

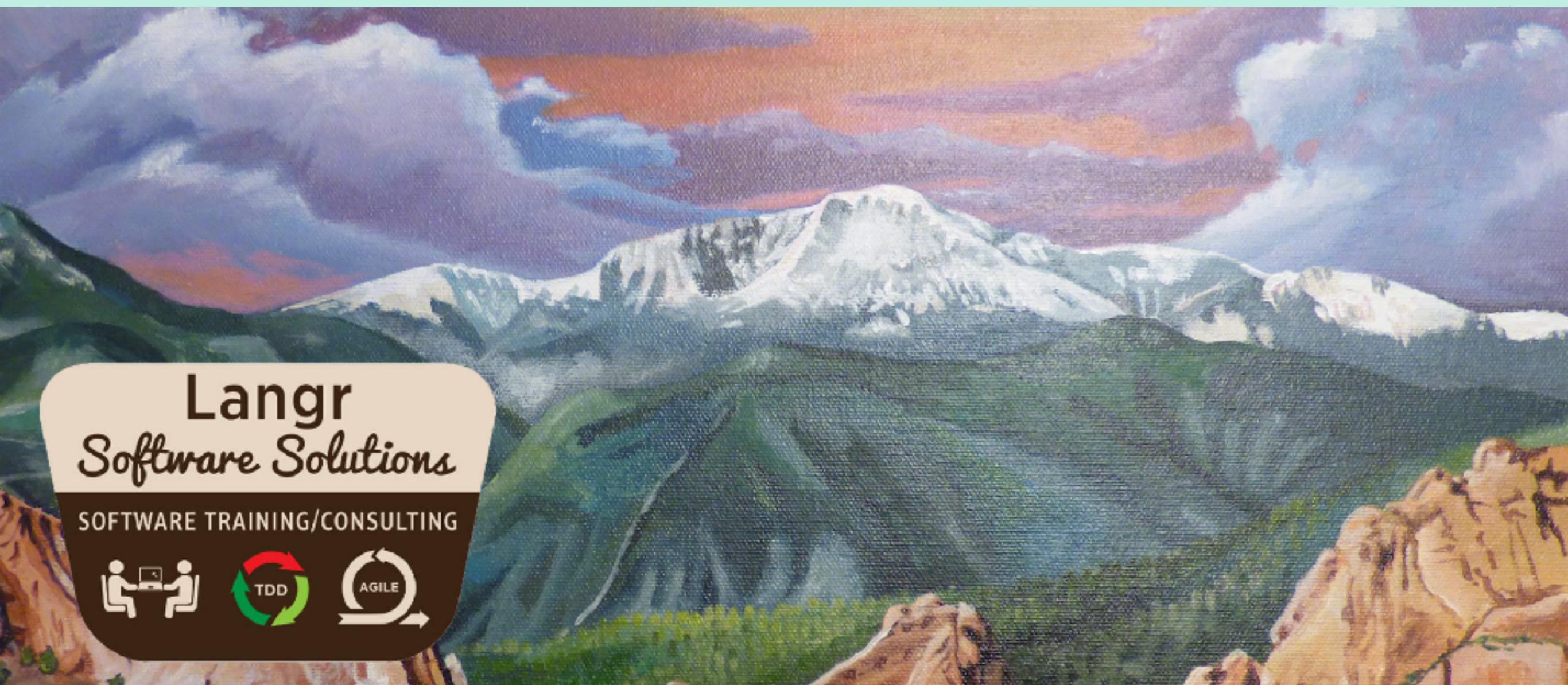


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Test-Driven Development Foundations: Scala v1.0

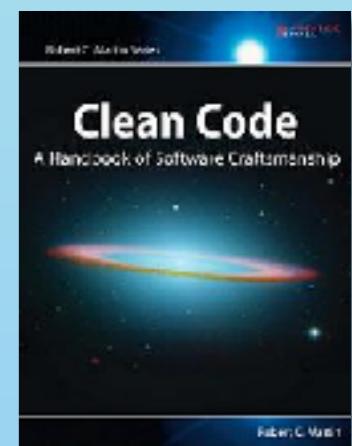
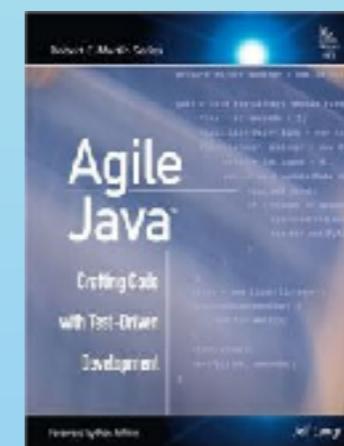
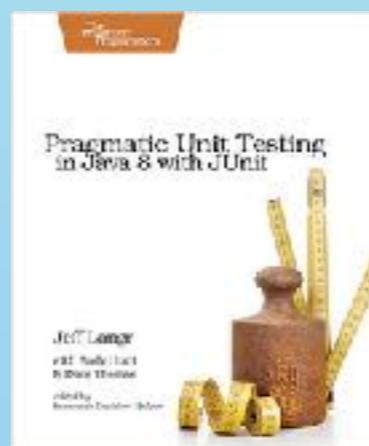
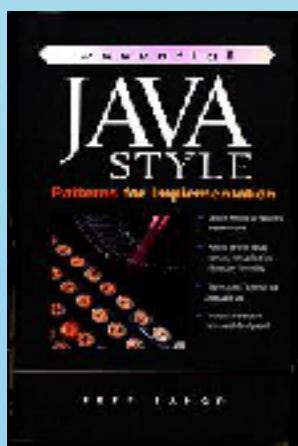
Jeff Langr

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@JLangr



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What's a Unit Test Look Like?

```
describe("something") {  
    it("demonstrates some behavior") {  
        // Arrange  
  
        // Act  
  
        // Assert  
    }  
}
```

The AAA mnemonic is courtesy of Bill Wake.

A Sample Unit Test

```
describe("an auto") {  
    val auto = Auto()  
  
    it("idles engine when started") {  
        auto.depressBrake()  
  
        auto.pressStartButton()  
  
        auto.RPM() shouldBe 1000 +- 50  
    }  
}
```

What's an Assertion Look Like?

