

Test Driven Development & Behavior Driven Development

in Java and React with Daniel Hinojosa



Behavior Driven Development



How the customer explained it



How the project leader understood it



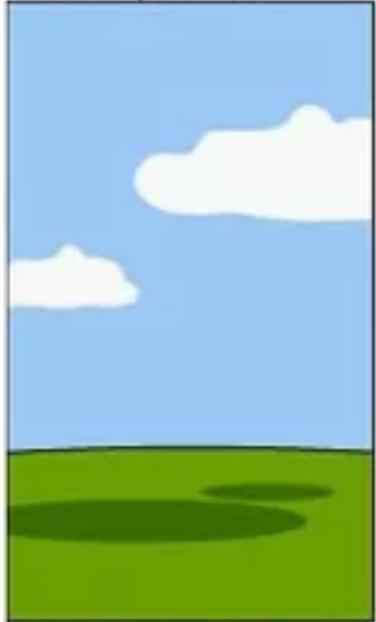
How the engineer designed it



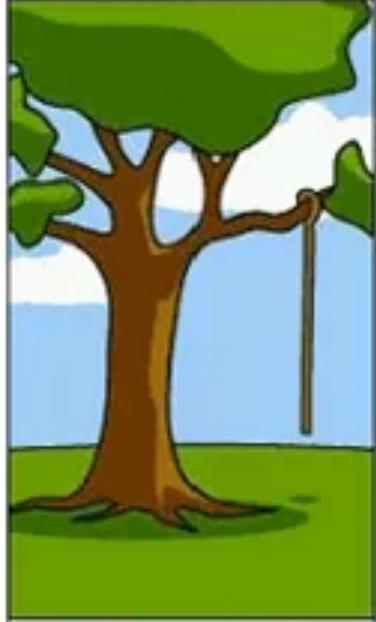
How the programmer wrote it



How the sales executive described it



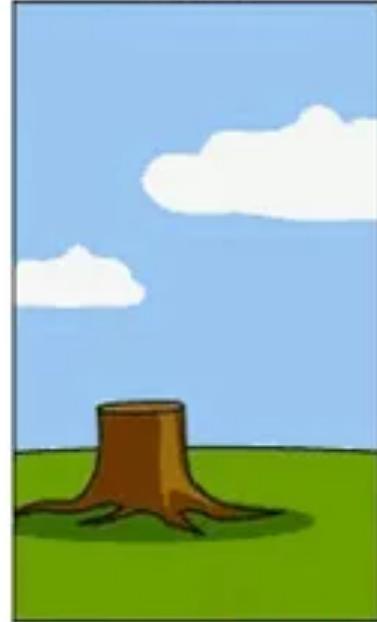
How the project was documented



What operations installed



How the customer was billed



How the helpdesk supported it



What the customer really needed

Behavior Driven Development

- Created by Dan North and Team at Thoughtworks
- Created as an extension to TDD
- Helps teams focus their efforts on identifying, understanding, and building valuable features that matter!
- Makes sure features are well designed and well implemented
- **A means of communication!**

BDD Practices

- Use conversations around concrete examples of system behavior to help understand how features will provide value to the business

BDD Collaboration

- BDD tools can help turn these requirements into automated tests that help guide the developer, verify the feature, and document what the application does

Excruciating Project Planning

1. Business Analyst has requirements
2. Requirements set on word processor
3. Requirements delivered to development team
4. Developer translates into code and unit tests (we hope)
5. QA then creates tests that verify the requirements
6. Code is retranslated into documentation

BDD The Easy Way

1. Business Analyst, QA, Developer share a list of requirements, and work on features, without code
2. Developer (and perhaps testers) uses BDD tool (JBehave, RSpec, Cucumber) into automated tests that verify that a feature is complete
3. QA uses the completed test for further testing
4. The BDD Tests are low-level documentation
5. The BDD Tests are also a checklist of features

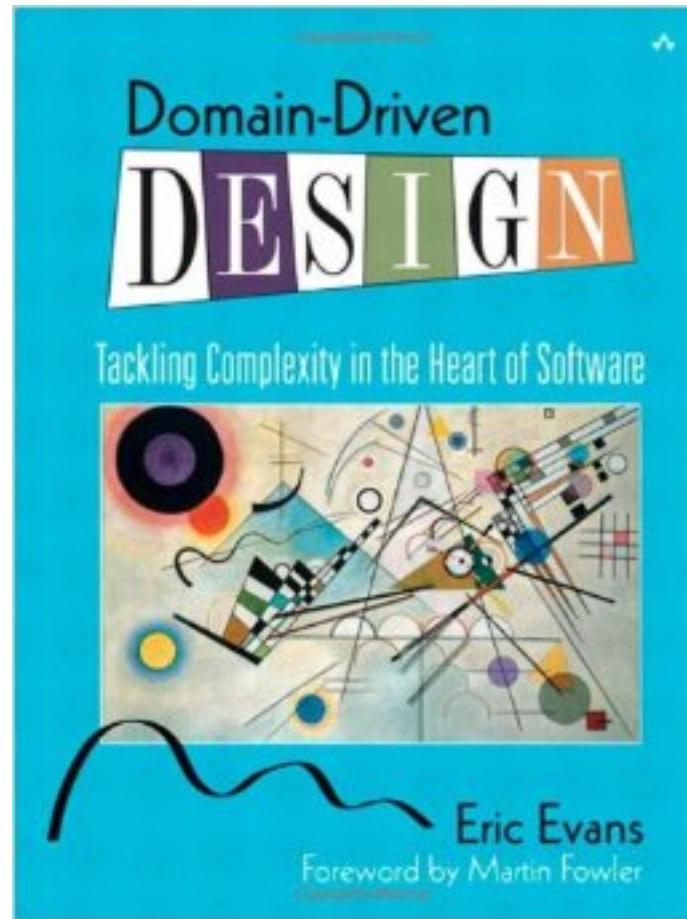
BDD so far...

1. Shared goals
2. Avoiding YAGNI*
3. Understand Stakeholders Goals
4. Manage Uncertainty
5. Reduce Risk



Domain Driven Design

- Eric Evans
- Created a business language
- Something business analysts and product owners can use *unambiguously*
- It is called *Gherkin!*







Gherkin by Example

Given a insurance policy

When a customer renews the policy

Then the policy must refer to record of payment

And the policy must update the expiration to one year from the current date

Gherkin with Scenarios

Scenario: Wilson posts to his own blog

Given I am logged in as Wilson

When I try to post to "Expensive Therapy"

Then I should see "Your article was published."

Scenario: Wilson fails to post to somebody else's blog

Given I am logged in as Wilson

When I try to post to "Greg's anti-tax rants"

Then I should see "Hey! That's not your blog!"

Scenario: Greg posts to a client's blog

Given I am logged in as Greg

When I try to post to "Expensive Therapy"

Then I should see "Your article was published."

Gherkin with Backgrounds

Feature: Feedback when entering invalid credit card details

In user testing we've seen a lot of people who made mistakes entering their credit card. We need to be as helpful as possible here to avoid losing users at this crucial stage of the transaction.

Background:

Given I have chosen some items to buy
And I am about to enter my credit card details

Scenario: Credit card number too short

When I enter a card number that's only 15 digits long

And all the other details are correct

And I submit the form

Then the form should be redisplayed

And I should see a message advising me of the correct number of digits

Scenario: Expiry date must not be in the past

When I enter a card expiry date that's in the past

And all the other details are correct

And I submit the form

Then the form should be redisplayed

And I should see a message telling me the expiry date must be wrong

Gherkin Keywords

- Feature
- Background
- Scenario
- Given
- When
- Then
- And
- But
- *
- Scenario Outline
- Examples

BDD is Evolutionary

- **It is not important to have everything known**
- Change is certain to happen
- Early feedback from the users and stakeholders needed to ensure that they're on track
- **Never wait until the end of the project to ask stakeholders if it meets specification**

Scenarios Begets Scenarios

- Scenarios can create other Scenarios
- Be flexible with your Scenarios
- Some Scenarios may not need to exist anymore
 - ...because things cannot be automated
 - ...because things are just too hard
 - ...because the payoff isn't that great



Cucumber

Cucumber

- An open source tool for executable specifications
- Gherkin syntax and glue to hook into testing
- Wide range of languages
 - JVM Languages
 - Ruby
 - JavaScript
 - More
- Features are plain text documents with no code

Sample Feature

Feature: As a stake holder, we should analyze our accepted risk given each plausible scenario to better serve the public and to maximize all possible sources of revenue.

Scenario: A person, under 30, in excellent health, should be provided a quote with a 1 risk.

Given a prospect

And a birth date of 1993-02-01

And a current date of 2016-05-01

And the health risk list is empty

When all the factors are taken into consideration

Then the quote risk should be 1

Cucumber Gherkin Lists

- Lists can be created in Gherkin
- Either as a comma delimited list in a statement
 - or as a list with a bar
- The Lists in Gherkin can be translated into a `java.util.List` or `java.util.Set` or `cucumber.api.DataTable`

Sample Feature with a List

Scenario: A person, over 30 and under or equal to 45, with high blood pressure, and high blood sugar should be provided a quote with a 5 risk.

Given a prospect
And a birth date of 1993-02-01
And a current date of 2016-05-01
And the health risk includes **High-Blood-Pressure**, **High-Blood-Sugar**
When all the factors are taken into consideration
Then the quote risk should be 5

Sample Feature with a Bar List

Scenario: A person, over 30 and under or equal to 45, with high blood pressure, and high blood sugar, and moderate cholesterol they should be provided a quote with a 5 risk.

Given a prospect

And a birth date of 1993-02-01

And a current date of 2016-05-01

And the health risk includes

| High-Blood-Pressure |

| High-Blood-Sugar |

| Moderate-Cholesterol |

When all the factors are taken into consideration

Then the quote risk should be 5

Scenario Outlines

- Perfect when you have several scenarios that follows the exact same number of steps, except with vastly different input and output
- Makes use of placeholders within the scenario outline as brackets
- Place holders are where you want the values to be inputted.

More on Scenario Outlines

- Requires an examples section.
- One Feature can have multiple Scenario Outlines
- One Scenario Outline can have multiple examples for categorization
- Scenario Outlines are just compiled down to multiple Scenarios
- Try to maintain only *key examples* to avoid example bloat

Scenario Outlines

Scenario Outline: A person with a certain table of elements, should be provided with the following table of risks

Given a prospect

And a birth date of <birth-date>

And a current date of <current-date>

And the health risk includes <health-risks>

When all the factors are taken into consideration

Then the quote risk should be <quote-risk>

Examples:

birth-date	current-date	health-risks	quote-risk
2000-01-30	2016-07-14		0
1978-01-30	2016-07-14	high-blood-pressure	1

Scenario Outlines With Labels

Scenario Outline: A person with a certain table of elements, should be provided with the following table of risks

```
Given a prospect
And a birth date of <birth-date>
And a current date of <current-date>
And the health risk includes <health-risks>
When all the factors are taken into consideration
Then the quote risk should be <quote-risk>
```

Examples: Low Risk

birth-date	current-date	health-risks	quote-risk
2000-01-30	2016-07-14		0
1978-01-30	2016-07-14	high-blood-pressure	1

Examples: Moderate Risk

birth-date	current-date	health-risks	quote-risk
2000-01-30	2016-07-14	Asthma, high-blood-sugar	2
1978-01-30	2016-07-14	high-blood-pressure, high-blood-sugar	4

Cucumber with Backgrounds

Since there is not enough room in slides

<https://github.com/cucumber/cucumber/wiki/Background>

BDD Important Reminders

- No Amigo should be left in isolation
- Product Owners are not left to write their own specs.
- You must collaborate!
- Really define business goals, don't just find filler
- Consider to express features as “Why would this bring us value?”
 - and “Who will this serve?”

What about Jasmine?



Jasmine

- BDD Style Framework for Javascript
- Availability in Different Languages/Framework
 - Node
 - Ruby
 - Python

Jasmine Example

```
describe('Person', function () {
  it('calls the sayHello() function', function () {
    var fakePerson = new Person();
    spyOn(fakePerson, 'sayHello');
    fakePerson.helloSomeone('world');
    expect(fakePerson.sayHello).toHaveBeenCalled();
  });
});
```

storytime

BDD & Cucumber

Cucumber/BDD To The Point

- “I [aslakhellesoy] am the creator of Cucumber, the biggest problem with Cucumber is that most people trying it out don’t understand what it is”
- “A Tool that facilitates *collaboration and software design*”

<https://news.ycombinator.com/item?id=10194242>

Cucumber/BDD To The Point

- You pop a story off your backlog and run a 20 min. meeting called a Discovery Workshop with the ... (Three amigos)
- *"You have a conversation about the story and come up with some concrete examples to describe the various acceptance criteria for your stories. Not in Cucumber's Gherkin language - just in plain conversational language."*
- *For example: "The one where I upload a picture that is too big". Or: "The one where there are five taxis in range". These conversations act as catalysts to uncover subtle details where business and IT might have a different understanding.*

<https://news.ycombinator.com/item?id=10194242>

Cucumber/BDD To The Point

- Two things can happen at the end of this short meeting. You ask people to do a thumbs-up or thumbs-down vote on whether they understand everything that needs to be done, and whether the story is small enough. If enough people give a thumbs down, you send the story back for further analysis, maybe breaking it up into something smaller. If it's mostly thumbs-up, you're good to go.

<https://news.ycombinator.com/item?id=10194242>

Cucumber/BDD To The Point

- After the 20 min. meeting you have 2-5 concrete examples that a developer (and perhaps a tester) can flesh out in more detail using Gherkin (Given-When-Then) to make it even more concrete. For example:

Scenario: Close taxis with higher rating win

Given taxi A with rating 0.8 is 1400m from the customer

And taxi B with 0.9 is 1500m from the customer

When the customer requests a taxi

Then taxi B should be assigned

Cucumber/BDD To The Point

- The dev shows the example to the business person, who confirms that this is right (or wrong).
- Now, the developer follows the regular TDD workflow, using the Scenario to guide the development of the core domain logic. The Cucumber scenario doesn't go through a UI using Selenium WebDriver or similar. The domain logic is implemented in such a way that external services, message queues and databases are stubbed out.

