Test-Driven Development
JUnit

CSE 2311 - Software Development Project

Click to edit Master text styles
Second level
Third level
Fifth level

Tuesday, January 15, 2013

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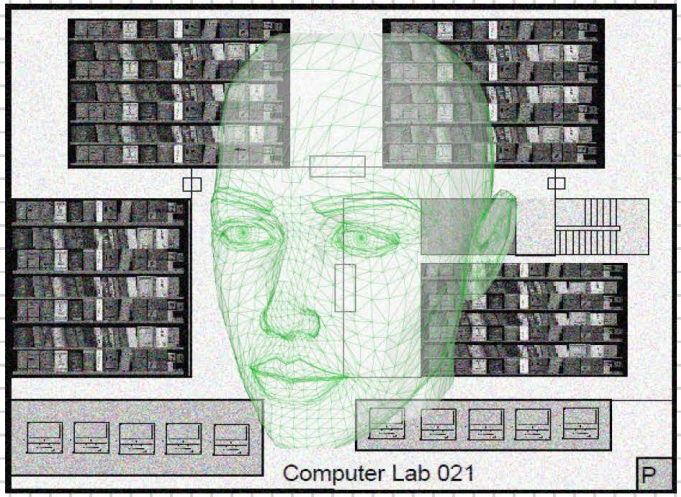
The Steacie Library

DUNGEON HACKFEST



WHAT: All day CODING!!! Lunch provided!
Work on a project, app, or widget.
CODE, COLLABORATE, AND CREATE!

WHERE: Steacie Library Basement
aka The Dungeon

WHEN: Thursday February 21, 2013

TIME: 0900 to 1730

REGISTER:
www.library.yorku.ca/cms/steacie/hackfest

Unit Testing

- Testing the internals of a class

- Black box testing
  - Test public methods
- Classes are tested in isolation
  - One test class for each application class

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What is TDD?

- Before you write code, think about what it will do.
- Write a test that will use the methods you haven't even written yet.

- A test is not something you "do", it is something you "write" and run once, twice, three times, etc.
  - It is a piece of code
  - Testing is therefore "automated"
  - Repeatedly executed, even after small changes

- *The TDD slides are based on a slide set by Craig Murphy*

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What is TDD?

- TDD is a technique whereby you write your test cases before you write any implementation code

- Tests drive or dictate the code that is developed

- An indication of “intent”
  - Tests provide a specification of “what” a piece of code actually does
  - Some might argue that “tests are part of the documentation”

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TDD Stages

1. Write a single test.
2. Compile it. It should not compile because you have not written the implementation code
3. Implement just enough code to get the test to compile
4. Run the test and see it **fail**
5. Implement just enough code to get the test to pass
6. Run the test and see it **pass**
7. **Refactor** for clarity and "once and only once"
8. Repeat

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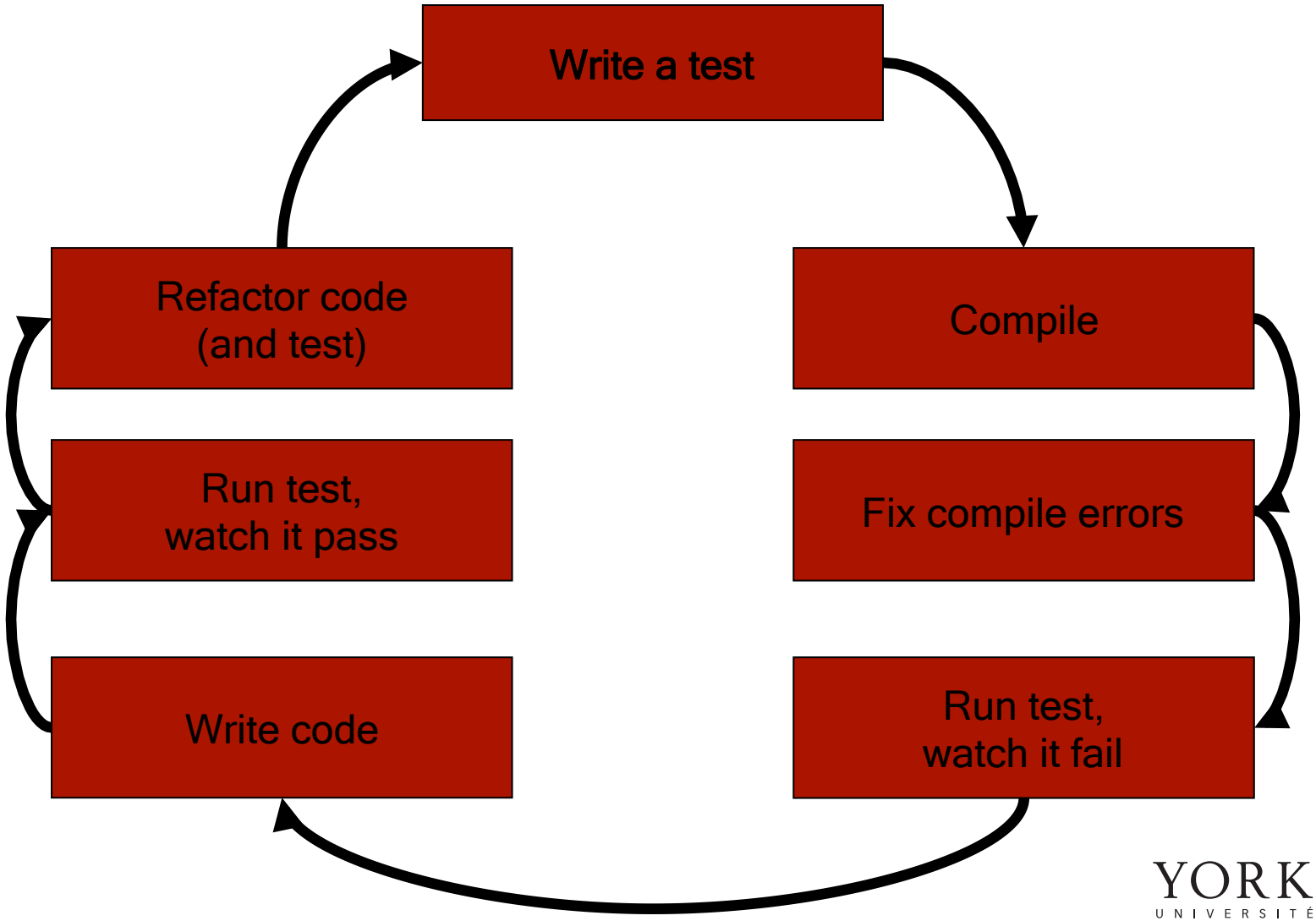
TDD Stages