Some fundamentals:

```
someCondition shouldBe true  
someCondition should be (true)  
idleSpeed shouldEqual 1000  
idleSpeed should not equal 2000  
idleSpeed should equal (1000)  
idleSpeed should not be < (900)  
alphabetizedName shouldEqual "Schmoo, Kelly Loo"  
alphabetizedName should startWith regex ("S.*,")
```

See http://www.scalatest.org/user_guide/using_matchers

What's an Assertion Look Like?

More interesting stuff:

```
someList should contain('0')
someList should contain theSameElementsInOrderAs
  Seq('0', 'T', 'T', 'F', 'F', 'S', 'S')
someList should contain inOrder('0', 'T', 'S')
someList should not be empty
someList should have length 7
forAll (someList) { c: Char => c.isLetter should be (true)}
someOption shouldBe empty
```

You can also create custom matchers!

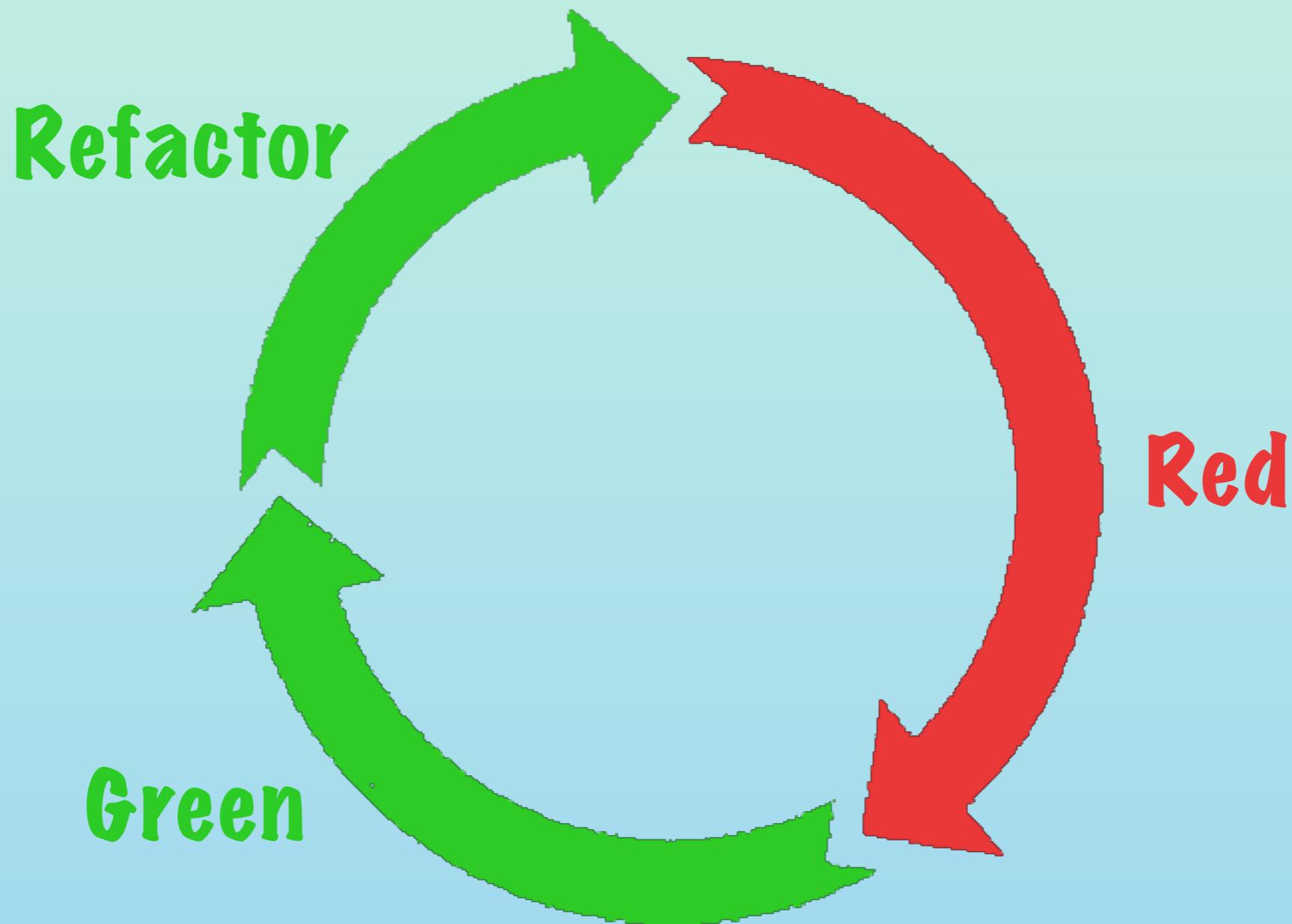
See http://www.scalatest.org/user_guide/using_matchers