<https://news.ycombinator.com/item?id=10194242>

Cucumber/BDD To The Point

- Lower level unit tests are still written, and there are far more of those than Cucumber Scenarios.
- *Cucumber is there to make sure you write the right code.*
- *Unit testing tools are there to make sure you write the code right.*

<https://news.ycombinator.com/item?id=10194242>

Cucumber/BDD To The Point

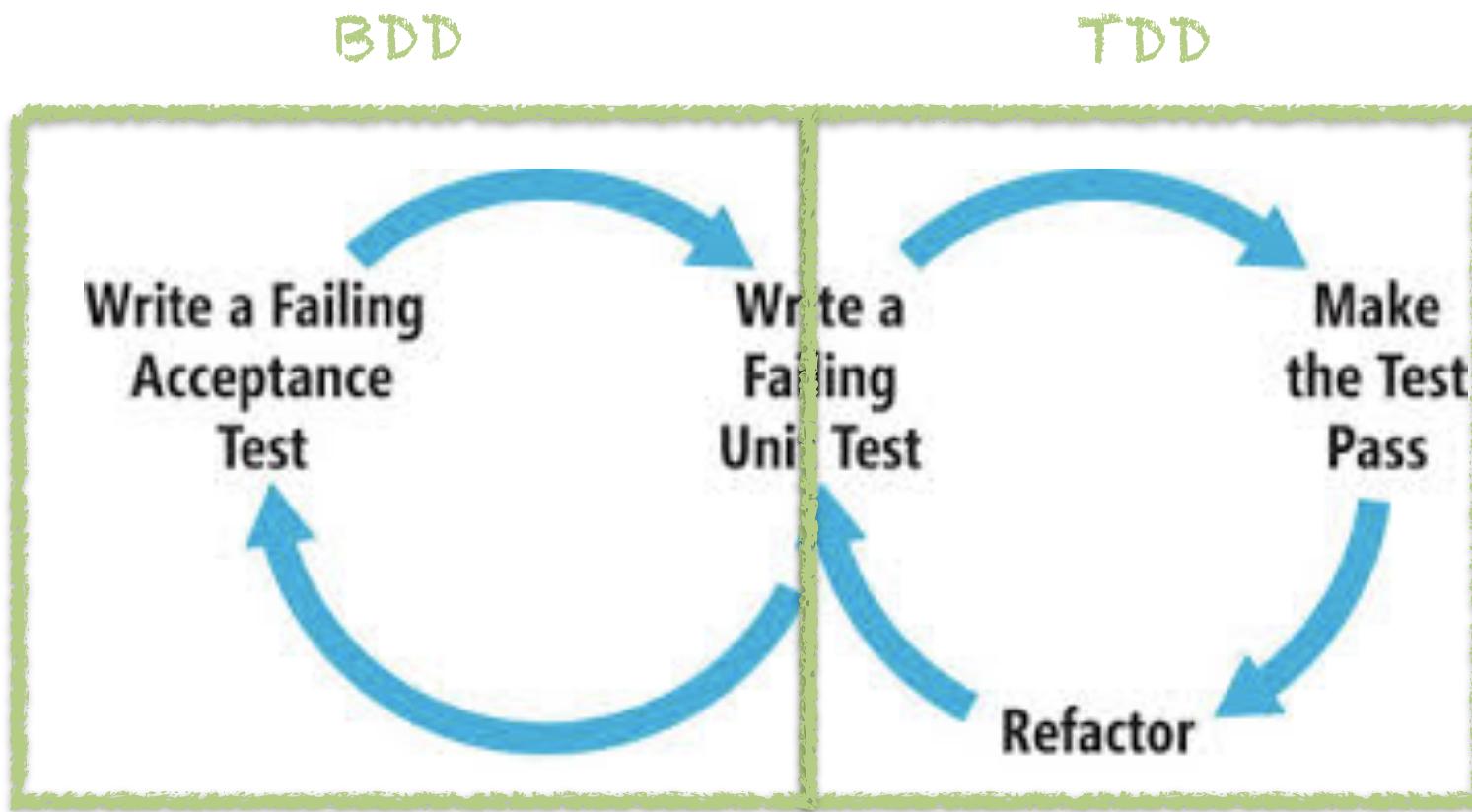
- The purpose of Cucumber is to bridge the communication gap between business and IT by providing a small set of essential scenarios to illustrate core behavior of unwritten software.
- These scenarios do become regression tests, but their real value is to prevent defects by uncovering bad assumptions up-front.
- ***You end up with executable, living documentation accessible to everyone on the team. -Documentation of how the software should behave - and how it actually behaves.***

<https://news.ycombinator.com/item?id=10194242>

... And above's talk, more trouble about
yourself. And don't mention us
when we hear you first think that we had
of the same sort themselves. What a
will you know? Oh, you'll know all sorts of
things, they say—even their books—without our
secret out. Keep your eyes open. When we... when
do they teach them at these schools?

And that is the very end of the adventures of
the wardrobe. But if the Professor was right it
was only the beginning of the adventures of
Jarnia.

The End



Cucumber, Jasmine,...

JUnit, TestNG, Mocha,

The Adam
Book

TEST-DRIVEN DEVELOPMENT

BY EXAMPLE

KENT BECK



The Process

“

1. Quickly add a test.
2. Run all tests and see the new one fail.
3. Make a little change.
4. Run all tests and see them all succeed.
5. Refactor to remove duplication.

”

Kent Beck – Test Driven Development By Example 2003

“

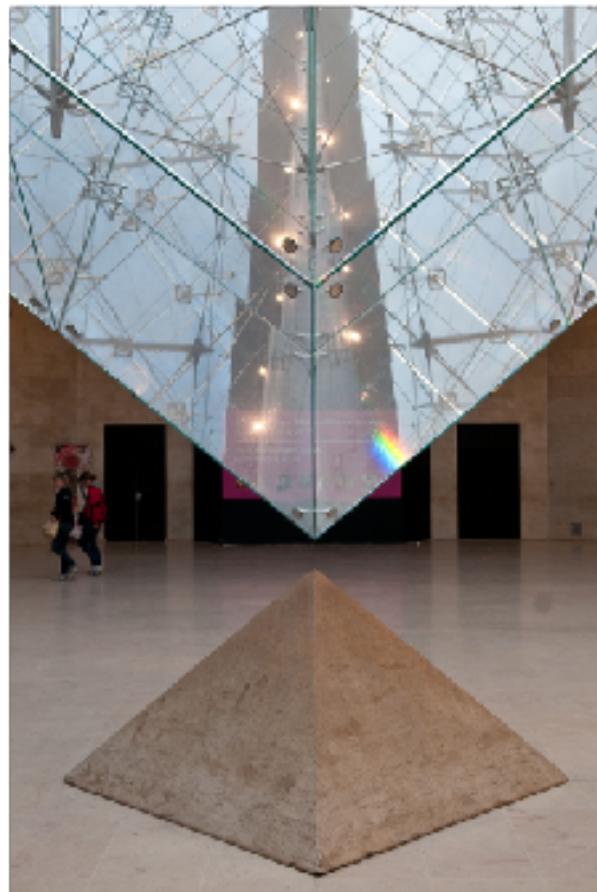
1. Write a failing test.
2. Write code to make it pass.
3. Repeat steps 1 and 2.
4. Along the way, refactor aggressively.
5. When you can't think of any more tests, you must be done.

”

Neal Ford – Evolutionary Architecture and
Emergent Design 2009

Benefits

- Promotes design decisions up front
- Allows you and your team to understand your code
- Model the API the way you want it to look
- Means of communicating an API before implementation
- Avoids Technical Debt
- Can be used with any programming language

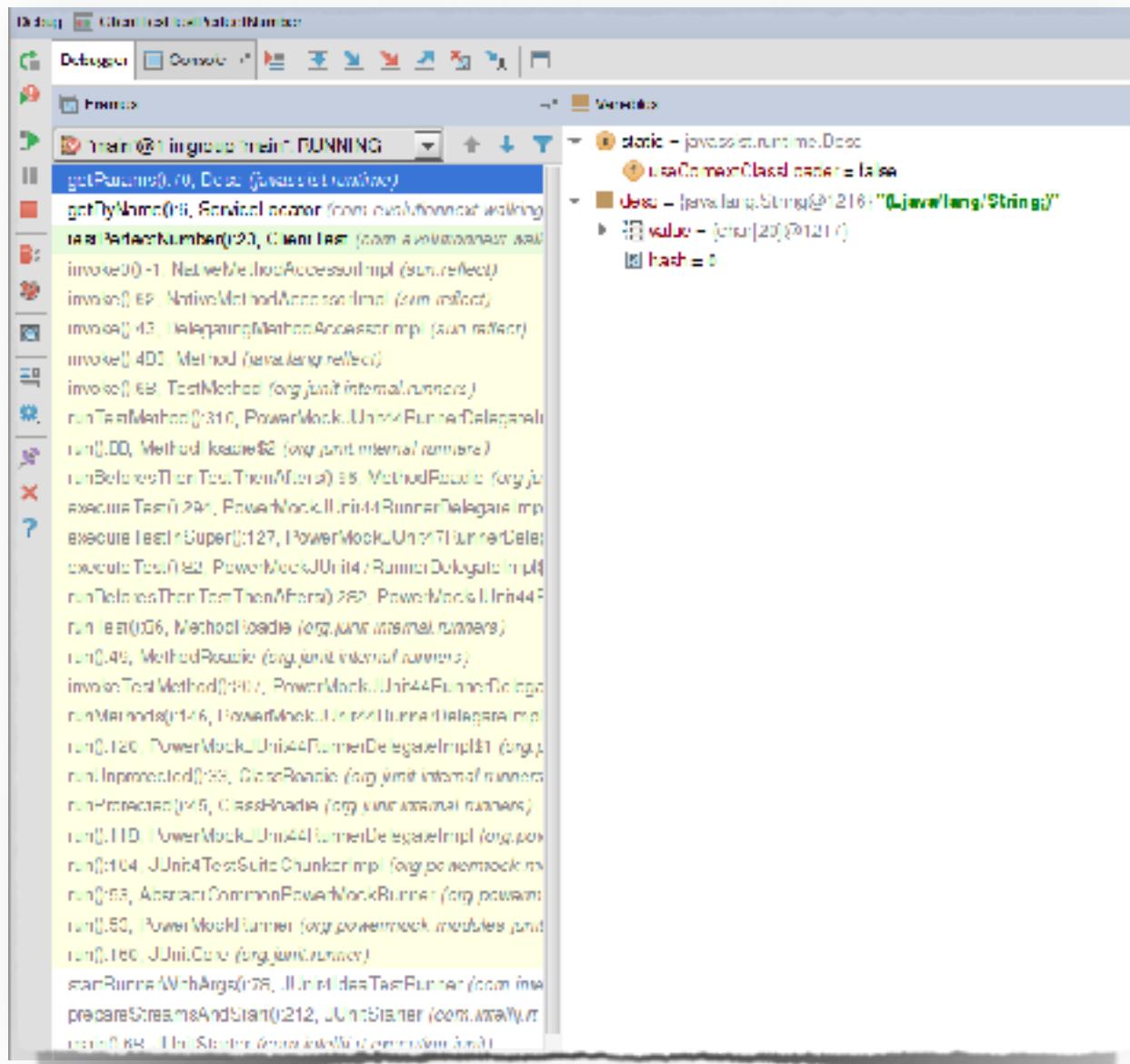


```
public class TaxCode {  
    public void applyTaxAndSurcharge(Order order) {  
        Money total = order.total();  
        if (order.after(LocalDate.of("2001-01-01"))) {  
            if (order.customer.getState().equals("FL") ||  
                order.customer.getState().equals("NY"))  
                order.applySurcharge(new Money(10))  
                order.applyTax(new Money(total * .15));  
                TaxWS.findTaxRate(order.customer.getState());  
            } else  
                order.applyTax(new Money(total));  
        } else {  
            order.applyTax(0);  
            order.applySurcharge(0);  
        }  
    }  
}
```

"Game"ifying Development

Consider each fail test a challenge

Less Debugging!



Disadvantages

- People find it difficult and unintuitive at first
- Requires team investment
- Many do not see the advantages until it is too late

Bob Martin's Three TDD Laws

“

You may not write production code until you have written a failing unit test.

”

Bob Martin – Clean Code 2008

“

You may not write more of a unit test than is sufficient to fail, and not compiling is failing.

”

Bob Martin – Clean Code 2008

“

You may not write more production code than is sufficient to pass the currently failing test.

”

Bob Martin – Clean Code 2008

Adopting TDD

Adopting TDD As An Individual

- Practice Makes Perfect
- TDD every new method, class, or function
- Contribute to an open source project for fun
- Use testing when learning a new language!

* You should learn a new language
every year anyway

Adopting TDD As A Team

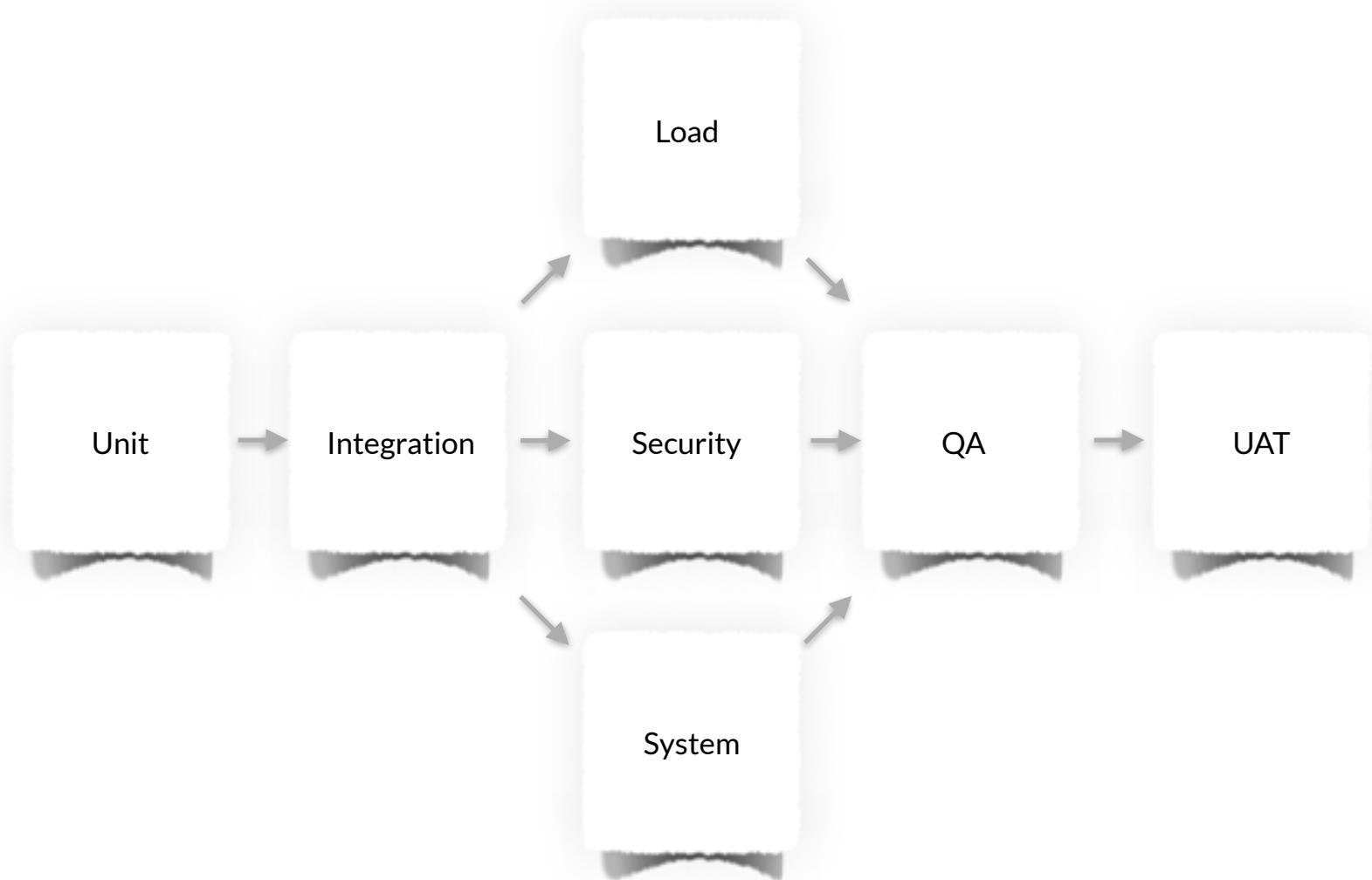
- For Green Field Projects
 - Start Immediately!
 - Prevent Technical Debt
- For Brown Field Projects
 - Adopt "Testing Thursdays or Fridays" if affordable
 - Powermock in Java if necessary*

