

CS1632, Lecture 7: Test-Driven Development

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THE DARK AGES

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Nowadays...

- ▶ We know how important tests are to prevent issues like that
- ▶ Code quality is everyone's responsibility, including developers'
- ▶ Developers write tests (usually unit tests)

But...

- ▶ What to test?
- ▶ How deep to go into testing?
- ▶ How many edge cases?
- ▶ How to prioritize testing and development?
- ▶ What order should I write tests?
- ▶ How do I structure code to be testable?

There is no one right answer

- ▶ Many studies done
- ▶ Different domains, different developers, different languages, etc...
- ▶ “No silver bullet”

Test-Driven Development

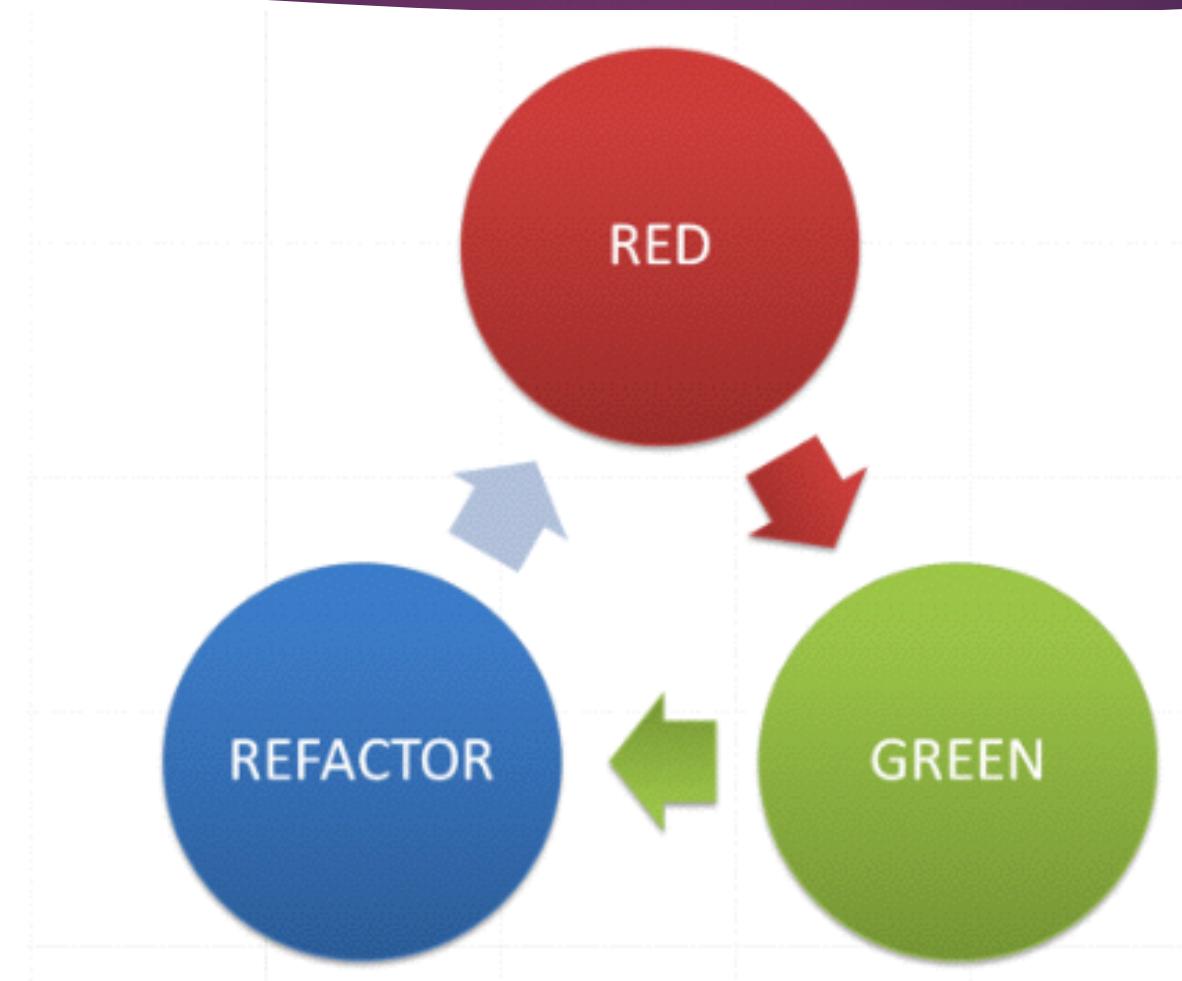
- ▶ A strategy for developing highly tested, quality software
- ▶ Not the be-all and end-all of strategies
- ▶ Google “TDD is dead” for a great argument against it
- ▶ Welcome to the still-forming world of software development!

So What is TDD?