Exercise: Simple Outcomes



Flesh out the tests in `com.langrsoft.util.BasicsTest`

Test-Driven Development



An incremental design technique

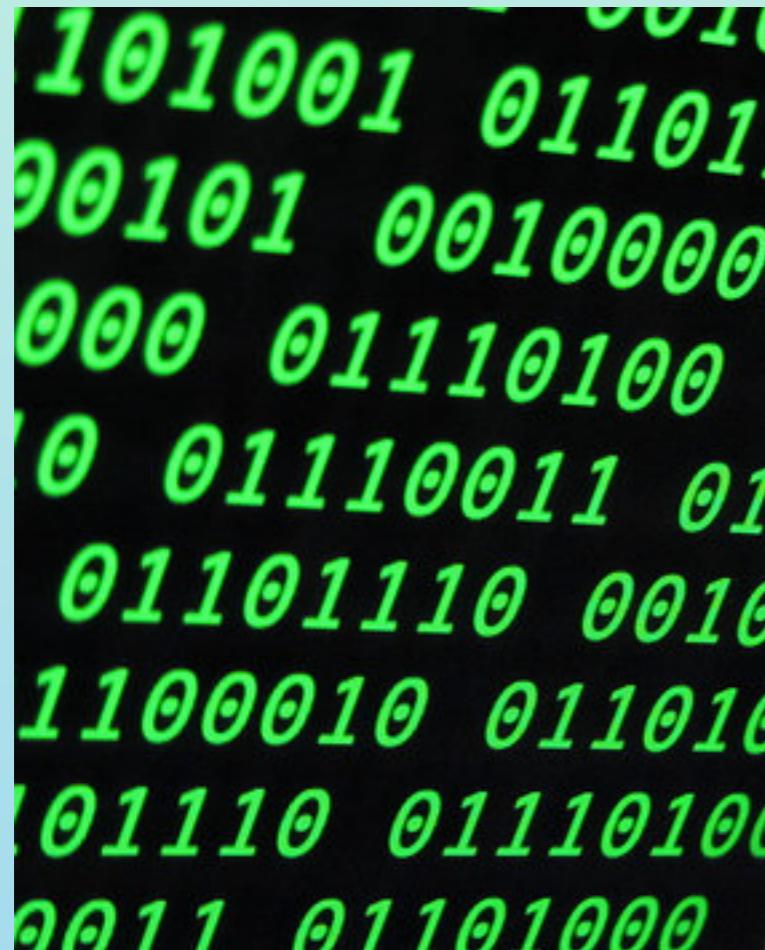
Exercise: (Test)-Code-Refactor

TDD Paint by Numbers



See `com.langrsoft.util.NameNormalizerTest`

Core TDD Themes



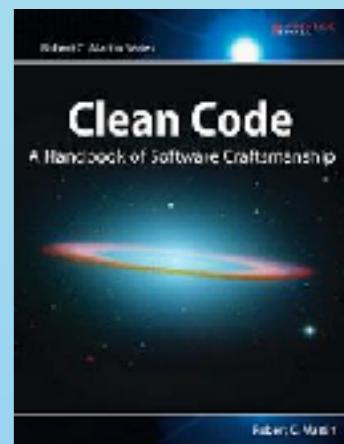
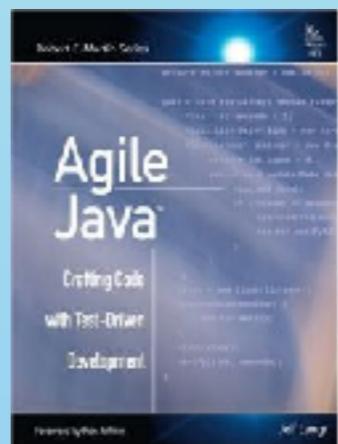
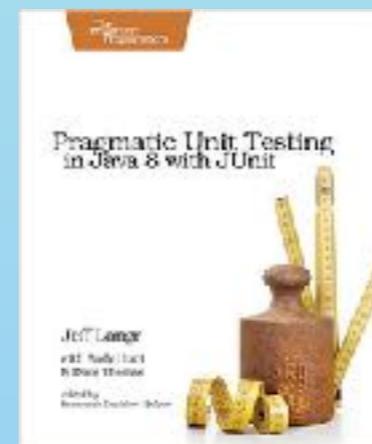
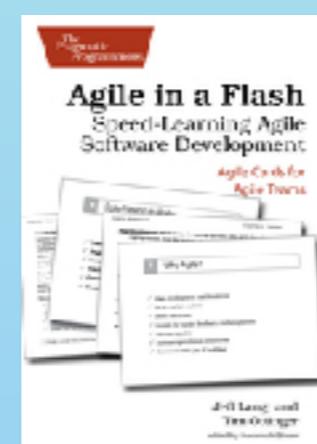
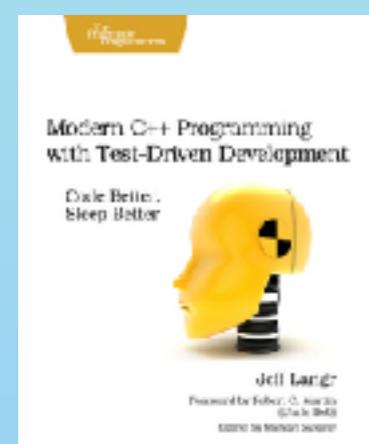
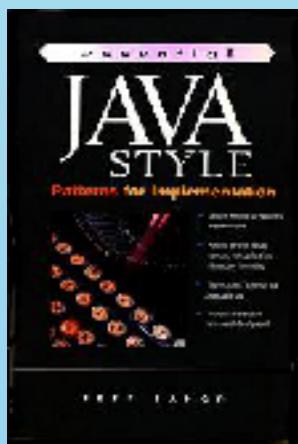
- Drive *behavior*
- Specification by example
- Small increments
- Stick to the cycle
 - Always see red
 - Always refactor

It's just code!

Stepping Back: Writing Tests

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Recent File List

Create a list of recently-opened files
(max: 5) for use in a GUI application.



What tests do we need?

ZOMBIES!

- Zero
- One
- Many
- Boundaries
- Interface definition
- Exceptional behavior
- Simple Solutions & Scenarios



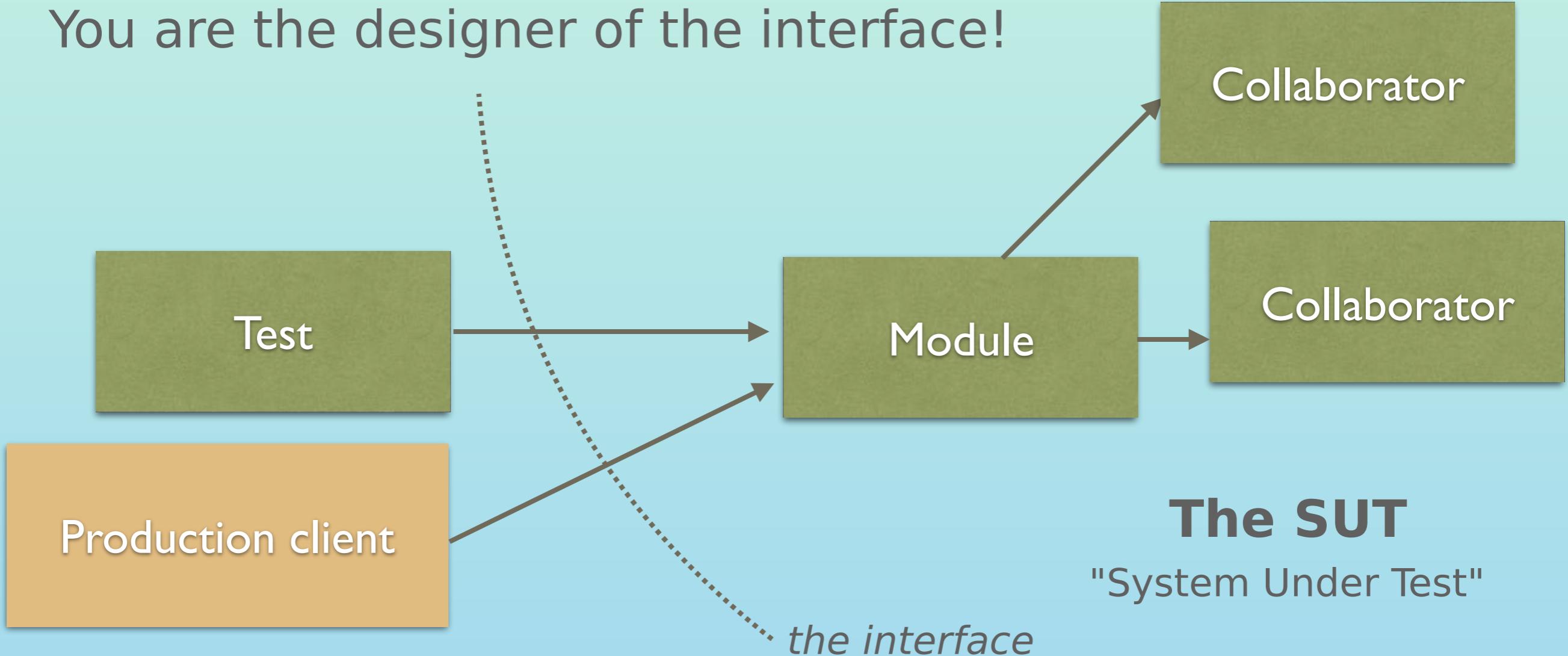
<http://blog.wingman-sw.com/archives/677>