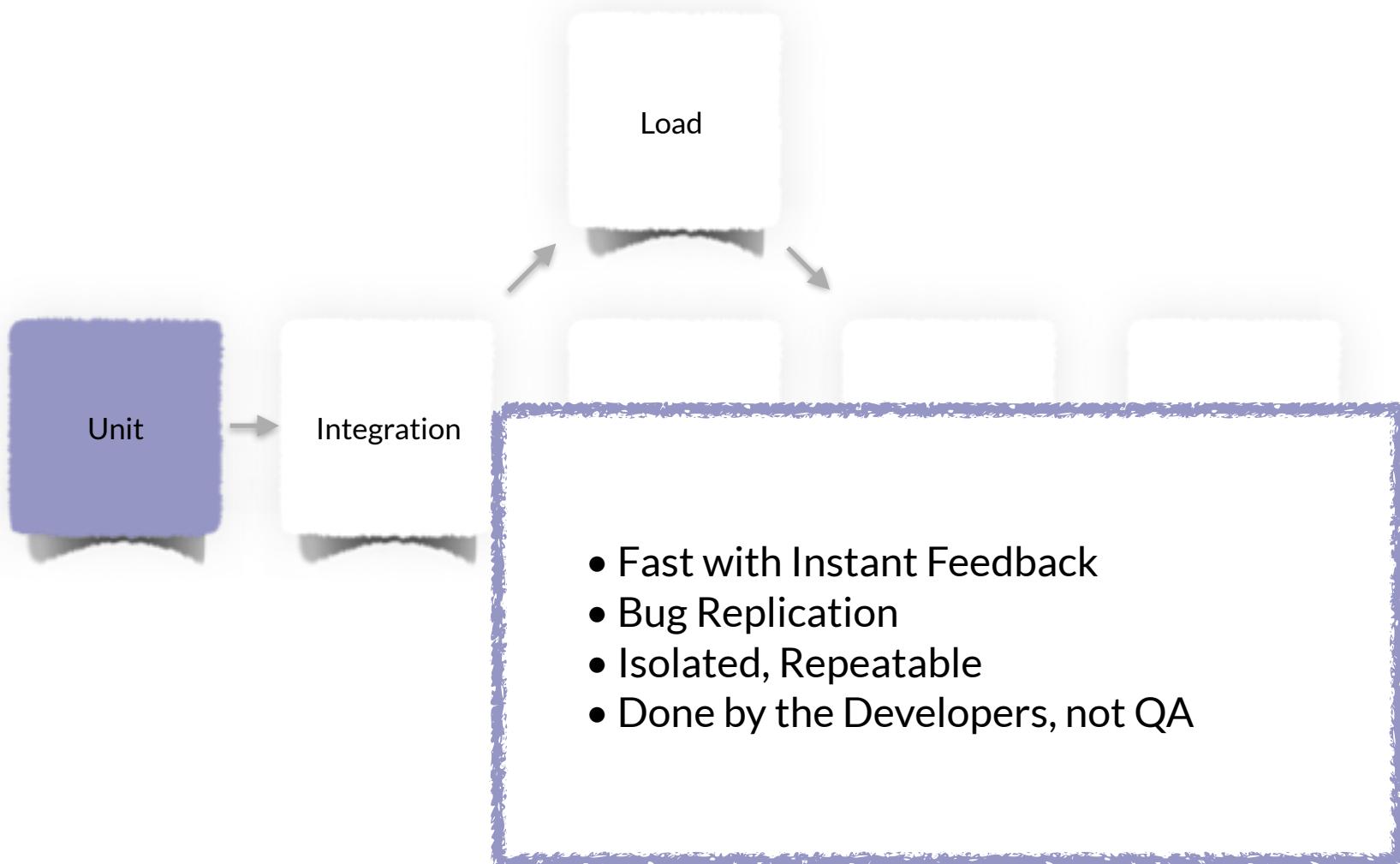
* Powermock in Java, or any class manipulation utility is usually a sign of bad design

Measuring and Monitoring TDD

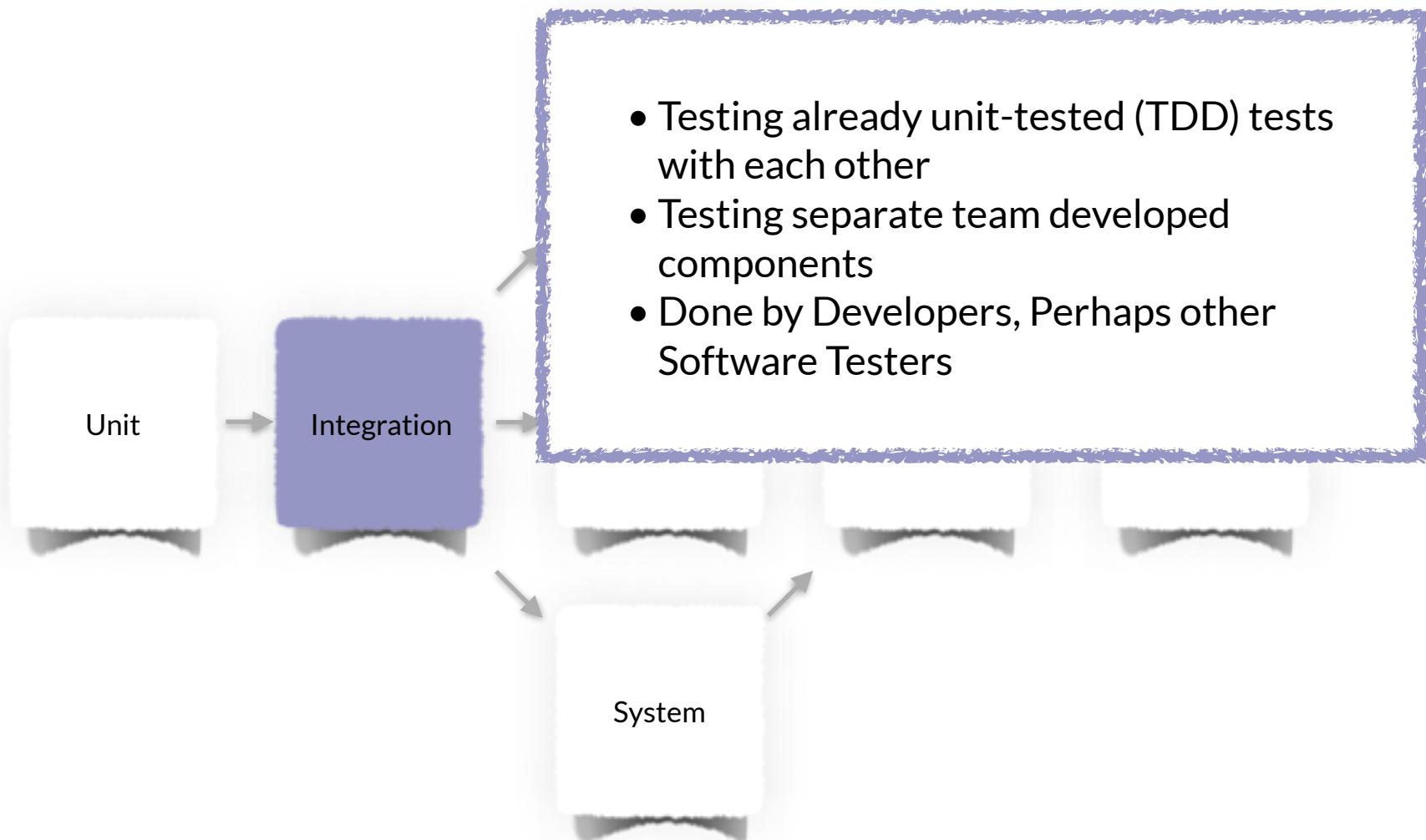
- Use Code Coverage to check that code is being tested
 - Cobertura
 - Emma
 - Jacoco
- Employ Pair Programming
- Employee Code Review
 - Non-TDD Code is easy to spot

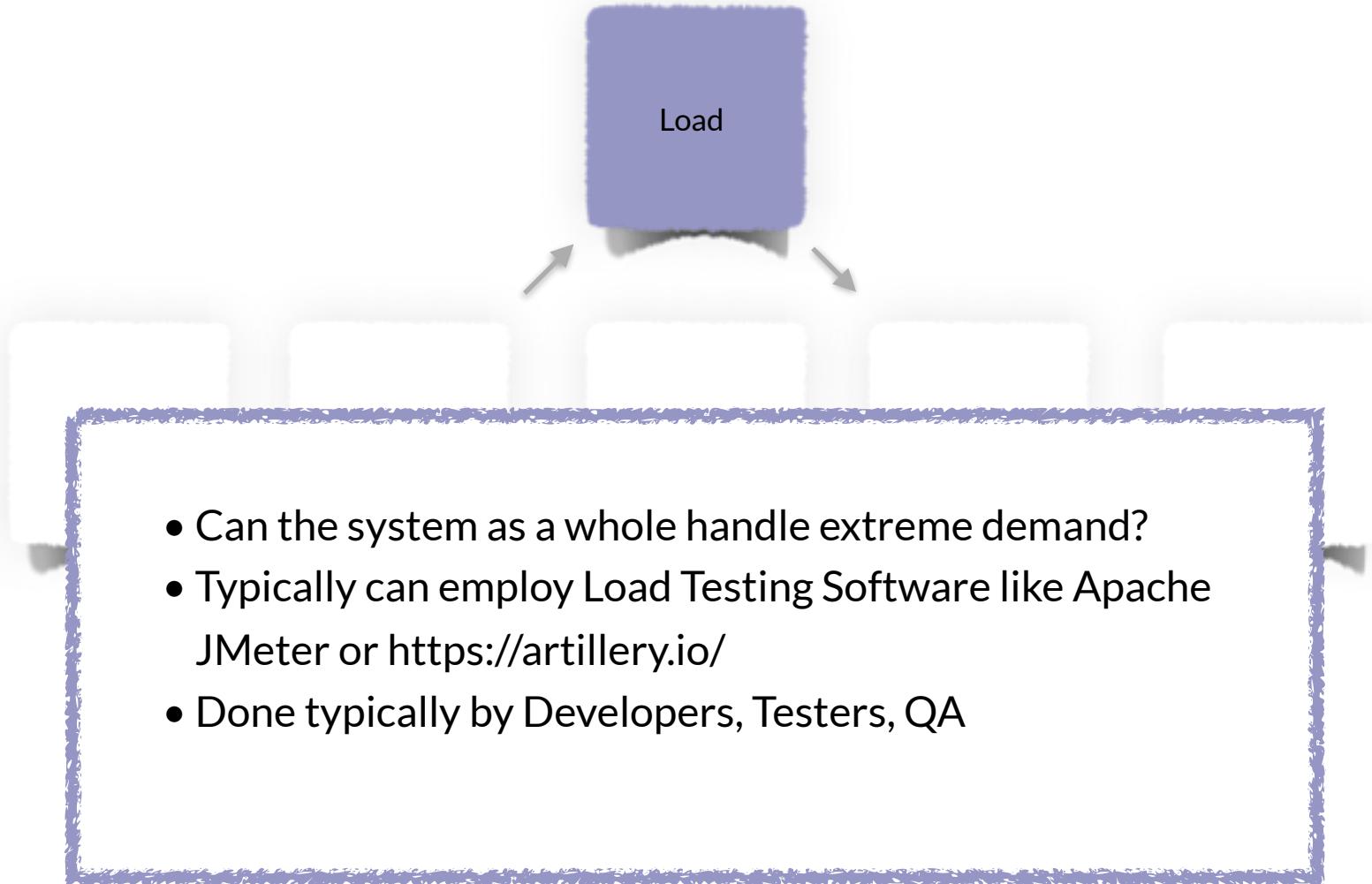
Levels of Testing



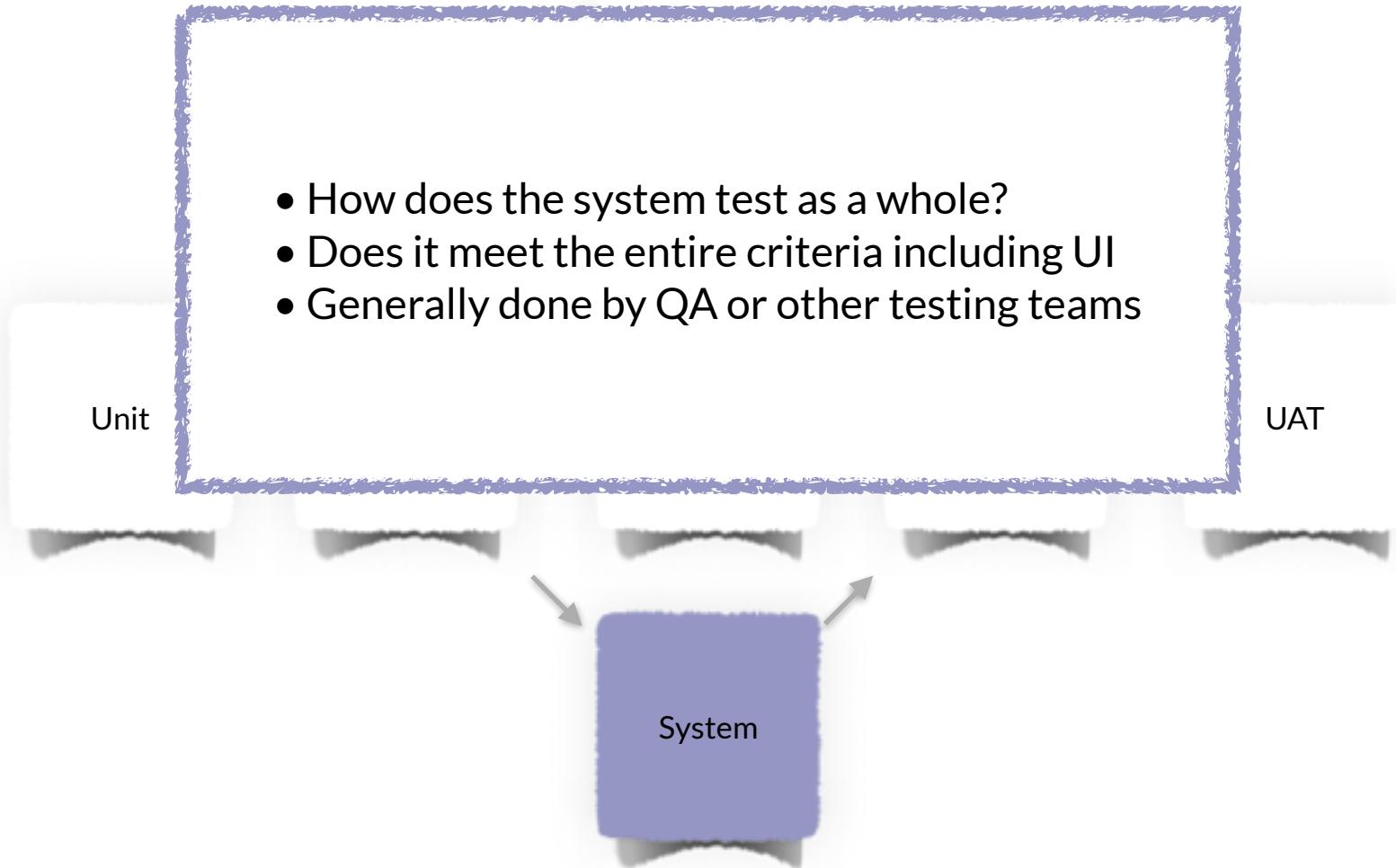


- Fast with Instant Feedback
- Bug Replication
- Isolated, Repeatable
- Done by the Developers, not QA