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Why TDD?

- Programmers dislike testing
  - They will test reasonably thoroughly the first time
  - The second time however, testing is usually less thorough
  - The third time, well..
- Testing is considered a “boring” task
- Testing might be the job of another department / person
- TDD encourages programmers to maintain an exhaustive set of repeatable tests
  - Tests live alongside the Class/Code Under Test (CUT)
  - With tool support, tests can be run selectively
  - The tests can be run after every single change

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Summary

- TDD does not replace traditional testing
  - It defines a proven way that ensures effective unit testing
  - Tests are working examples of how to invoke a piece of code
    - Essentially provides a working specification for the code
- No code should go into production unless it has associated tests
  - Catch bugs before they are shipped to your customer
- No code without tests
- Tests determine, or dictate, the code

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Summary

- TDD means less time spent in the debugger

- TDD negates fear
  - Fear makes developers communicate less
  - Fear makes developers avoid repeatedly testing code
    - Afraid of negative feedback

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Summary

- TDD promotes the creation of a set of “programmer tests”
  - Automated tests that are written by the programmer
  - Exhaustive
  - Can be run over and over again
- TDD allows us to **refactor**, or change the implementation of a class, without the fear of breaking it
  - TDD and refactoring go hand-in-hand
- With care, [some] User Acceptance Tests can be codified and run as part of the TDD process

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Resources

- JUnit: http://junit.sourceforge.net
- NUnit: http://www.nunit.org
- CSUnit: http://www.csunit.org

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XP approach to testing

- In the Extreme Programming approach
  - Tests are written before the code itself
  - If the code has no automated test cases, it is assumed not to work
  - A testing framework is used so that automated testing can be done after every small change to the code
    - This may be as often as every 5 or 10 minutes
  - If a bug is found after development, a test is created to keep the bug from coming back

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XP consequences

- Fewer bugs
- More maintainable code
- The code can be refactored without fear
- Continuous integration
  - During development, the program *always works*
  - It may not do everything required, but what it does, it does right

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JUnit

- JUnit is a framework for writing tests
  - Written by Erich Gamma (of Design Patterns fame) and Kent Beck (creator of XP methodology)
  - Uses Java features such as annotations and static imports
  - JUnit helps the programmer:
    - define and execute tests and test suites
    - formalize requirements
    - write and debug code
    - integrate code and always be ready to release a working version

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Terminology

- A test fixture sets up the data (both objects and primitives) that are needed for every test
  - Example: If you are testing code that updates an employee record, you need an employee record to test it on
- A unit test is a test of a *single* class
- A test case tests the response of a single method to a particular set of inputs
- A test suite is a collection of test cases
- A test runner is software that runs tests and reports results

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Structure of a JUnit test class

- To test a class named **`Fraction`**
- Create a test class **`FractionTest`**

```
import org.junit.*;
import static org.junit.Assert.*;
public class FractionTest
{
        …
}
```


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Test fixtures

- Methods annotated with `@Before` will execute before every test case
- Methods annotated with `@After` will execute after every test case

```
@Before
public void setUp() {…}
@After
public void tearDown() {…}
```


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Class Test fixtures

- Methods annotated with `@BeforeClass` will execute once *before* all test cases
- Methods annotated with `@AfterClass` will execute once *after* all test cases
- These are useful if you need to allocate and release expensive resources once