Test Lists

- **Z:** No files opened
- **O:** One file opened
- **M:** Multiple files opened
- **B:** One more than capacity opened
- **E:** File opened twice

Your Test Is the First Client

You are the designer of the interface!



Structuring the Test

"shifts duplicate filename to top of recently-used list"

■ Arrange	Add file with name <code>opened-A.txt</code> Add file with name <code>opened-B.txt</code> Add file with name <code>opened-C.txt</code>
■ Act	Add file with name <code>opened-A.txt</code>
■ Assert	Expect recently-used list to equal: <code>opened-A.txt</code> <code>opened-C.txt</code> <code>opened-B.txt</code>

Assert-First

```
it("should sift duplicate filename to top") {  
    // ?  
  
    recentlyUsedList.orderedFilenames shouldEqual  
        Seq(duplicateOfAddedFirst, "3rd", "2nd")  
}
```

Consider working from the outcome.

Assert-First

```
it("should sift duplicate filename to top") {  
    // ?  
  
    recentlyUsedList.add(duplicateOfAddedFirst)  
  
    recentlyUsedList.orderedFilenames shouldEqual  
        Seq(duplicateOfAddedFirst, "3rd", "2nd")  
}
```

Assert-First

```
it("should sift duplicate filename to top") {  
    recentlyUsedList.add("1st")  
    recentlyUsedList.add("2nd")  
    recentlyUsedList.add("3rd")  
    val duplicateOfAddedFirst = "1st"  
  
    recentlyUsedList.add(duplicateOfAddedFirst)  
  
    recentlyUsedList.orderedFilenames shouldEqual  
        Seq(duplicateOfAddedFirst, "3rd", "2nd")  
}
```

Exercise: Stock Portfolio Module

- is it empty or not?
- what is the count of unique symbols?
- given a symbol and # of shares, make a purchase
- how many shares exist for a given symbol?
- given a symbol and # of shares, sell the shares
- throw an exception when selling too many shares



"Tokyo Stock Exchange," courtesy <https://www.flickr.com/photos/31029865@N06/>
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*** Remember! ***

Red: Ensure test fails

Green: Implement no more code than necessary

Refactor: Clarify and eliminate all duplication

	09:00	11:30	12:30	15:00
TDK	3430	+85	トヨタ自	2522
キーエンス	18480	-80	ホンダ	2362
デンソー	2115	+38	スズキ	1613
ファナック	11790	+340	ニコン	1726
ローム	3565	+45	HOYA	1639
京セラ	6260	+120	キヤノン	3465
村田製	3960	+15	リコー	671
日東電	2819	+9	凸版印	575
三菱重	328	+2	大日印	756
日産自	696	+4	任天堂	10560
食品		+0.83	電力・ガス	56.43
エネルギー資源	113.35	+1.53	運輸・物流	
建設・資材		+0.62	商社・卸売	
素材・化学	97.74	+0.62	小売	
医薬品		+0.37	銀行	

Test-Driving a Functional Solution

```
it("is empty for newly created data") {  
    Portfolio.isEmpty(PortfolioData()) shouldBe true  
}
```

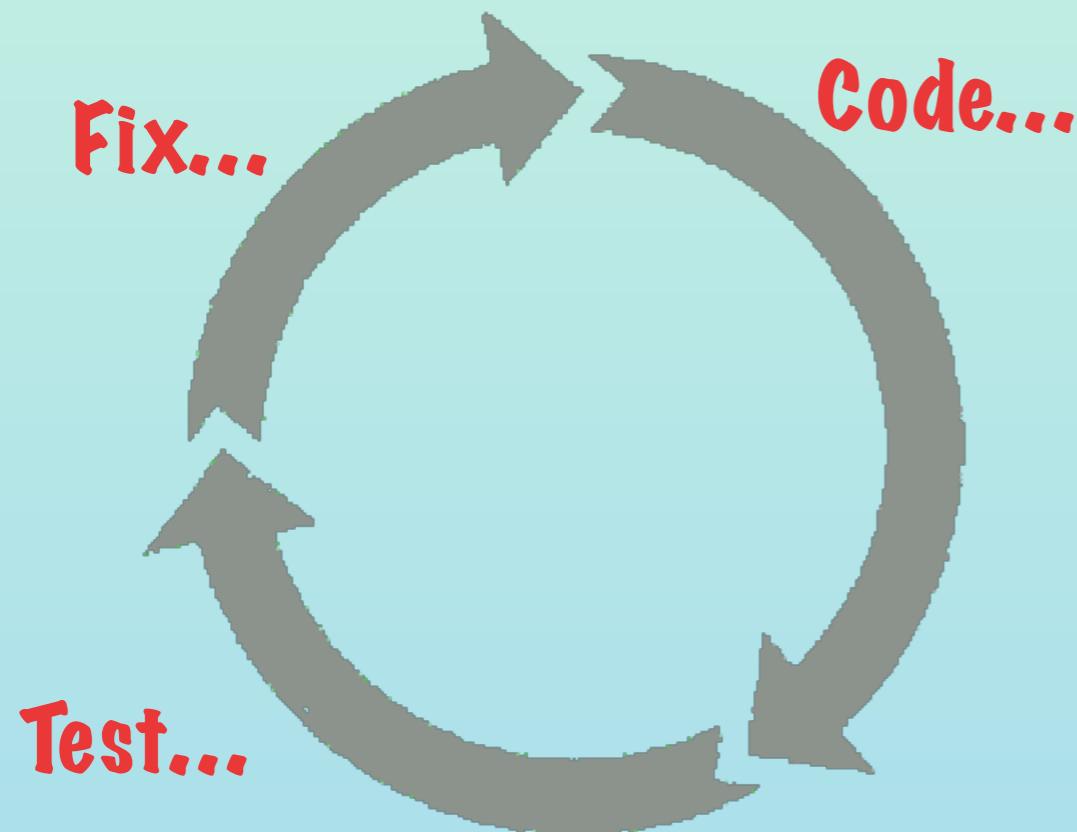


```
case class PortfolioData(/* ... */)  
object Portfolio {  
    def isEmpty(data: PortfolioData) = { /* ... */ }  
}
```