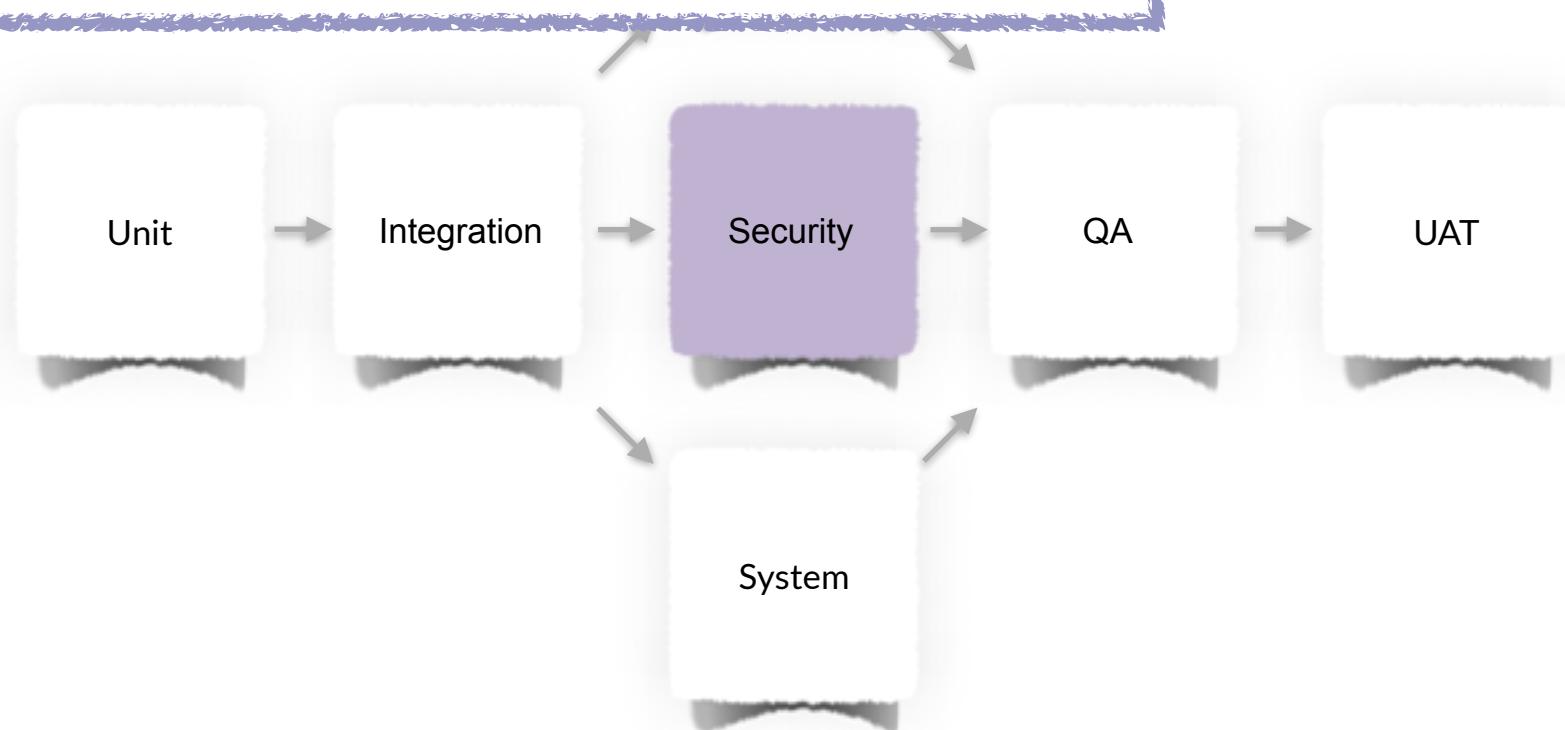


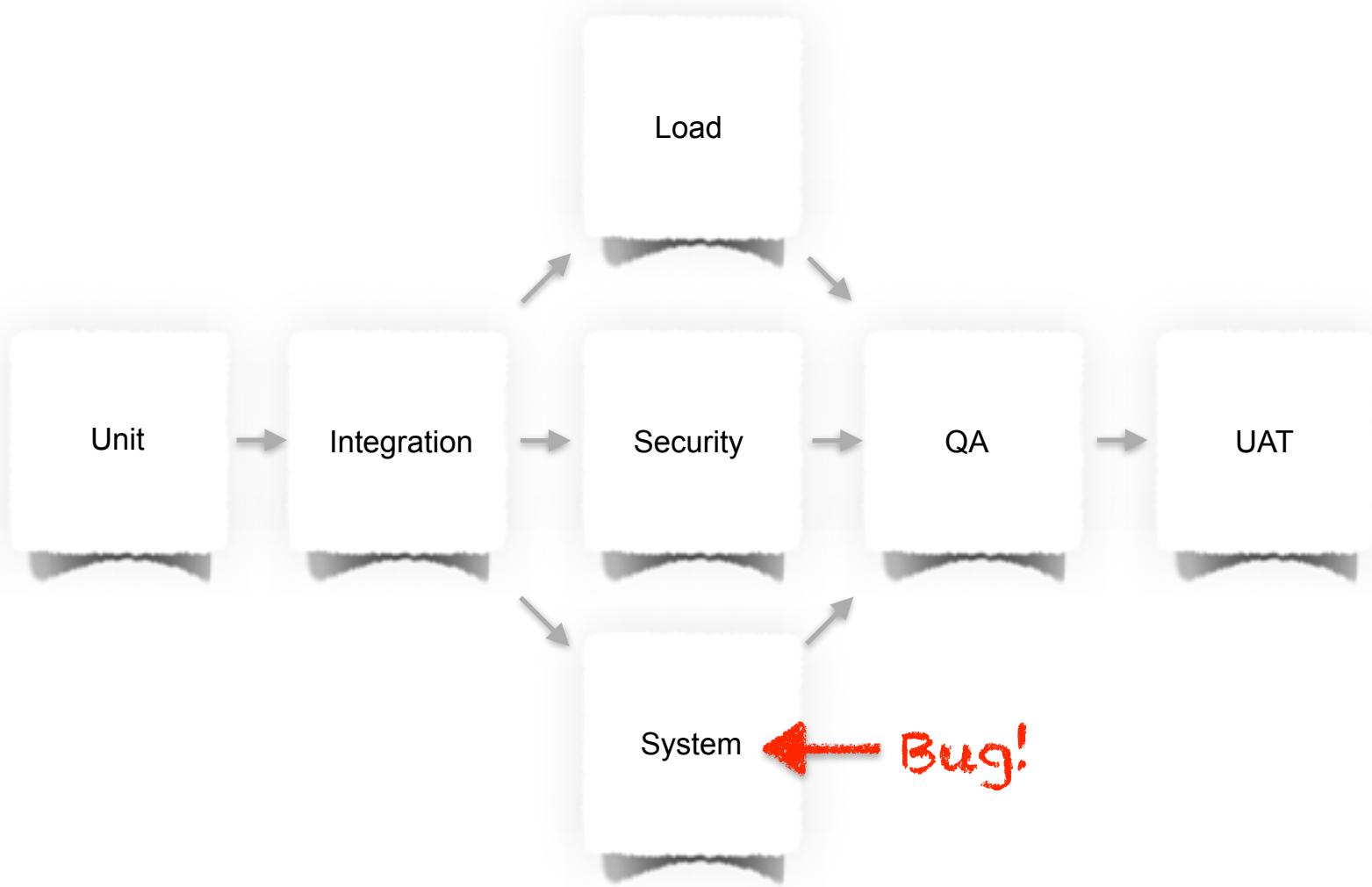


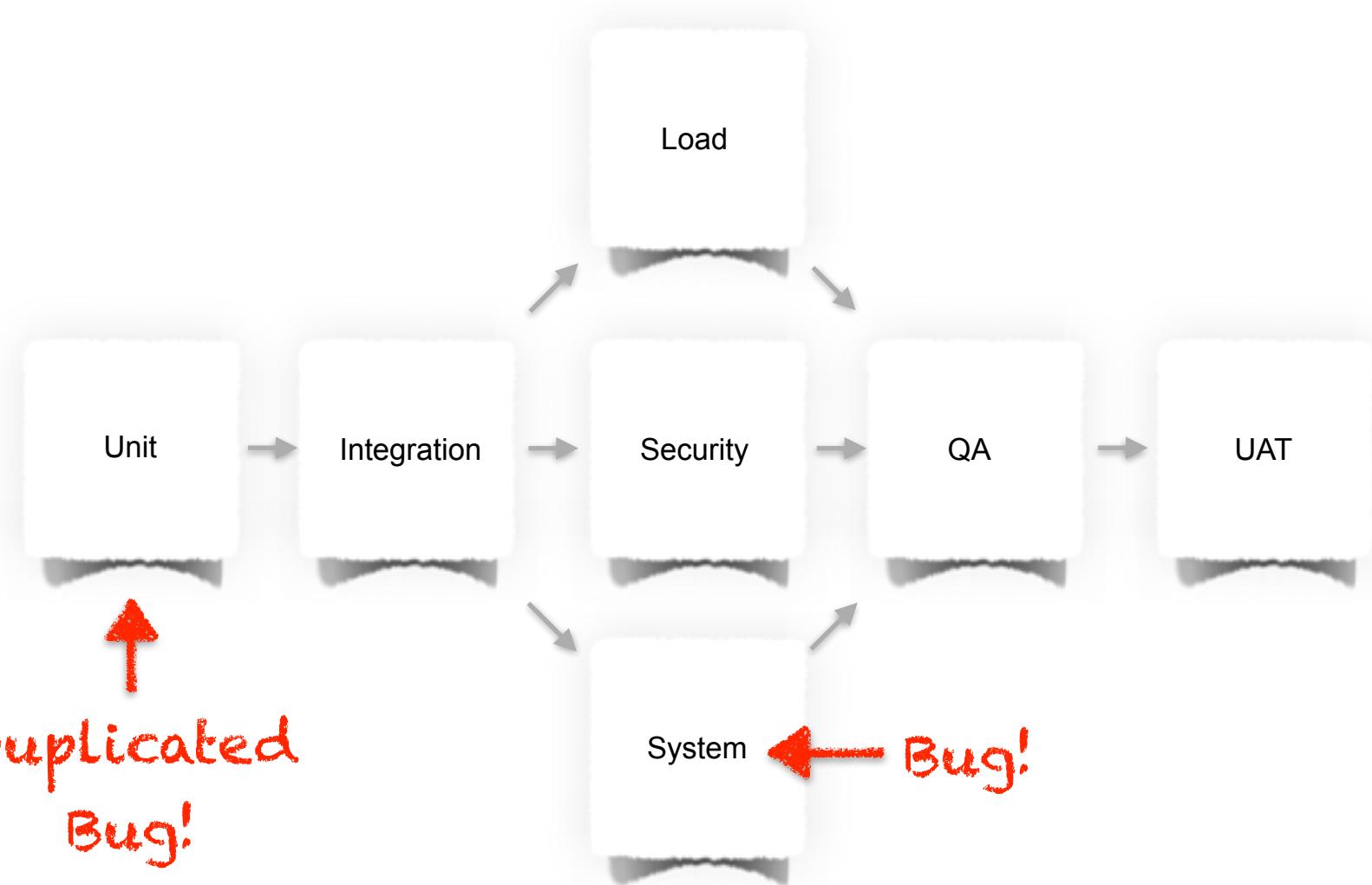
- How does the system test as a whole?
- Does it meet the entire criteria including UI
- Generally done by QA or other testing teams



- Is the system secure?
- Can it be hacked or compromised
- No holds barred testing
- Results in creation of system tests and Unit Test to plug up
- Done by developers, technical managers, testers, or QA







Infrastructure Changes Required

- TDD Adherence among all developers
- Continuous Integration Server:
 - Performs unit testing every hour
 - Breaks the build if agreed testing metrics are not met



What to test?

Any program can be a long series of functions and statements

But we don't do that.

- We break things up into logical sections
 - We also want to reuse those sections
 - Those things must form a cohesive unit
 - Single Responsibility Principle

Production Test

We test the logical sections

What not to test?

What not to test?

- The main method, this is where wiring takes place
- GUIs
 - There are other varying testing frameworks to test GUIs
 - Selenium Web Driver (Web, JavaScript)
 - Fest-Swing (Java Swing Applications)
 - TestFX (Java FX Applications)
 - DOM testers can come with preferred JavaScript libraries
 - What about getters and setters? Yes*

* Strong Opinion

Testing Libraries On The JVM

Demo: Bringing it all in!

Trivia

- True/False: BDD is about Given When and Thens?
- True/False: Is it Ok to for the Product Owners or Business Analysts to work on scenarios and deliver later?
- True/False: Acceptance Criteria should be executable with instant feedback?

Thank you!

Test Driven Development Continued

JUnit

- Kent Beck
- Original Testing Framework on the JVM
- Most popular
- Plugins easy available for Eclipse and IntelliJ

TestNG

- Developed by Cedric Beust
- Multiple Features for Testing
 - Groups (also now available in JUnit)
 - Providers
 - Ordered Testing
 - JUnit Integration

Cucumber JVM

- Specification Testing Framework
- Used primarily to test features demanded by stakeholder
- Non-Programmer Readable Style Tests
- Can be used for Unit Testing

Testing Libraries In Node/JS

Mocha

- Mocha.js
- Node.js and Web Based Testing
- Asynchronous Capable

Jasmine

- Behavior Driven Development Based Framework
- Node.js and Web Based Testing
- Handy Testing Utilities

Code Coverage Libraries On The JVM

What is Code Coverage?

- Analyzes what production code has been covered by Unit Testing
- Line Coverage tests which line have been covered by tests
- Branch Coverage tests if all conditions have been tested in your `if, else, else, while, do`
- Cyclomatic Complexity
 - Algorithm to determine code complexity
 - Aim for 5 (even if the max should be 10)

How does code coverage work?

- Code that is compiled is then instrumented at byte code level
- Detects when a line of code is process by thread

Example JVM Coverage Report

Packages

All
[net.sourceforge.cobertura.ant](#)
[net.sourceforge.cobertura.check](#)
[net.sourceforge.cobertura.coveragedata](#)
[net.sourceforge.cobertura.instrument](#)
[net.sourceforge.cobertura.merge](#)
[net.sourceforge.cobertura.reporting](#)
[net.sourceforge.cobertura.reporting.html](#)
[net.sourceforge.cobertura.reporting.htmlReport](#)
[net.sourceforge.cobertura.reporting.xml](#)
[net.sourceforge.cobertura.util](#)

All Packages

Coverage Report - All Packages

Package	# Classes	Line Coverage	Branch Coverage	Complexity
All Packages	55	75%	64%	2.319
net.sourceforge.cobertura.ant	11	82%	71%	1.848
net.sourceforge.cobertura.check	3	0%	0%	2.429
net.sourceforge.cobertura.coveragedata	13	N/A	N/A	2.277
net.sourceforge.cobertura.instrument	10	90%	49%	1.854
net.sourceforge.cobertura.merge	1	88%	39%	5.5
net.sourceforge.cobertura.reporting	3	87%	51%	2.882
net.sourceforge.cobertura.reporting.html	4	91%	47%	4.444
net.sourceforge.cobertura.reporting.htmlReport	1	87%	39%	4.5
net.sourceforge.cobertura.reporting.xml	1	100%	33%	1.524
net.sourceforge.cobertura.util	9	80%	31%	2.892
someotherpackage	1	60%	N/A	1.2

Report generated by Cobertura 1.9 on 6/9/07 12:37 AM.