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Test cases

- Methods annotated with `@Test` are considered to be test cases

```
@Test
public void testadd() {…}
@Test
public void testToString() {…}
```


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What JUnit does

- For *each* test case t:
  - JUnit executes all `@Before` methods
    - Their order of execution is not specified
  - JUnit executes t
    - Any exceptions during its execution are logged
  - JUnit executes all `@After` methods
    - Their order of execution is not specified
- A report for all test cases is presented

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Within a test case

- Call the methods of the class being tested
- Assert what the correct result should be with one of the provided assert methods
- These steps can be repeated as many times as necessary
- An assert method is a JUnit method that performs a test, and throws an AssertionError if the test fails
  - JUnit catches these exceptions and shows you the results

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List of assert methods 1

- `assertTrue(boolean b)`
  `assertTrue(String s, boolean b)`
  - Throws an AssertionError if ***b*** is False
  - The optional message ***s*** is included in the Error
- `assertFalse(boolean b)`
  `assertFalse(String s, boolean b)`
  - Throws an AssertionError if ***b*** is True
  - All assert methods have an optional message

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Example: Counter class

- Consider a trivial “counter” class
- The constructor creates a counter and sets it to zero
- The increment method adds one to the counter and returns the new value
- The decrement method subtracts one from the counter and returns the new value
- An example and the corresponding JUnit test class can be found on the course website

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List of assert methods 2

- `assertEquals(Object ***expected***, Object ***actual***)`

- Uses the equals method to compare the two objects
- Primitives can be passed as arguments thanks to autoboxing
- Casting may be required for primitives
- There is also a version to compare arrays

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List of assert methods 3

- `assertSame(Object expected, Object actual)`
  - Asserts that two references are attached to the same object (using ==)

- `assertNotSame(Object expected, Object actual)`
  - Asserts that two references are not attached to the same object

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List of assert methods 4

- `assertNull(Object object)`
  Asserts that a reference is null
- `assertNotNull(Object object)`
  Asserts that a reference is not null
- `fail()`
  Causes the test to fail and throw an AssertionError
  - Useful as a result of a complex test, or when testing for exceptions

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Testing for exceptions

- If a test case is expected to raise an exception, it can be noted as follows

```
@Test(expected = Exception.class)
public void testException() {
   //Code that should raise an exception
   fail("Should raise an exception");
}
```


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The assert statement

- A statement such as

  ```
  assert boolean_condition;
  ```

  will also throw an AssertionError if the ***boolean_condition*** is false

- Can be used instead of the Junit assertTrue method

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Ignoring test cases

- Test cases that are not finished yet can be annotated with `@Ignore`
- JUnit will not execute the test case but will report how many test cases are being ignored

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JUnit in Eclipse

- JUnit can be downloaded from http://junit.sourceforge.net/
- If you use Eclipse, as in this course, you do not need to download anything
- Eclipse contains wizards to help with the development of test suites with JUnit
- JUnit results are presented in an Eclipse window

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Hello World demo

- Run Eclipse
- File -> New -> Project, choose Java Project, and click Next. Type in a project name, e.g. ProjectWithJUnit.
- Click Next
- Click Create New Source Folder, name it test
- Click Finish
- Click Finish

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Create a class

- Right-click on ProjectWithJUnit
  Select New -> Package
  Enter package name, e.g. **cse2311.week2**
  Click Finish
- Right-click on cse2311.week2
  Select New -> Class
  Enter class name, e.g. **HelloWorld**
  Click Finish

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Create a class - 2

- Add a dummy method such as
  public String say() { return null; }
- Right-click in the editor window and select Save

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Create a test class

- Right-click on the HelloWorld class
  Select New -> Junit Test Case
- Change the source folder to test as opposed to src

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Create a test class

- Check to create a setup method
- Click Next
- Check the checkbox for the say method
  - This will create a stub for a test case for this method
- Click Finish
- Click OK to “Add JUnit 4 library to the build path”
- The HelloWorldTest class is created
- The first version of the test suite is ready

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Run the test class - 1st try

- Right click on the HelloWorldTest class
- Select Run as -> JUnit Test
- The results appear in the left
- The automatically created test case fails

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Create a better test case

- Import the class under test
```
import cse2311.week2.HelloWorld;
```
- Declare an attribute of type HellowWorld
```
HelloWorld hi;
```
- The setup method should create a HelloWorld object
```
hi = new HelloWorld();
```
- Modify the testSay method body to
```
assertEquals("Hello World!",
                hi.say());
```


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Run the test class - 2nd try

- Save the new version of the test class and re-run
- This time the test fails due to expected and actual not being equal
- The body of the method say has to be modified to
  `return("Hello World!");`
  for the test to pass

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Create a test suite

- Right-click on the cse2311.week2 package in the test source folder
- Select New -> Class. Name the class **AllTests**.
- Modify the class text so it looks like class AllTests on the course website
- Run with Run -> Run As -> JUnit Test
- You can easily add more test classes

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