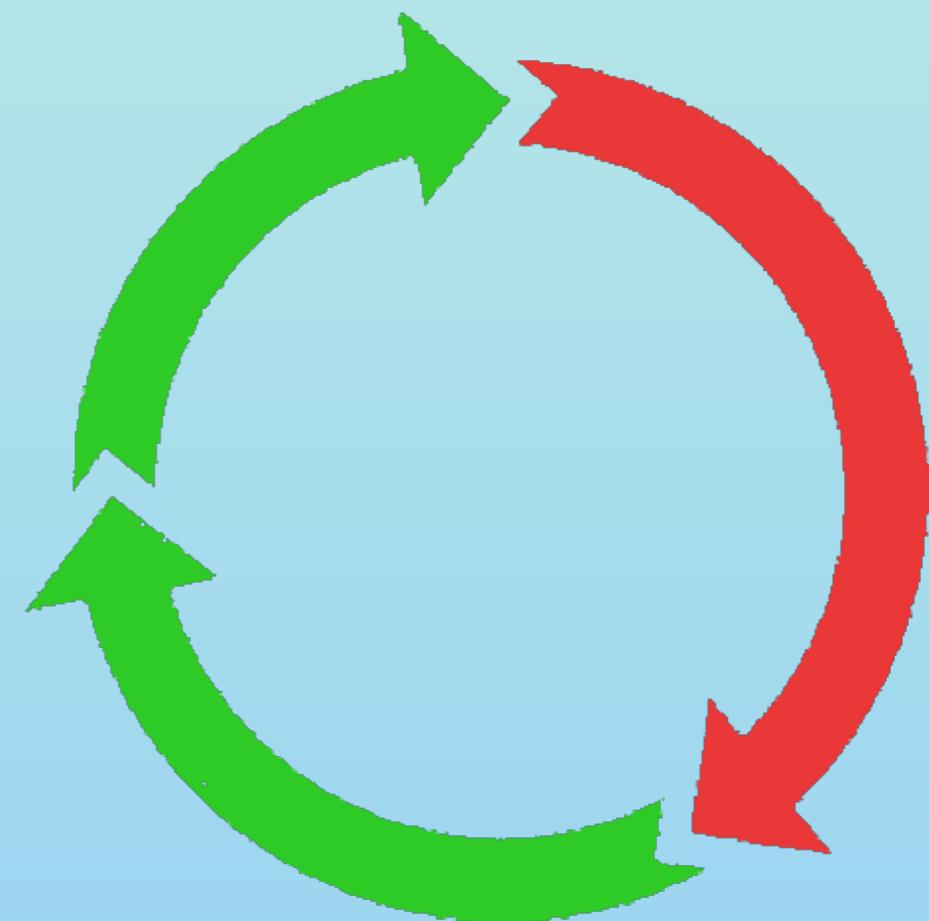
Later...

```
it("increments size with each purchase") {  
    var data = Portfolio.buy(PortfolioData(), "BAYN", 10)  
    data = Portfolio.buy(data, "IBM", 10)  
    Portfolio.symbolCount(data) shouldBe 2  
}
```

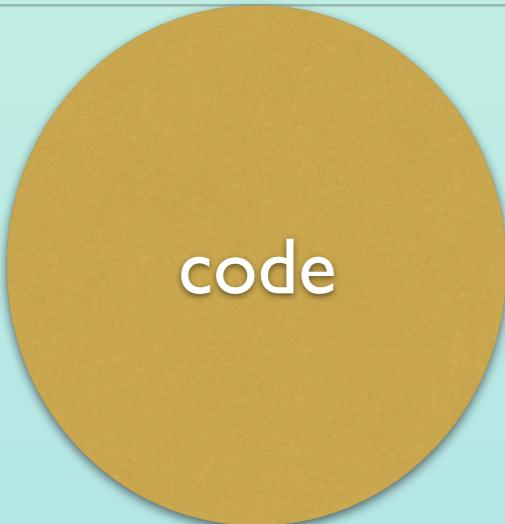
TAD** and TDD: What's the Difference?



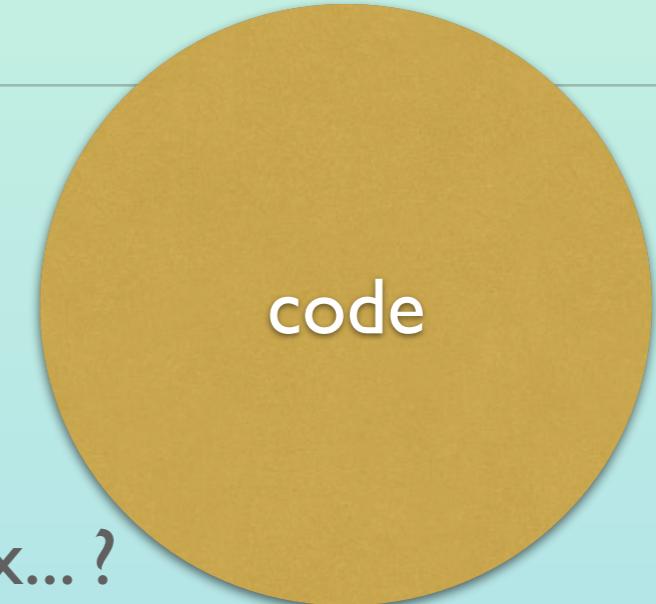
"Test-After Development"