Classes

[AntUtil](#) (88%)
[Archive](#) (100%)
[CoverageData](#) (0%)
BranchCoverageData (N/A)
[CheckTask](#) (0%)
[ClassData](#) (N/A)
[ClassInstrumenter](#) (94%)
[ClassPattern](#) (100%)
[CoberturaFile](#) (73%)
[CommandInvoker](#) (96%)
[CommonMethodTask](#) (99%)
[ComplexityCalculator](#) (100%)
[ConfigurationUtil](#) (50%)
[CopyFiles](#) (87%)
[CoverageData](#) (N/A)
[CoverageDataContainer](#) (N/A)
[CoverageDataFileHandler](#) (N/A)
[CoverageRate](#) (0%)
[ExcludeClasses](#) (100%)
[FileFinder](#) (96%)
[FileLocker](#) (0%)
[FirstPassMethodInstrumenter](#) (100%)
[HTMLReport](#) (94%)
[HasBeenInstrumented](#) (N/A)
[Header](#) (80%)
[SQLUtil](#) (62%)
[Ignore](#) (100%)
[IgnoreBranches](#) (0%)

Example JS Coverage Report

Code coverage report for `app/form_validator.js`

Statements: 100% (8 / 8) Branches: 100% (4 / 4) Functions: 100% (3 / 3) Lines: 100% (8 / 8) Ignored: none

[All files](#) » `app/` » `form_validator.js`

```
1  1 var isValidCommaDelimitedList = function (value) {
2    // allow letters, commas, and spaces
3  10  var commaDelimitedListRegEx = /^[A-Za-z,\s]+$/;
4  10  return commaDelimitedListRegEx.test(value);
5  };
6
7
8  1 var isValidTagmode = function (value) {
9  7  return value === 'all' || value === 'any';
10 };
11
12
13 1 var hasValidFlickrAPIParams = function (tags, tagmode) {
14  6  return isValidCommaDelimitedList(tags) && isValidTagmode(tagmode);
15 };
16
17
18 1 module.exports = {
19   isValidCommaDelimitedList: isValidCommaDelimitedList,
20   isValidTagmode: isValidTagmode,
21   hasValidFlickrAPIParams: hasValidFlickrAPIParams
22 };
23
```

Generated by [Istanbul](#) at Sat Feb 22 2014 17:31:46 GMT-0800 (PST)

Cobertura

- Open Source Code Coverage
- Spanish/Portuguese for "Coverage"
- Easy Use

Emma

- Open Source Coverage Tool
- Easy Use

JaCoCo

- Another Open Source Coverage Tool
- Easy Use
- Excellent Java 8 Use

SCCM

- Open Source
- Scala based Code Coverage for Scala programs

Build Tools

What is a build tool?

- Tool that manages a project
- Set of commands that allow to describe build a project
 - Compiling
 - Testing
 - Packaging
 - Cleaning Binaries
 - Deployment
- Any build tool can be used with TDD

Build Tools On The JVM

Ant

- First Popular JVM Build Tool
- XML Based
- Developed By James Duncan Davidson
- Flexible
- Contains Multiple Tasks
- Disadvantage: Lots of XML and too much configuration!

Maven

- An Apache Open Source project
- Development began in 2001
- Grew out of unwieldy Ant build files for other Apache projects
- Has gone through many iterations
- Current version is Maven 3.x
- Multiple Plugins

Gradle

- Open Source
- Groovy based Build Tool
- Feature Rich and Friendly
- Contains same features as Maven
- Allow scriptability
- Multiple Plugins

Buildr

- Open Source
- Ruby Based Build Tool
- Small following
- Flexible

SBT

- Official Name: Simple Build Tool
- Scala Build Tool
- Flexible
- Out of the box is simple
- Creating your tasks can be difficult

Leinigen

- Clojure Based Build Tool
- Open Source

Build Tools In JavaScript/Node

Node.js

- Brought MVC based projects to the forefront.
- Provides an excellent backend processing using JavaScript
- Some parts are backed using C++
- Based on Chrome's V8 JavaScript Engine

Gulp

- Node based workflow process tool
- All task & pipe based processes
- Large number of plugins



Grunt

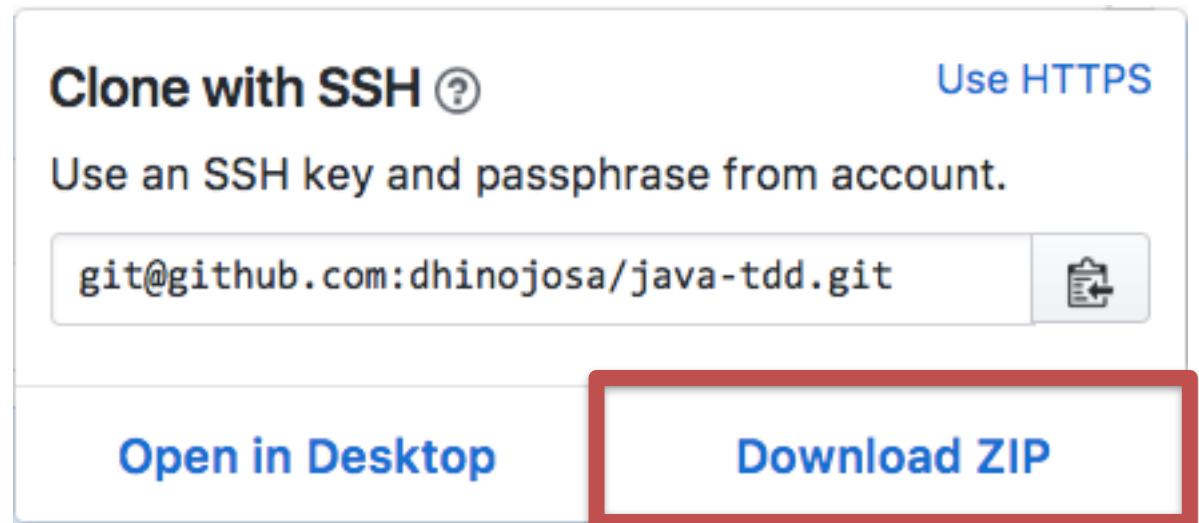
- Node based task runner managed by npm
- Large number of tasks
- Based on a Gruntfile that manages tasks



Lab: Retrieve Project

- For Java Based Project:
<http://www.github.com/dhinojosa/java-tdd>
- For JavaScript Based Project:
<http://www.github.com/dhinojosa/node-tdd>

Either clone or
download project
of your choice:



Lab: Run A Quick Test

- For Java Based Project:
 - cd java-tdd
 - mvn test
- For JavaScript Based Project:
 - cd node-tdd
 - npm install
 - npm run build
 - npm test

Setting up your IDEs

Quick Note About Java IDEs

- Integrated Development Environment
- They are tremendous for full projects
- They are terrible for simple file editing
- Two popular ones for the JVM
 - Eclipse
 - IntelliJ IDEA
- Full fledged Node/JS IDEs are since editors are usually used
 - WebStorm

* NetBeans still has some Mind Share, Not Sure it is Popular

Eclipse

- <http://www.eclipse.org>
- Variant Eclipse versions depending on focus (Spring STS, Jboss Tools, Scala-IDE, etc)
- Open Source
- Pluggable Features
- Most popular IDE among JVM developers



IntelliJ IDEA

- <http://www.jetbrains.com/idea>
- Community Edition (Free)
- Ultimate Edition (Various Pricing Packages)
- Has more keyboard shortcut bindings than Eclipse
- Pluggable Features
- Easy to Use



Learning Shortcuts for IDEs

Why Keyboard Shortcuts?

- You waste an enormous amount of time using a mouse
- Efficient development requires you know most if not all keyboard shortcuts
- Learn one or two keyboard shortcuts a day (It adds up)
- If you need to perform a task, look up the shortcut until it is committed to memory
- It is essential for successful Test Driven Development

Essential Shortcuts

(Windows/Linux)

- **CTRL+S - Save**
- **CTRL+C - Copy**
- **CTRL+X - Cut**
- **CTRL+V - Paste**
- **CTRL+Z - Undo**
- **CTRL+SHIFT+Z or CTRL+R - Redo**
- **ALT+TAB – Switch Applications**

Essential Shortcuts (Mac OS X)

- ⌘+S - **Save**
- ⌘+C - **Copy**
- ⌘+X - **Cut**
- ⌘+V - **Paste**
- ⌘+Z - **Undo**
- ⌘ + SHIFT(⇧) + Z - **Redo**
- ⌘ + TAB - **Switch Applications**

Essential Eclipse Shortcuts

(Linux/Windows)

- **CTRL + SHIFT + L – Toggle Keyboard Shortcut Help**
- **CTRL + E - Recent Files**
- **CTRL + M – Toggle Fullscreen**
- **CTRL + D – Delete Line**
- **SHIFT + CTRL + F – Format Code**
- **CTRL + 1 – Context Help**



Essential Eclipse Shortcuts

(Mac OSX)

- ⌘ + SHIFT(⬆) + L – **Toggle Keyboard Shortcut Help**
- ⌘ + E - **Recent Files**
- **CTRL** + M – **Toggle Fullscreen**
- ⌘ + D – **Delete Line**
- ⌘ + SHIFT(⬆) + F – **Format Code**
- ⌘ + 1 – **Context Help**



MoreUnit for Eclipse

- Eclipse Plugin that allows you to:
 - Switch between Test and Production Easily
 - Run Tests
- **CTRL + J – Switch to Test/Production Code**
- **CTRL + R – Run the Test**



Installing MoreUnit for Eclipse

- Help > Eclipse Marketplace...
- Search for MoreUnit
- Click Install
- Accept License Agreement
- Restart Eclipse if necessary



Essential IntelliJ Shortcuts

(Linux/Windows)

- **CTRL + SHIFT + A – Keyboard Shortcut Lookup**
- **CTRL + E – Recent Files**
- **CTRL + SHIFT + F12 – Maximize Screen**
- **CTRL + Y – Delete Line**
- **SHIFT + ALT + L – Format Code**
- **ALT + ENTER – Context Help**
- **CTRL + SHIFT + T – Toggle between Test and Class**
- **CTRL + SHIFT + F10 – Run**

https://www.jetbrains.com/idea/docs/IntelliJIDEA_ReferenceCard_Mac.pdf



Essential IntelliJ Shortcuts

(Mac OSX)

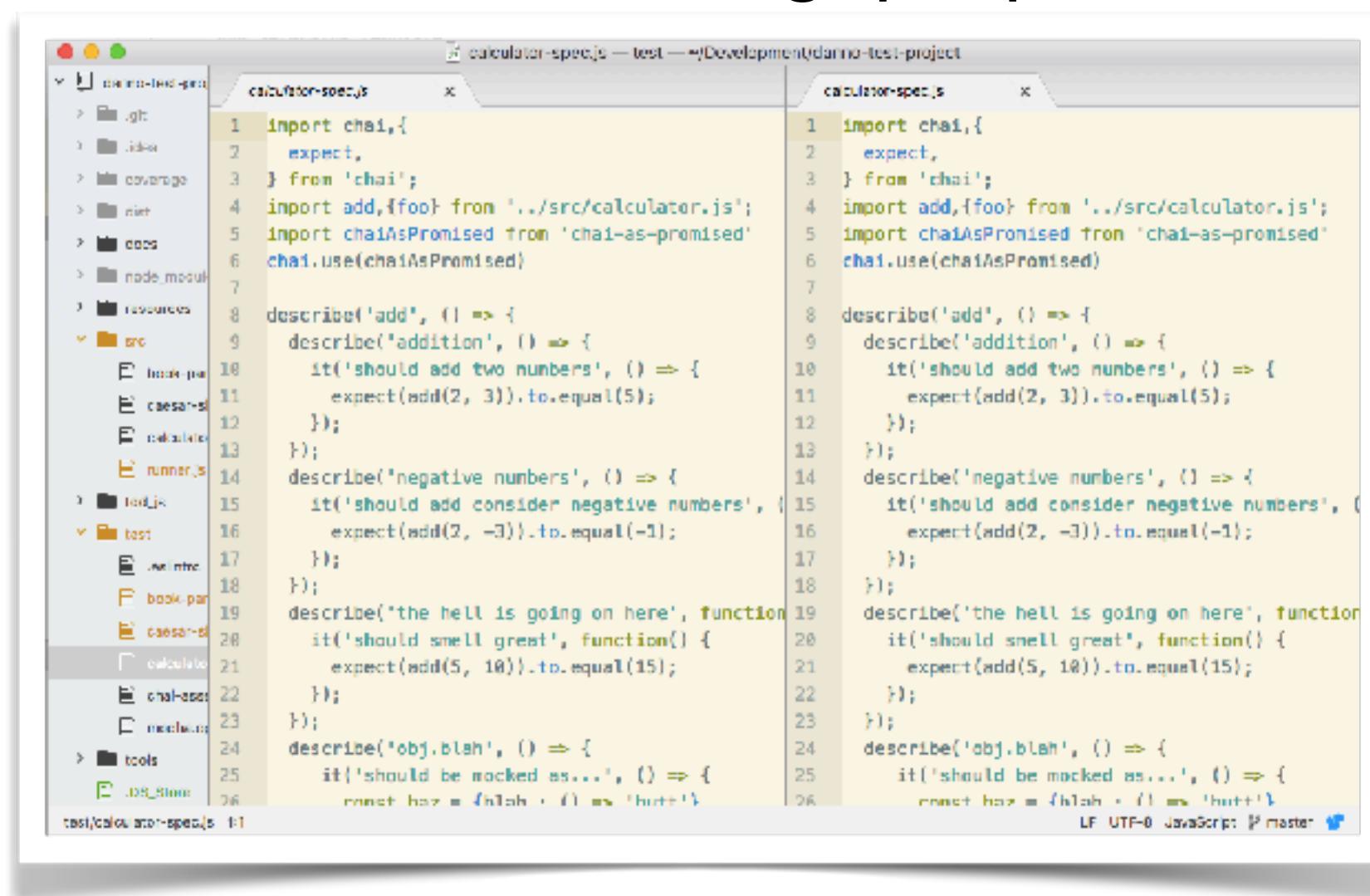
- SHIFT(⇧) + ⌘ + A – **Toggle Keyboard Shortcut Help**
- ⌘ + E - **Recent Files**
- ⌘ + SHIFT(⇧) + F – **Toggle Fullscreen**
- ⌘ + DELETE(⌫) – **Delete Line**
- ⌘ + OPTION(⌥) + L – **Format Code**
- OPTION(⌥) + ENTER(⏎) – **Context Help**

https://www.jetbrains.com/idea/docs/IntelliJIDEA_ReferenceCard_Mac.pdf



Editor Can't Toggle?

