        def newSet = set [ ]
        expect (newSet.isEmpty) toBe true orSay "a new set is not empty"
    }
    specify "sets don't contain duplicates" by {
        def s = set ["one"]
        expect (s.size) toBe 1
        s.add "one"
        expect (s.size) toBe 1
    }
    specify "even if an element has been added twice, it's in the set just once" by {
        def s = set ["one"]
        s.add "one"
        s.remove "one"
        expect (s.isEmpty) toBe true orSay "after removing its single element, set is not empty"
    }
}
```



So why Unit Test?

- Not much work to write or run
- Documents your class
- Gives you and others confidence that your code works
- No need to wait for “testing team”
- Tests are fined grained – can be run independently
- Tests can be aggregated easily
- Which tests fail give you a hint of where a bug was introduced
- Provides a fairly-complete regression test

What is Test-Driven Development?

- A different way to build software
- A strict development method:
  - Add a test.
  - Run the test.
  - Make a small change.
  - Run the tests again. (If they fail, go back to 3)
  - Refactor (while testing)

Where did this come from?

- Test-First Development (+refactoring)
- A practice of Extreme Programming
  - Accept and love change
  - Release early, release often
- There are many supposed advantages, but we'll discuss those after we try it

So why Test-first?

- You always know what to do next: write a test or make a test pass
- You test code while you are writing it, instead of after you have forgotten about it
- Your tests are always up to date – no backlogs of testing to-do
- You take the customer's point of view – what do I really want the code to do
- The code you have is exactly what is requested – no more, no less

Patterns for Testing

Simple Smalltalk Testing: With Patterns

Kent Beck,
First Class Software, Inc.
KentBeck@compuserve.com

http://swing.fit.cvut.cz/projects/stx/doc/online/english/tools/misc/testfram.htm