Small Increments



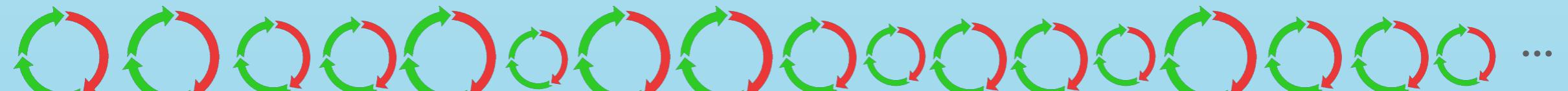
...fix... ?



...fix... ?

TAD

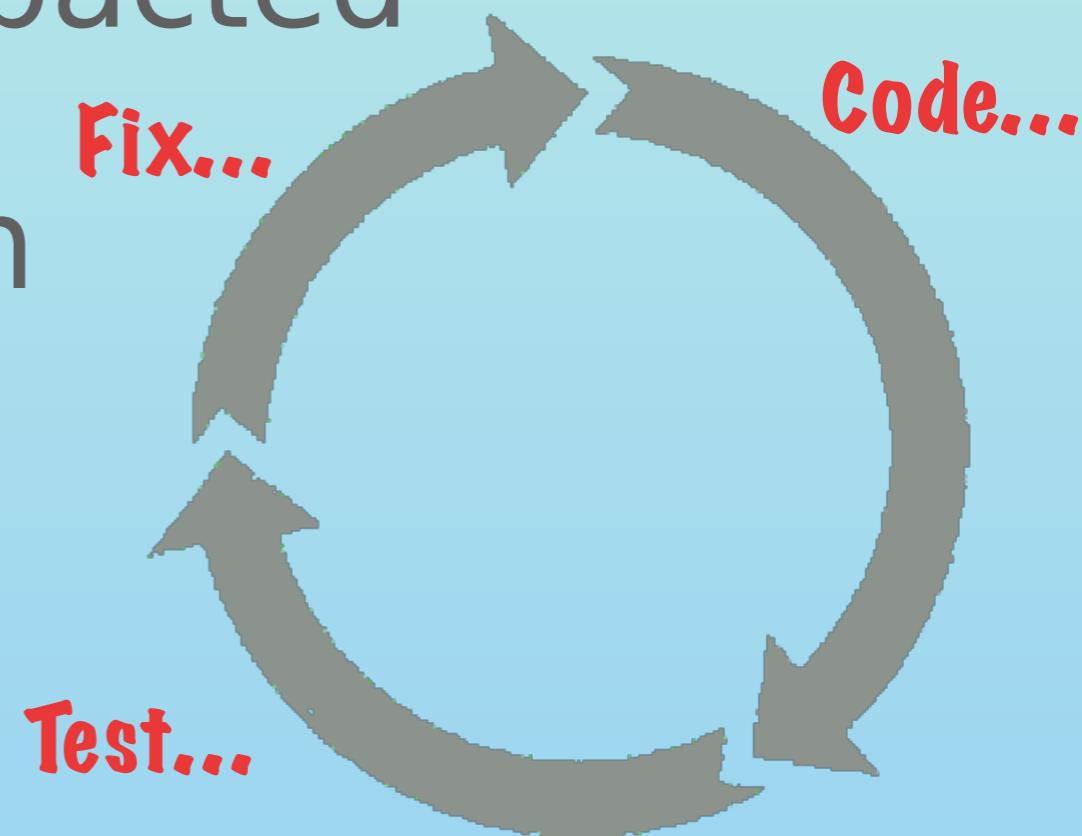
vs.



TDD

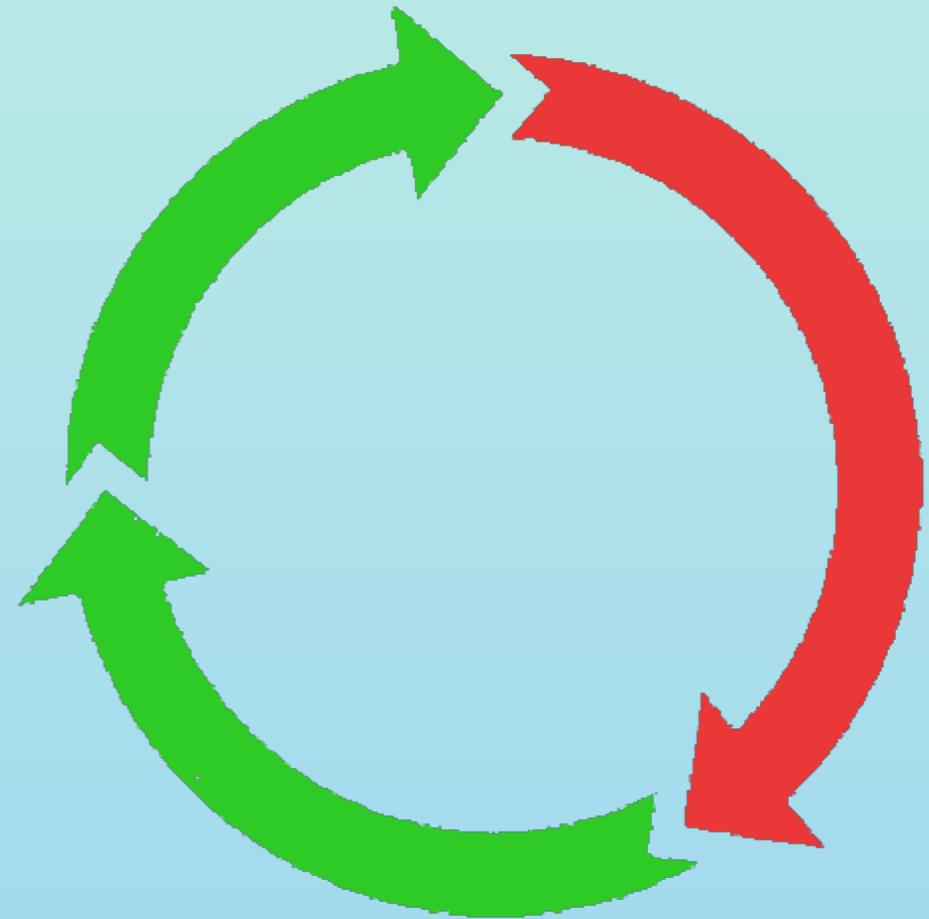
Test-After Development (TAD)

- Some refactoring accommodated
- Coverage: ~70%
- Design not usually impacted
- Some defect reduction
- Separate task?