Consider using split pane



The screenshot shows a code editor window with two panes. The left pane displays the file structure of a project named 'calculator-spec.js' under 'test'. The right pane shows the content of the 'calculator-spec.js' file. Both panes have identical code, demonstrating a bug where the editor fails to toggle between them.

```
calculator-spec.js — test — ~/Development/darino-test-project
calculator-spec.js x
calculator-spec.js x

calculator-spec.js
1 import chai,
2   expect,
3 } from 'chai';
4 import add,{foo} from '../src/calculator.js';
5 import chaiAsPromised from 'chai-as-promised'
6 chai.use(chaiAsPromised)
7
8 describe('add', () => {
9   describe('addition', () => {
10     it('should add two numbers', () => {
11       expect(add(2, 3)).to.equal(5);
12     });
13   });
14   describe('negative numbers', () => {
15     it('should add consider negative numbers', () => {
16       expect(add(2, -3)).to.equal(-1);
17     });
18   });
19   describe('the hell is going on here', function() {
20     it('should smell great', function() {
21       expect(add(5, 10)).to.equal(15);
22     });
23   });
24   describe('obj.blah', () => {
25     it('should be mocked as...', () => {
26       expect(baz = {blah: 1}).to.be.undefined;
27     });
28   });
29 });

calculator-spec.js
1 import chai,
2   expect,
3 } from 'chai';
4 import add,{foo} from '../src/calculator.js';
5 import chaiAsPromised from 'chai-as-promised'
6 chai.use(chaiAsPromised)
7
8 describe('add', () => {
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11       expect(add(2, 3)).to.equal(5);
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15     it('should add consider negative numbers', () => {
16       expect(add(2, -3)).to.equal(-1);
17     });
18   });
19   describe('the hell is going on here', function() {
20     it('should smell great', function() {
21       expect(add(5, 10)).to.equal(15);
22     });
23   });
24   describe('obj.blah', () => {
25     it('should be mocked as...', () => {
26       expect(baz = {blah: 1}).to.be.undefined;
27     });
28   });
29 });

LF UTF-8 JavaScript # master
```

Atom Keyboard Shortcuts



<https://github.com/nwinkler/atom-keyboard-shortcuts>

Sublime Keyboard Shortcuts



[http://docs.sublimetext.info/en/latest/reference/
keyboard_shortcuts_win.html](http://docs.sublimetext.info/en/latest/reference/keyboard_shortcuts_win.html)

Sublime Keyboard Shortcuts



[http://docs.sublimetext.info/en/latest/reference/
keyboard_shortcuts_osx.html](http://docs.sublimetext.info/en/latest/reference/keyboard_shortcuts_osx.html)

Assertion Language Reference

JUnit Reference

JUnit

Standard JUnit

- assertEquals(expected, actual)
- assertEquals(message, expected, actual)
- assertNotEquals(unexpected, actual)
- assertNotEquals(message, unexpected, actual)
- assertNull(object)
- assertNull(message, object)
- assertNotNull(object)
- assertNotNull(message, object)

Standard JUnit

- `assertSame(expected, actual)`
- `assertSame(message, expected, actual)`
- `assertTrue(boolean)`
- `assertTrue(message, boolean)`
- `assertArrayEquals(expectedArray, actualArray)`
- `assertArrayEquals(message, expectedArray, actualArray)`
- `fail()`
- `fail(message)`

TestNG Reference

Test**NG**

Standard TestNG

- assertEquals(actual, expected)
- assertEquals(actual, expected, message)
- assertNotEquals(actual, unexpected)
- assertNotEquals(actual, unexpected, message)
- assertNull(object)
- assertNull(message, object)

Standard TestNG

- `assertSame(actual, expected)`
- `assertSame(actual, expected, message)`
- `assertTrue(boolean)`
- `assertTrue(message, boolean)`
- `assertEquals(actualArray, expectedArray)`
- `assertEquals(actualArray, expectedArray, message)`
- `fail()`
- `fail(message)`

Hamcrest Reference

Hamcrest

Hamcrest

- Fluent Assertion Language
- Uses Matchers to Assertions
- Allows Essentially Wildcard Matching using Matchers

Simple Hamcrest Matchers

- `assertThat(cheese, is(equalTo(smelly)))`
- `assertThat("", isEmptyString())`
- `assertThat(((String)null),
 isEmptyOrNullString())`
- `assertThat(cheese, is(not(equalTo(smelly))))`
- `assertThat(cheese, is(nullValue())`
- `assertThat(cheese, is(notNullValue())`

Descriptive Testing with Hamcrest

- **describedAs**("a big decimal equal to %0",
equalTo(myBigDecimal),
myBigDecimal.toString())

Comparison Hamcrest Matchers

- `assertThat(1, comparesEqualTo(1))`
- `assertThat(2, greaterThan(1))`
- `assertThat(1, greaterThanOrEqualTo(1))`
- `assertThat(1, lessThan(2))`
- `assertThat(1, lessThanOrEqualTo(1))`
- `assertThat("Foo", equalToIgnoringCase("FOO"))`
- `assertThat(" my\tfoo bar ",
equalToIgnoringWhiteSpace(" my foo bar"))`

Instance Hamcrest Matchers

- `assertThat(cheese, is(
 instanceOf(Cheddar.class)))`
- `assertThat(cheese, isA(Cheddar.class))`
- `assertThat(cheese, is(sameInstance(cheddar))`
- `assertThat(cheese, is(theInstance(cheddar))`
- `assertThat(Integer.class,
 is(typeCompatibleWith(Number.class)))`
- `assertThat(cheddar, is(any(Cheese.class)))`

Array Hamcrest Matchers

- `assertThat("foo", isIn(new String[]{"bar", "foo"}))`
- `assertThat(new Integer[]{1,2,3},
 is(array(equalTo(1), equalTo(2), equalTo(3))))`
- `assertThat(new Integer[]{1,2,3}, hasItemInArray(equalTo(3)))`
- `assertThat(new String[] {"foo", "bar"},
 hasItemInArray(startsWith("ba")))`
- `assertThat(new String[] {"foo", "bar"},
 contains(Arrays.asList(equalTo("foo"), equalTo("bar"))))`
- `assertThat(new String[] {"foo", "bar"},
 containsInAnyOrder("bar", "foo"))`
- `assertThat(new String[] {"foo", "bar"},
 arrayWithSize(equalTo(2)))`
- `assertThat(new String[0], emptyArray())`

Collection Hamcrest Matchers

- `assertThat(Arrays.asList("bar", "baz"), everyItem(startsWith("ba")))`
- `assertThat(Arrays.asList("foo", "bar"), hasItem("bar"))`
- `assertThat(Arrays.asList("foo", "bar"), hasItem(startsWith("ba")))`
- `assertThat(Arrays.asList("foo", "bar", "baz"), hasItems("baz", "foo"))`
- `assertThat(Arrays.asList("foo", "bar", "baz"), hasItems(endsWith("z"), endsWith("o")))`
- `assertThat(Arrays.asList("foo", "bar"), hasSize(equalTo(2)))`
- `assertThat(new ArrayList<String>(), is(empty()))`

Map Hamcrest Matchers

- `assertThat(myMap, hasKey(equalTo("bar")))`
- `assertThat(myMap, hasKey("bar"))`
- `assertThat(myMap, hasValue("foo"))`
- `assertThat(myMap, hasValue(equalTo("foo")))`

Floating Point Hamcrest Matchers

- `assertThat(1.03, is(closeTo(1.0, 0.03)))`
- `assertThat(new BigDecimal("1.03"),
is(closeTo(new BigDecimal("1.0"),
new BigDecimal("0.03"))))`

String Hamcrest Matchers

- `assertThat("myStringOfNote",
 containsString("ring"))`
- `assertThat("myStringOfNote", startsWith("my"))`
- `assertThat("myStringOfNote", endsWith("Note"))`

Property Hamcrest Matchers

- `assertThat(myBean, hasProperty("foo"))`
- `assertThat(myBean, hasProperty("foo",
equalTo("bar")))`
- `assertThat(myBean,
samePropertyValuesAs(myExpectedBean))`

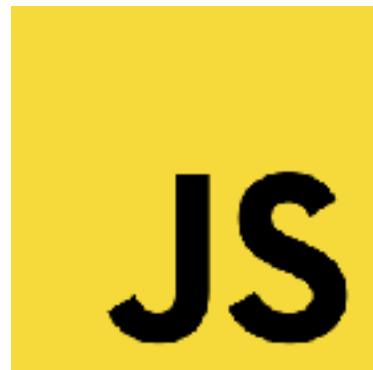
Wildcard Matchers

- `assertThat("myValue", allOf(startsWith("my") ,
containsString("Val")))`
- `assertThat("myValue", anyOf(startsWith("foo") ,
containsString("Val")))`
- `assertThat("fab", both(containsString("a"))
 .and(containsString("b")))`
- `assertThat("fan",
 either(containsString("a"))
 .and(containsString("b")))`
- `assertThat(cheese, is(anything()))`

AssertJ

AssertJ

- Update to Fest Assert
- Contains assertions for Guava, Joda-Time, Swing
- `import static org.assertj.core.api.Assertions.*;`



JavaScript

Strict vs. Non-Strict Equality

- A strict comparison (e.g., `==`) is only true if the operands are of the same type and the contents match.
- The more commonly-used abstract comparison (e.g. `==`) converts the operands to the same type before making the comparison

Non-Strict Equality

```
1 | 1 == 1          // true
2 | '1' == 1        // true
3 | 1 == '1'        // true
4 | 0 == false      // true
5 | 0 == null       // false
6 | var object1 = {'value': 'key'}, object2 = {'value': 'key'};
7 | object1 == object2 //false
8 | 0 == undefined // false
9 | null == undefined // true
```

Strict Equality

```
1 | 3 === 3    // true
2 | 3 === '3' // false
3 | var object1 = {'value': 'key'}, object2 = {'value': 'key'};
4 | object1 === object2 //false
```

JavaScript Equality Table

Node Assert

Node Assert Basics

<https://nodejs.org/api/assert.html>

Chai Assert

BDD Style Chai

- Uses natural English language chains
- to, be, been, is, that, which, and, has, have, with, at, of, same, but, does
- <http://chaijs.com/api/bdd/>

Assert Style Chai

- TDD Style Asserts
- assert.exists(foo, “Foo is neither null or undefined”);
- <http://chaijs.com/api/bdd/>

Mocha Asserts

- Use an Assertion Library as needed
 - Should.js
 - Chai
 - Better-Assert
 - Unexpected

Mocha Assert

cyber-dojo.org

the place to practice programming



setup a new practice session

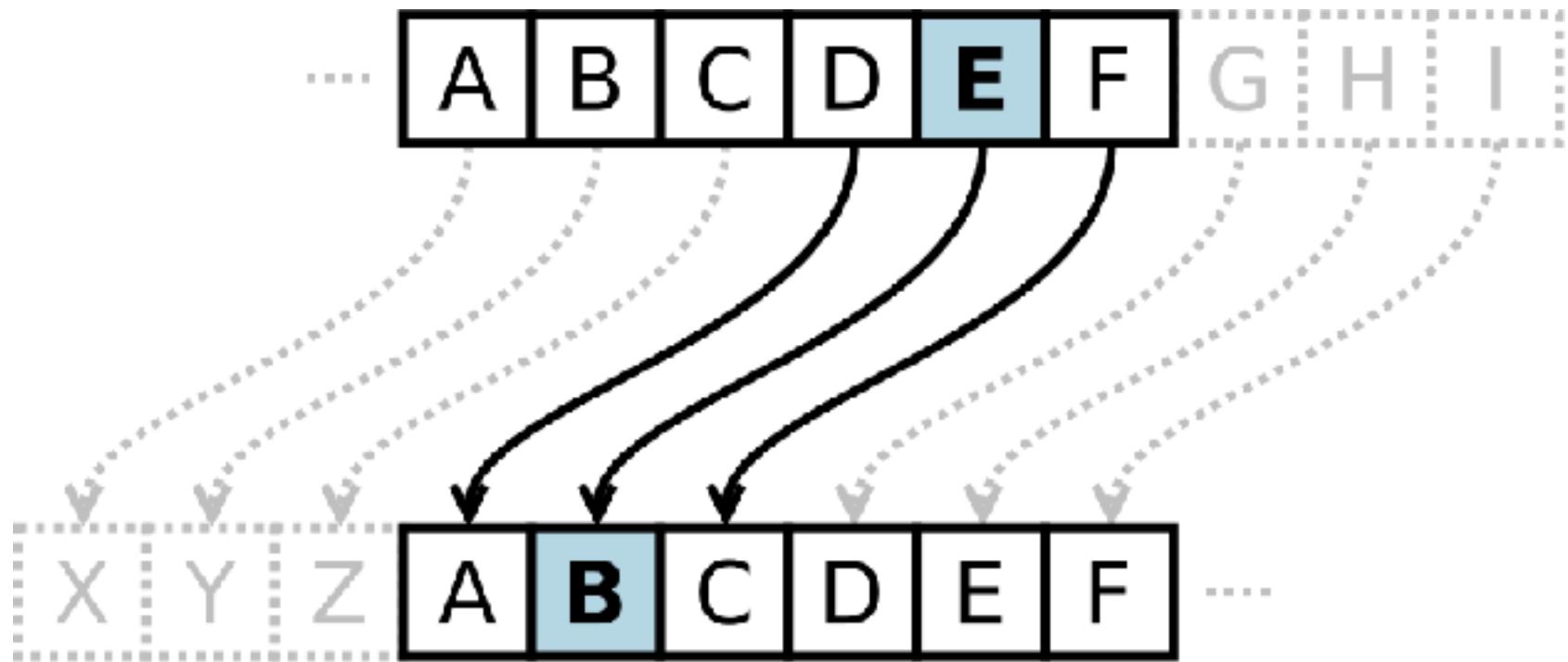
enter a practice session

review a practice session

100% of your donation buys
Raspberry Pi computers to
help children learn to program

**please
donate**

Group Lab: Caesar Cipher



“Foo” $\Rightarrow +5 \Rightarrow$ “Ktt”

Individual Lab/Homework!

Fizz Buzz



Fizz Buzz Test

The "Fizz-Buzz test" is an interview question designed to help filter out the 99.5% of programming job candidates who can't seem to program their way out of a wet paper bag. The text of the programming assignment is as follows:

"Write a program that prints the numbers from 1 to 100. But for multiples of three print "Fizz" instead of the number and for the multiples of five print "Buzz". For numbers which are multiples of both three and five print "FizzBuzz"."

*Don't believe it,
it's more like 60%*

<http://wiki.c2.com/?FizzBuzzTest>

Day 2: Isolated Testing

Isolated Testing

Isolation

- The key to unit testing is isolation
- Mock, Stub, Dummy, or Fake dependencies
- Prefer to investigate an interface of the object you wish to inject.

Evidence of Dependencies

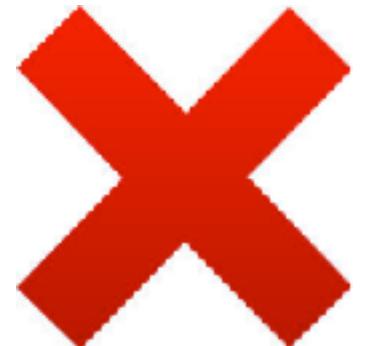
No evidence of a Dependency

```
public void method1() {  
    new Employee("Roger", "Moore");  
}
```



No evidence of a static dependency

```
public void method2() {  
    Resource resource =  
        ServerInstance.find("/accounts/resource");  
    resource.addDeposit(3000.00);  
}
```



Static Dependency Hard to Control

```
public Resource method3() {  
    Resource resource =  
        ServerInstance.find("/accounts/resource");  
    resource.addDeposit(3000.00);  
    return resource;  
}
```



Full Evidence of a Dependency

```
public Resource method4(Resource resource)
{
    resource.addDeposit(3000.00);
    return resource;
}
```



Full Evidence of a Dependency

```
public Employee method4() {  
    return new Employee("Sean",  
"Connery"); //OK  
}
```



Full Evidence of a Dependency

```
public List<Employee> method5() {  
    return Arrays.asList(  
        new Employee("Sean", "Connery"),  
        new Employee("George", "Lazenby"),  
        new Employee("Pierce", "Brosnan"),  
        new Employee("Roger", "Moore"),  
        new Employee("Timothy", "Dalton"),  
        new Employee("Daniel", "Craig"));  
}
```



Fakes

“

Objects that actually have working implementations, but usually take some shortcut which makes them not suitable for production (an in memory database is a good example).

”

Martin Fowler - <http://martinfowler.com/articles/mocksArentStubs.html>

Dummies

“

Objects that are passed around but never actually used. Usually they are just used to fill parameter lists.