A software development methodology that comprises:

1. Writing tests BEFORE writing code
2. Writing ONLY code that is tested
3. Writing ONLY tests that test the code
4. A very short turnaround cycle
5. Refactoring early and often

The Red-Green-Refactor Loop



The Red-Green-Refactor Loop

- ▶ Red – Write a test for new functionality
 - ▶ This should immediately fail!
- ▶ Green
 - ▶ Write only enough code to make the test pass
- ▶ Refactor
 - ▶ Review code and make it better

Detailed Run-Through of RGR Loop

1. Write a test for new functionality
2. Run test suite - only the new test should fail
3. Write only enough code to make test pass
4. Run test suite
5. If any tests fail, go to step 3
6. Refactor code
7. Run test suite
8. If any tests fail, go to step 6
9. If any more functionality, go to step 1; otherwise done

TDD = A Kind of Test-First Development

- ▶ Basic idea is to think about expected behavior FIRST, before code
 - ▶ You don't want to “corrupt” your mind with implementation details
 - ▶ Figure out what the program should do (requirements!)
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- ▶ Side note: there are other kinds of test-first development, such as ATDD (Acceptance Test Driven Development) and BDD (Behavior Driven Development)

Step 1 – Write a test

- ▶ This test should be a small unit of functionality, say one input value and output value for a method.
- ▶ For pure TDD, you should not write multiple tests or tests which are very complex.

Step 2 – Run Test Suite

- ▶ Run all the tests - only the one you've just added should fail.
- ▶ If it doesn't fail, you've already written the code for it! This might be a redundant test.
- ▶ If other tests fail, something weird happened. Completed tests should always be passing at this point.

Step 3 – Write the Code

- ▶ Write just enough code to have the test pass.
- ▶ Avoid the temptation to over-engineer your solution or add more functionality than the test covers!

Step 4 – Re-run the Test Suite

- ▶ All the tests should pass this time, assuming you actually added the functionality.
- ▶ Otherwise:
 - ▶ If only your new test fails:
 - ▶ You have not written your code (or possibly test) correctly.
 - ▶ If other tests fail:
 - ▶ You have created a regression failure; that is, you've broken other functionality on the system!
 - ▶ Note that these are not mutually exclusive!

Step 5 – Check Test Results

- ▶ If any tests fail, fix them – either tests or code!
- ▶ Never move on before having an ENTIRELY GREEN (i.e. passing) test suite!

Step 6 - Refactor

- ▶ Your first attempt at writing code will probably not be perfect
 - ▶ Poor algorithm choice?
 - ▶ Bad variable names?
 - ▶ Poor performance?
 - ▶ Badly documented?
 - ▶ Magic numbers?
 - ▶ Not easily comprehensible?
 - ▶ General bad design?

Step 6 - Refactor

- ▶ Remember – you already have a working version before you refactor
 - ▶ We know it works because it provides the correct expected behavior according to the unit test suite
- ▶ When it comes to code, being right is more important than being good-looking

Step 7 – Re-run Test Suite Again

- ▶ Make sure that your refactoring did not cause any problems
- ▶ It should have the same functionality (according to the unit test suite), just better code
- ▶ That is, all unit tests should still pass

Step 8 – Check test results

- ▶ If any tests fail, something broke.
- ▶ Go and fix it before moving on!
- ▶ We are always aiming to have all-green tests

Step 9 - Done

Congratulations! You now have working code and can prove it with a test.

If there is more functionality to add, go back to step 1 and write a new test.

If not, SHIP IT.

YAGNI

- ▶ "You Ain't Gonna Need It"
- ▶ Don't add functionality you don't need right now.
Chances are you won't need it and you're just going to waste time writing code for it.
- ▶ Code to the test!

Benefits of TDD

- ▶ Automatically create tests!
 - ▶ Research shows that more tests are correlated with fewer defects
- ▶ Makes writing tests easy because it's done often
 - ▶ Anything you do often, you learn how to do better
- ▶ Tests are relevant
 - ▶ They are testing the exact functionality you are implementing
- ▶ Developer is focused on end result, not code
 - ▶ Code is a way to get the functionality the user wants

Benefits of TDD

- ▶ Ensures that you take small steps
 - ▶ You know where defects lie; help localize errors
 - ▶ Research shows more senior engineers take smaller steps
- ▶ Code is extensible
 - ▶ You are already constantly extending the codebase
- ▶ Large test suite automatically created for you!
 - ▶ Helps avoid regression errors
 - ▶ High code coverage
- ▶ Confidence in the codebase

Drawbacks of TDD

- ▶ Focus on unit tests may mean other aspects of testing get short shrift
 - ▶ Remember that unit tests focus on small units of code, not integration
- ▶ Extra up-front time
 - ▶ May be saved in large projects due to fewer defects / test coverage
- ▶ May not appropriate for prototyping
 - ▶ You may not always know expected behavior
- ▶ Hard to do large architectural changes
 - ▶ Some things just aren't possible to do in small steps

Drawbacks of TDD

- ▶ Complex or mission/life-critical systems will require a more robust testing strategy
- ▶ Tests become part of the overhead of the project
 - ▶ Especially if they are brittle/fragile, or poorly written!
- ▶ Could fall into trap of overtesting
 - ▶ More time-consuming test suite runs, which hurts productivity
- ▶ Can be difficult to implement TDD on existing projects developed in a different paradigm
 - ▶ TDD assumes easy-to-write, fast-to-execute tests

Fizzbuzzin' With TDD

Print out the numbers from 1 to 100, each on a separate line. If a number is evenly divisible by 3, print "Fizz" instead. If a number is evenly divisible by 5, print "Buzz" instead. If a number is evenly divisible by 3 and 5, print "FizzBuzz" instead. Otherwise, just print the number.

1

2

Fizz

4

Buzz

Fizz

...

Result?

- ▶ We now have a working, tested implementation of FizzBuzz
- ▶ We have automated test coverage for all equivalence classes
- ▶ We had a path forward at all points