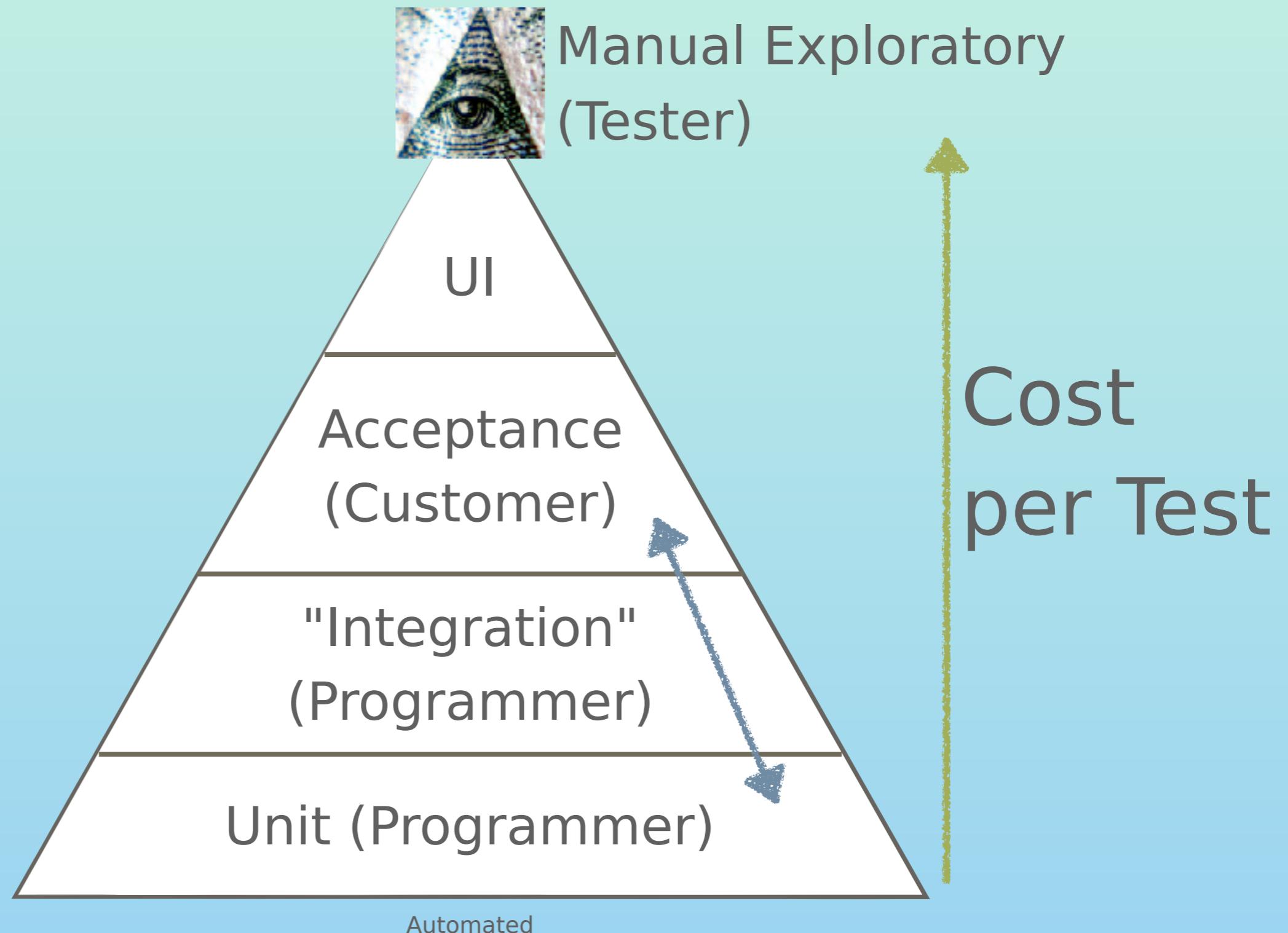


Test-Driven Development (TDD)

- Continual refactoring
- Coverage for all intended features
- Incremental design shaping
- Significant defect reduction
- Minimized debugging
- Integral part of coding process
- Clarify / document needs / choices
- Continual forward progress
- Consistent pacing
- Continual feedback / learning
- Sustainable