”

Stubs

“

Stubs provide canned answers to calls made during the test, usually not responding at all to anything outside what's programmed in for the test. Stubs may also record information about calls, such as an email gateway stub that remembers the messages it 'sent', or maybe only how many messages it 'sent'.

”

Mocks

“

Mocks are ... objects pre-programmed with expectations which form a specification of the calls they are expected to receive.

”

Java 8 Functions

- Lambda Expressions are available now on Java 8
- Potential to minimize the use of mocks & stubs, save time

Java 8 Functions

“

A functional interface is any interface that contains only one abstract method. (A functional interface may contain one or more default methods or static methods.) Because a functional interface contains only one abstract method, you can omit the name of that method when you implement it.

”

Functional Interface Definition - <https://docs.oracle.com/javase/tutorial/java/javaOO/lambdaexpressions.html>

The thing that you will find is the more you adapt either functions or higher abstractions *the more likely you will not need mocks.*

Mocking Frameworks

EasyMock

- One of the first mocking frameworks
- <http://www.easymock.org>
- Strict by default

JMock

- Mocking Framework
- No current release since 2012

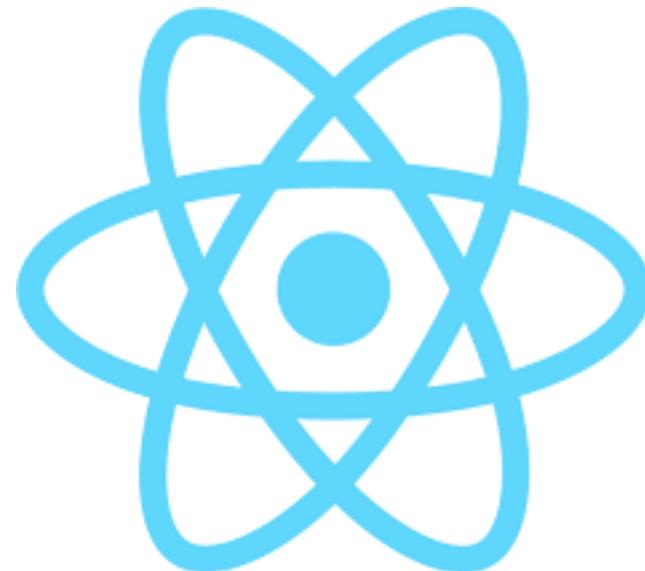
Mockito

- Flexible Mocking Framework
- Most popular of the mocking framework
- Lenient

Lab: Testing A Database with Java



Lab: Testing A React Application



Best Practices and Advice

Code Reviewer Guide

<http://misko.hevery.com/code-reviewers-guide/>



Miško Hevery

The Testability Explorer Blog



Exception Handling

- One Exception can be thrown for multiple reasons
- It is best to check the messages to avoid false positives

AntiPattern: Mocks returning Mocks

- Mocks returning Mocks shows bad form
- Having more than 2 mocks can possibly show bad form
- Shows that a class is multipurpose
- Likely broke the "Single Responsibility Principle"

“

Perhaps a better rule is that we want to test a single concept in each test function. We don't want long test functions that go testing one miscellaneous thing after another.

”

Bob Martin – Clean Code 2008

“

Every class should have responsibility over a single part of the functionality provided by the software, and that responsibility should be entirely encapsulated by the class. All its services should be narrowly aligned with that responsibility

”

Source: http://en.wikipedia.org/wiki/Single_responsibility_principle

Class Cohesion

- Methods should support most if not all private encapsulated member variables
- A few can go unused in some methods, but should have a very good reason to do so.
- Any private member variables that are not entirely supported by encapsulating variables should be removed or refactored

In VCS We Trust

- Commenting out code that you do think you need anymore is bad form
- If you don't need it, **delete it**
- Trust in your version control system
- Commit green and clean code constantly, so that you can recover it
- Take time or take training to know and understand your VCS very well

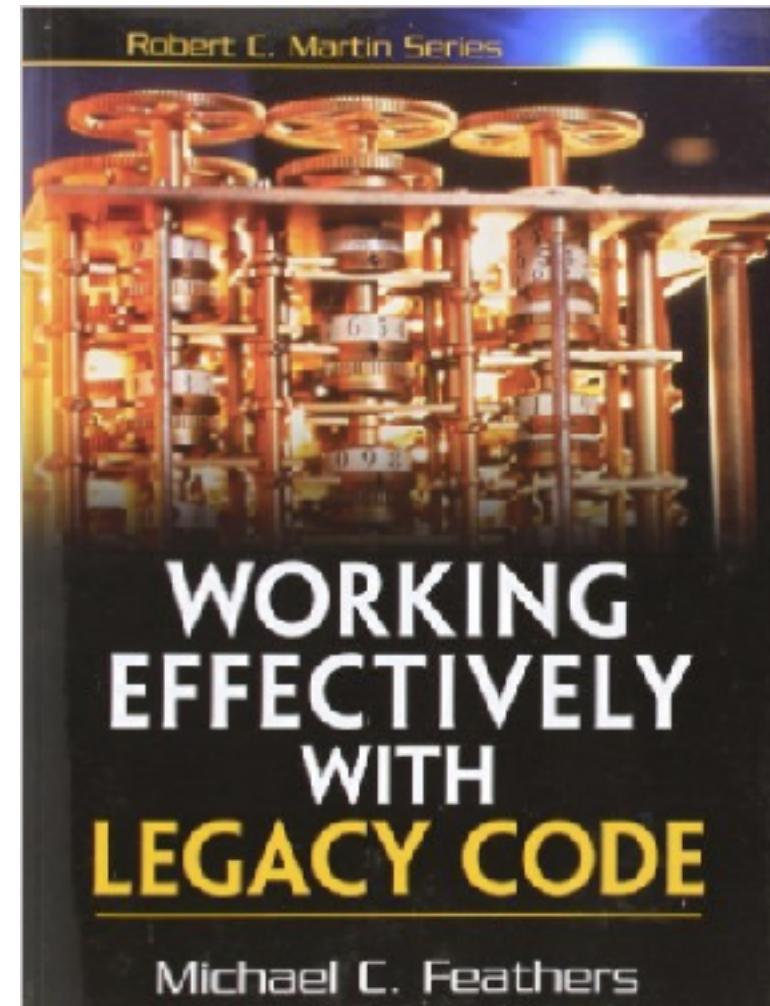
Fail Fast

- Definition: A fail-fast system is designed to immediately report at its interface any failure or condition that is likely to lead to failure.
- Do not hide exceptions
- Go wrong fast and upfront or go wrong in production

What about Powermock?



Testing Legacy Code



```
class Service1 {  
    def bar(int i) {  
        foo.bar(i + 9)  
    }  
}
```



```
class Service2 {  
    def bar(int i) {  
        foo.bar(i + 3)  
    }  
}
```



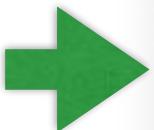
```
class Foo {  
    def barBar(int i) {  
        ...  
    } }  
}
```

Legacy Code Techniques

Parameterize Method

Parameterize Method

```
public class Foo {  
    public void bar() {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
}
```



Step 1: Identify the method that you want to replace

Parameterize Method

```
public class Foo {  
    public void bar() {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
  
    public void bar() {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
}
```

Step 1.1: Make a copy of the method

Parameterize Method

```
public class Foo {  
    public void bar() {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
  
    public void bar(Bar b) {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
}
```

Step 2.1: Add a parameter to the method for the object whose creation you are going to replace.

Parameterize Method

```
public class Foo {  
    public void bar() {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
  
    public void bar(Bar b) {  
        Bar bar =  
        bar.baz();  
        bar.qux();  
    }  
}
```

Step 2.2: Remove the object creation

Parameterize Method

```
public class Foo {  
    public void bar() {  
        Bar bar = new Bar();  
        bar.baz();  
        bar.qux();  
    }  
  
    public void bar(Bar b) {  
        Bar bar = b;  
        bar.baz();  
        bar.qux();  
    }  
}
```

Step 2.3: Add an assignment from the parameter to the variable that holds the object

Parameterize Method

```
public class Foo {  
    public void bar() {  
  
    }  
  
    public void bar(Bar b) {  
        Bar bar = b;  
        bar.baz();  
        bar.qux();  
    }  
}
```

Step 3.1: Delete the body of the original method

Parameterize Method

```
public class Foo {  
    public void bar() {  
        bar(new Bar());  
    }  
  
    public void bar(Bar b) {  
        Bar bar = b;  
        bar.baz();  
        bar.qux();  
    }  
}
```

Step 3.1: Make a call to the parameterized method, using the object creation expression for the original object.

Parameterize Method

```
public class Foo {  
    public void bar() {  
        bar(new Bar());  
    }  
  
    public void bar(Bar b) {  
        Bar bar = b;  
        bar.baz();  
        bar.qux();  
    }  
}
```

Addendum: The new method is now testable

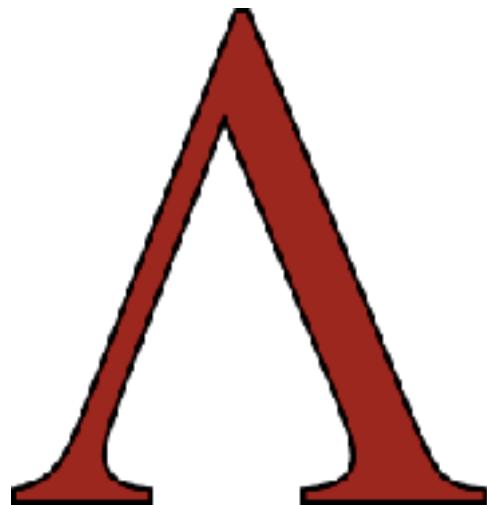
Parameterize Method

```
public class Foo {  
    public void bar() {  
        bar(new Bar());  
    }  
  
    public void bar(Bar bar) {  
        bar.baz();  
        bar.qux();  
    }  
}
```

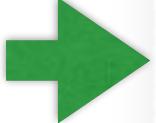
Addendum: After your test, perform refactoring

Parameterize Method to Overcome Static Calls

Parameterize Method to Overcome Static Calls



Parameterize Method



```
public class Foo {  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 1: Identify the method that you want to replace

Parameterize Method

```
public class Foo {  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 1.1: Make a copy of the method

Parameterize Method

```
public class Foo {  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
  
    public void bar(int a, int b,  
                    Function<String, Resource> f){  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 2.1: Add a functional interface to the method for the static you are going to replace.

Parameterize Method

```
public class Foo {  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
  
    public void bar(int a, int b,  
                    Function<String, Resource> f){  
        Resource r = f("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 2.3: Add an assignment from the parameter to the variable that holds what the function will return, including the static's former parameters.

Parameterize Method

```
public class Foo {  
    public void bar(int a, int b) {  
  
    }  
  
    public void bar(int a, int b,  
                  Function<String, Resource> f){  
        Resource r = f("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 3.1: Delete the body of the original method

Parameterize Method

```
public class Foo {  
    public void bar(int a, int b) {  
        bar(a, b,  
            s -> Server.getResource(s)  
    }  
  
    public void bar(int a, int b,  
                    Function<String, Resource> f){  
        Resource r = f("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 3.2: Make a call to the parameterized method, using the object creation expression for the original object.

Caveat

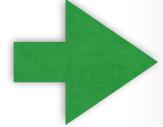
If the function is something where you don't expect much of a different behavior to change you may opt for a “*Parameterize Constructor*” with the function instead.

Parameterize Constructor

Parameterize Constructor

- Constructors are not a part of the interface!
- It is false to think that a change in the constructor will change your interface.

Parameterize Constructor



```
public class Foo {  
    public Foo() {  
        Bar bar = new Bar();  
        bar.init();  
    }  
  
    public baz() {  
        bar.qux();  
    }  
}
```

Step 1: Identify the constructor that you want to parameterize

Parameterize Constructor

```
public class Foo {  
    public Foo() {  
        Bar bar = new Bar();  
        bar.init();  
    }  
  
    public Foo() {  
        Bar bar = new Bar();  
        bar.init();  
    }  
  
    public baz() {  
        bar.qux();  
    }  
}
```

Step 1.1: Make a copy of it.

Parameterize Constructor

```
public class Foo {  
    public Foo() {  
        Bar bar = new Bar();  
        bar.init();  
    }  
  
    public Foo(Bar b) {  
        Bar bar = new Bar();  
        bar.init();  
    }  
  
    public baz() {  
        bar.qux();  
    }  
}
```

Step 2.1: Add a parameter to the constructor for the object whose creation you are going to replace

Parameterize Constructor

```
public class Foo {  
    public Foo() {  
        Bar bar = new Bar();  
        bar.init();  
    }  
  
    public Foo(Bar b) {  
        Bar bar = b  
        bar.init();  
    }  
  
    public baz() {  
        bar.qux();  
    }  
}
```

Step 2.2: Remove the object creation and add an assignment from the parameter to the instance variable for the object.

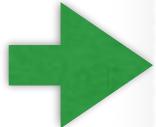
Parameterize Constructor

```
public class Foo {  
    public Foo() {  
        this(new Bar());  
    }  
  
    public Foo(Bar b) {  
        Bar bar = b  
        bar.init();  
    }  
  
    public baz() {  
        bar.qux();  
    }  
}
```

Step 3: Remove the body of the old constructor and replace it with a call to the new constructor

**Parameterize Constructor
with Lambdas to overcome
static calls**

Parameterize Constructor



```
public class Foo {  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 1: Identify the static method that you want to parameterize in a constructor

Parameterize Constructor

```
public class Foo {  
    public Foo() {}  
    public Foo() {}  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 1.1: Make a copy of the constructor
(in this case there was no explicit constructor, so I
made two to preserve signatures)

Parameterize Constructor

```
public class Foo {  
    public Foo() {}  
    public Foo(Function<String, Resource> f) {}  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 2.1: Add a parameter to the new constructor
for the functional interface that matches your static's
signature

Parameterize Constructor

```
public class Foo {  
    private Function<String, Resource> f;  
    public Foo() {}  
    public Foo(Function<String, Resource> f) {}  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 2.2: Create a member variable to store the function

Parameterize Constructor

```
public class Foo {  
    private Function<String, Resource> f;  
    public Foo() {}  
    public Foo(Function<String, Resource> f) {  
        this.f = f;  
    }  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 2.2: Add an assignment from the parameter to the member variable in the copied constructor

Parameterize Constructor

```
public class Foo {  
    private Function<String, Resource> f;  
    public Foo() {  
        this(s -> Server.getResource(s))  
    }  
    public Foo(Function<String, Resource> f) {  
        this.f = f;  
    }  
    public void bar(int a, int b) {  
        Resource r = Server.getResource("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 3: Remove the body of the old constructor
(if applicable) and replace it with a call to the new constructor

Parameterize Constructor

```
public class Foo {  
    private Function<String, Resource> f;  
    public Foo() {  
        this(s -> Server.getResource(s))  
    }  
    public Foo(Function<String, Resource> f) {  
        this.f = f;  
    }  
    public void bar(int a, int b) {  
        Resource r = f("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Step 4: Replace the static with your function

Parameterize Constructor

```
public class Foo {  
    private Function<String, Resource> f;  
    public Foo() {  
        this(Server::getResource)  
    }  
    public Foo(Function<String, Resource> f) {  
        this.f = f;  
    }  
    public void bar(int a, int b) {  
        Resource r = f("account")  
        r.send(r.process(a, b) * 10);  
    }  
}
```

Addendum: test your method with TDD, refactor

Sprout Class & Method

Sprout Method

Sprout Method



```
public class Foo {  
    int i;  
    public void bar {  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 1: Identify where you need to make your code change.

Sprout Method

```
public class Foo {  
    int i;  
    public void bar {  
        //baz()  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 2: If the change can be formulated as a single sequence of statements in one place in a method, write down a call for a new method that will do the work involved and then comment it out.

Sprout Method

```
public class Foo {  
    int i;  
    public void bar {  
        //baz(i)  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 3: Determine what local variables you need from the source method, and make them arguments to the call.

Sprout Method

```
public class Foo {  
    int i;  
    public void bar {  
        //float f = baz(i)  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 4: Determine whether the sprouted method will need to return values to source method. If so, change the call so that its return value is assigned to a variable.

Sprout Method

```
public class Foo {  
    int i;  
    public void baz {...}  
    public void bar {  
        //float f = baz(i)  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

```
public class FooTest {  
    @Test  
    public void testBaz {  
        Foo foo = new Foo();  
        assertEquals(  
            19.0f, foo.baz(10))  
    }  
}
```

Step 5: Develop the sprout method using test-driven development

Sprout Method

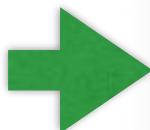
```
public class Foo {  
    int i;  
    public void baz {...}  
    public void bar {  
        float f = baz(i)  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

```
public class FooTest {  
    @Test  
    public void testBaz {  
        Foo foo = new Foo();  
        assertEquals(  
            19.0f, foo.baz(10))  
    }  
}
```

Step 5: Remove the comment in the source method to enable the call.

Sprout Class

Sprout Class



```
public class Foo {  
    int i;  
    public void bar() {  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 1: Identify where you need to make your code change.

Sprout Class

```
public class Foo {  
    int i;  
    public void bar() {  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 2.1: If the change can be formulated as a single sequence of statements in one place in a method, think of a good name for a class that could do that work.

Sprout Class

```
public class Foo {  
    int i;  
    public void bar() {  
        // Other other = new Other();  
        // other.baz();  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 2.2: Write code that would create an object of that class in that place, and call a method in it that will do the work that you need to do; then comment those lines out.

Sprout Class

```
public class Other {  
    public Other(int i) {}  
    public void baz(){}  
}
```

```
public class Foo {  
    int i;  
    public void bar() {  
        // Other other = new Other(i);  
        // other.baz();  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 3: Determine what local variables you need from the source method, and make them arguments to the classes' constructor.

Sprout Class

```
public class Other {  
    public Other(int i) {}  
    public float baz(){}  
}  
  
public class Foo {  
    int i;  
    public void bar() {  
        // Other other = new Other(i);  
        // other.baz();  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 4.1: Determine whether the sprouted class will need to return values to the source method. If so, provide a method in the class that will supply those values,

Sprout Class

```
public class Other {  
    public Other(int i) {}  
    public float baz(){}  
}
```

```
public class Foo {  
    int i;  
    public void bar {  
        // Other other = new Other(i);  
        // float f = other.baz();  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 4.2: Add a call in the source method to receive those values.

Sprout Class

```
public class Other {  
    public Other(int i) {}  
    public float baz(){}  
}
```

```
public class OtherTest {  
    @Test  
    public void testBaz() {  
        ...  
        assertEquals(...)  
    }  
}
```

Step 5: Develop the sprout class test first (TDD)

Sprout Class

```
public class Other {  
    public Other(int i) {}  
    public float baz(){}  
}
```

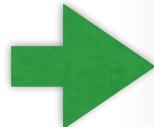
```
public class Foo {  
    int i;  
    public void bar {  
        Other other = new Other(i);  
        float f = other.baz();  
        doSomething1;  
        doSomething2;  
        doSomething3;  
    }  
}
```

Step 6: Remove the comments

Wrap Class & Method

Wrap Method

Wrap Method (v1)



```
public class Foo {  
    public void deposit(int amt) {...}  
}
```

1. Identify a method you need to change.

Wrap Method (v1)

```
public class Foo {  
    protected void depositTx(int amt) {...}  
    public void deposit(int amt) {}  
}
```

Step 2: Rename the method and then create a new method with the same name and signature as the old method.

Wrap Method (v1)

```
public class Foo {  
    protected void depositTx(int amt) {  
        ...  
    }  
    public void deposit(int amt) {  
        depositTx(amt);  
    }  
}
```

Step 3: Place a call to the old method in the new method

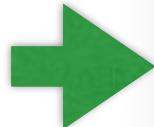
Wrap Method (v1)

```
public class Foo {  
    public void depositTx(int amt) {...}  
    public void deposit(int amt) {  
        audit(amt, "Depositing");  
        depositTx(amt);  
        audit(amt, "Deposited");  
    }  
    protected void audit(int amt, String msg) {...}  
}
```

Step 4: Develop a method for the new feature, test first, and call it from the new method

Wrap Method (v2)

Wrap Method (v2)



```
public class Foo {  
    public void deposit(int amt) {...}  
}
```

1. Identify a method you need to change.

Wrap Method (v2)

```
public class Foo {  
    public void deposit(int amt) {...}  
    protected void audit(int amt, String msg) {...}  
}
```

Step 2: Develop a new method for it using test-driven development.

Wrap Method (v2)

```
public class Foo {  
    public void deposit(int amt) {...}  
    protected void audit(int amt, String msg) {...}  
    public void auditedDeposit(int amt) {  
        audit(amt, "Depositing");  
        deposit(amt);  
        audit(amt, "Deposited");  
    }  
}
```

Step 3: Create another method that calls the new method and the old method.

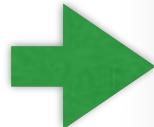
Wrap Method (v2)

```
public class Foo {  
    public void deposit(int amt) {...}  
    protected void audit(int amt, String msg) {...}  
    public void auditedDeposit(int amt) {  
        audit(amt, "Depositing");  
        deposit(amt);  
        audit(amt, "Deposited");  
    }  
}
```

Addendum: You now have a choice, regular or audited

Wrap Class

Wrap Class



```
public class Foo {  
    public void deposit(int amt) {...}  
}
```

1. Identify a method you need to change.

Wrap Class

```
public interface Foo {  
    public void deposit(int amt);  
}
```

```
public class FooImpl implements Foo {  
    public void deposit(int amt) {...}  
}
```

2. Extract an interface from a class

Wrap Class

```
public interface Foo {  
    public void deposit(int amt);  
  
    public class FooLogger implements Foo {  
        public FooLogger(Foo foo) {...}  
        public void deposit(int amt) {}  
    }  
  
    public void deposit(int amt) {...}  
}
```

3. Create a class that accepts the interface you are going to wrap as a constructor argument

Wrap Class

```
public class FooLogger implements Foo {  
    public FooLogger(Foo foo) {...}  
    protected void audit(int amt, String msg) {...}  
    public void deposit(int amt) {}  
}
```

```
public class FooLoggerTest {  
    @Test  
    public void testAudit() {...}  
}
```

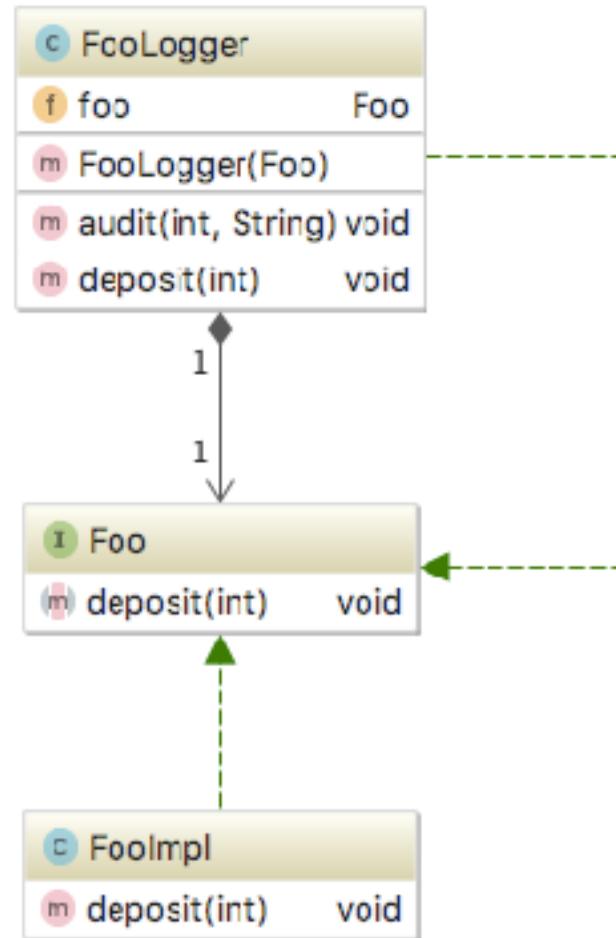
4. Create a new method using TDD that does the new work and behavior

Wrap Class

```
public class FooLogger implements Foo {  
    private Foo foo;  
    public FooLogger(Foo foo) {this.foo = foo;}  
    protected void audit(int amt, String msg) {...}  
    public void deposit(int amt) {  
        audit(amt, "Depositing");  
        foo.deposit(amt);  
        audit(amt, "Deposited");  
    }  
}
```

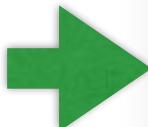
-
5. Ensure that you call the old methods on the old class

Wrap Class



Introduce Instance Delegator

Introduce Instance Delegator



```
public class Foo {  
    public static bar(int x, String y) {...}  
}
```

Step 1: Identify a static method that is problematic to use in a test.

Introduce Instance Delegator

```
public class Foo {  
    public static void bar(int x, String y) {...}  
    public void inBar(int x, String y) {  
        }  
}
```

Step 2: Create an instance method for
the static method on the class,
preserving signatures

Introduce Instance Delegator

```
public class Foo {  
    public static void bar(int x, String y) {...}  
    public void inBar(int x, String y) {  
        bar(x, y);  
    }  
}
```

Step 3: Make the instance method
delegate to the static method.

Introduce Instance Delegator

```
public class Nom {  
    public void chomp(int i, int j, String status) {  
        Foo.bar(i + j, status);  
    }  
}
```

Step 4: Find locations where the static call was made.

Introduce Instance Delegator

```
public class Nom {  
    public Nom() {}  
    public Nom(Foo foo) {this.foo = foo;}  
    public void chomp(int i, int j, String status) {  
        foo.inBar(i + j, status);  
    }  
}
```

Step 5. Use ParameterizeMethod or
ParameterizeConstructor to exchange it for the
instance call.

Passing Null

Passing Null

- It's important to get the test out as soon as possible.
- If you need to create a test and the subject under test (SUT) is hard to construct *pass null!*

Subclass and Override Method

Subclass and Override Method

```
public class InterestRateCalc {  
    private final float callWS() {..}  
    public float calculate {...}  
}
```

Step 1: Identify the method dependencies that are complex, gather those that are giving you problems

Subclass and Override Method

```
public class InterestRateCalc {  
    private float callWS() {..}  
    public float calculate {...}  
}
```

Step 2: Make each method overridable

Subclass and Override Method

```
public class InterestRateCalc {  
    protected float callWS() {..}  
    public float calculate {...}  
}
```

Step 3: Adjust the visibility

Subclass and Override Method

```
public class TestableInterestRateCalc extends InterestRateCalc {  
    protected float callWS() {return 100.0;} //fake  
    public float calculate {...} //testable  
}
```

Step 4: Create a subclass that overrides the methods. Verify that you are able to build it in your test harness.

Subclass and Override Method

```
public class InterestRateCalcTest
        extends InterestRateCalc {
    @Override
    protected float callWS() {return 100.0;} //fake

    public void testCalculate() {
        assertEquals(200, this.calculate());
    }
}
```

Addendum: You can also extend in a test class!

Sensing Variables

Sensing Variables

- A publicly accessible public variable used to determine if a certain behavior is triggered.
- It is then used in a test to verify and used to test other regressions.
- Once long methods have been broken up the tests and sensing variable can be removed.
- Great for the long “inverted pyramid” code

Sensing Variables

```
public class TaxCode {  
    public void applyTaxAndSurcharge(Order order) {  
        Money total = order.total();  
        if (order.after(LocalDate.of("2001-01-01))) {  
            if (order.customer.getState().equals("FL") ||  
                order.customer.getState().equals("NY"))  
                order.applySurcharge(new Money(10))  
                order.applyTax(new Money(total * .10));  
                TaxWS.findTaxRate(order.customer.getState());  
            } else  
                order.applyTax(new Money(total))  
        }  
    } else {  
        order.applyTax(0)  
        order.applySurcharge(0)  
    }  
}
```

Sensing Variables

```
public class TaxCode {  
    public boolean nyFLTAXApplied = false;  
    public void applyTaxAndSurcharge(Order order) {  
        Money total = order.total();  
        if (order.after(LocalDate.of("2001-01-01"))) {  
            if (order.customer.getState().equals("FL") ||  
                order.customer.getState().equals("NY"))  
                order.applySurcharge(new Money(10))  
                order.applyTax(new Money(total * .10))  
                TaxWS.findTaxRate(order.customer.getState());  
                nyFLTAXApplied = true;  
            else  
                order.applyTax(new Money(total));  
        }  
    } else {  
        order.applyTax(0)  
        order.applySurcharge(0)  
    }  
}
```

Sensing Variables

```
public class TaxCode {  
    public boolean nyFLTAXApplied = false  
    public void applyTaxAndSurcharge(Order order) {  
        Money total = order.total();  
  
        public class TaxCodeTest {  
            public void testNYFLTAXApplied() {  
                Order fakeOrder = ...;  
                TaxCode taxCode = new TaxCode();  
                taxCode.applyTaxAndSurcharge(fakeOrder);  
                assertTrue(taxCode.nyFLTAXApplied());  
            }  
        }  
  
        } else {  
            order.applyTax(0)  
            order.applySurcharge(0)  
        }  
    }  
}
```

The naysayers

"It takes a lot time"

"In the beginning, it does, but anything worthwhile takes time. It is a great practice, and the initial time investment up front will provide faster code maintenance later."

**"Mocking is kind of an
inane practice"**

**"There should only be two mocks or
less used per test. If there are more,
you may have to reevaluate your
design"**

"Seems I am going to spend my whole life testing!"

"Test your core. Test what you believe is critical to the project. Test also what you believe will have a negative impact if given the wrong input"

**"Testing in general sucks when
my boss asks me to make a
change"**

**"Don't change your class that you
worked so hard on. Respect your code.
There are many design patterns that you
can use to change the behavior of your
code. Look up Adapter Pattern,
Decorator Pattern, and the Strategy
Pattern"**

"We weren't taught that way"

**"Agreed, but we are doing more than
Hello World apps now. We are also paid
to maintain what we create."**

Quotes from the Pros

“

As a programmer, do you deserve to feel confident?" (Can you sleep at night knowing your code works)

”

Kent Beck, Is TDD Dead? You Tube
Video Series

“

The primary benefit of TDD is self testing code

”

Kent Beck, Is TDD Dead? You Tube Video Series

“

Testing extends what the compiler does, check against your domain to ensure what you are doing is accurate.

”

Daniel Hinojosa -- Yes, I am quoting myself

“

I know this sounds strident and unilateral, but given the record I don't think surgeons should have to defend hand-washing, and I don't think programmers should have to defend TDD.

”

Robert Martin, The Clean Coder: A Code of Conduct for Professional Programmers 2011

“

To me, legacy code is simply code without tests.

”

Michael Feathers, Working Effectively with Legacy Code 2004

Recap

Recap

- Test First.. Always
- Have an editor **and** an IDE of choice, and learn its keymap very well
- Learn your version control very well.
- Speed in TDD is key.
- Perhaps a mock can be replaced by a function!
- "Game"ify your development with testing