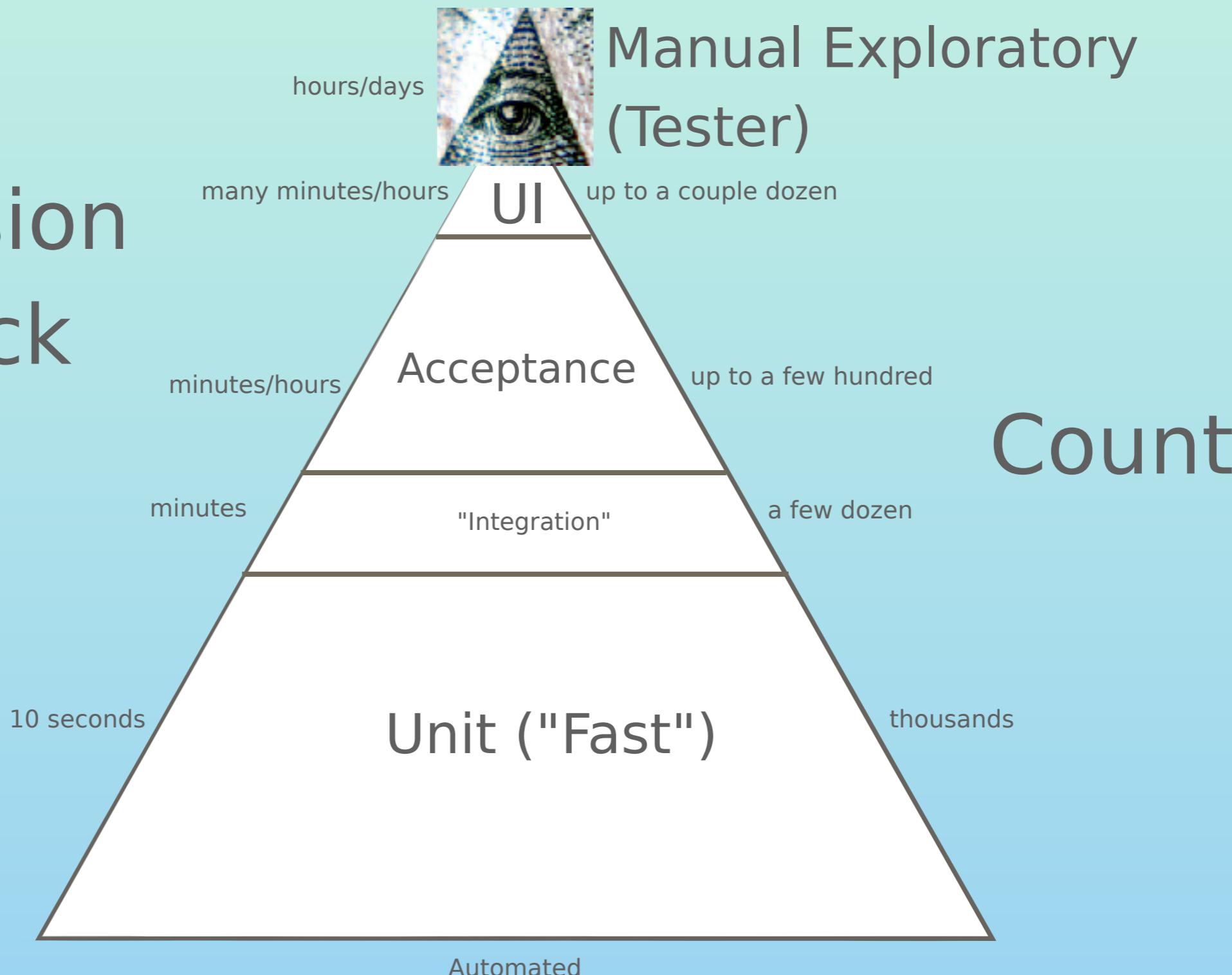
Unit Testing: Insufficient!



A Re-leveled Pyramid

Regression
Feedback

Count



Katas

<http://codekata.com>

Other sites:

<https://exercism.io>

<http://cyber-dojo.org>

<https://sites.google.com/site/tddproblems/>

<https://www.codewars.com>

<https://github.com/jlangr/name-normalizer>

<https://github.com/emilybache>

<https://projecteuler.net/archives>



Roman Numeral Converter

Given a positive integer
from 1 up to 4000,
answer its Roman equivalent



Feedback Q's

■ :-)

What have I learned of value?

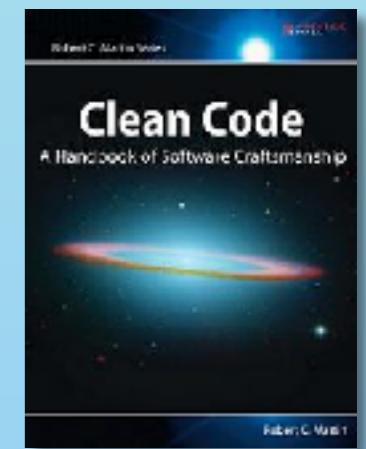
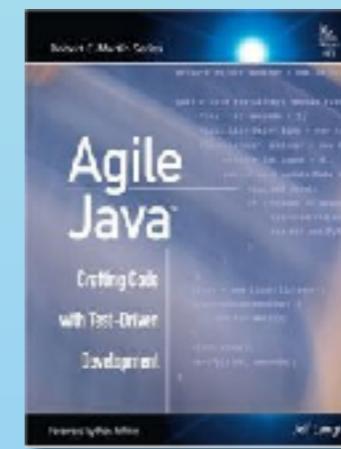
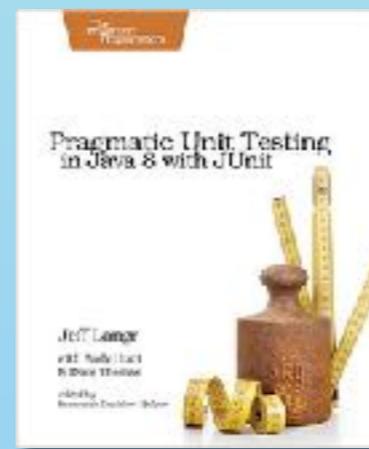
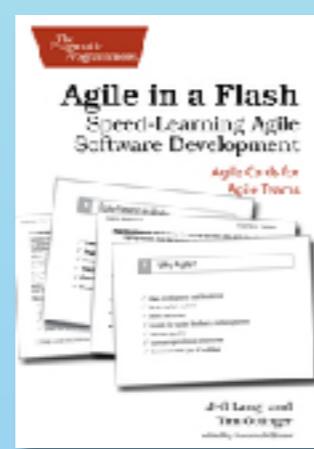
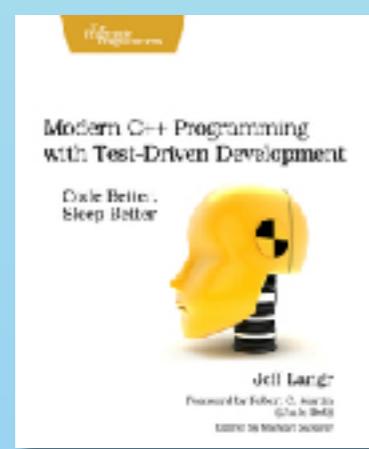
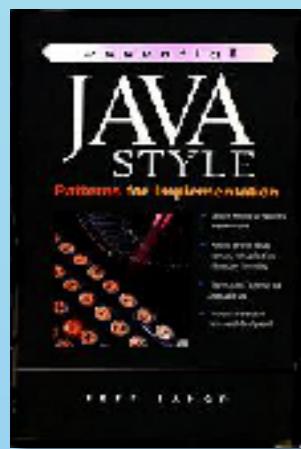
■ %-|

What, if anything, am I unclear about regarding the discussion / exercises?

■ ?:-/

What, if anything, did I find disturbing / disconcerting?

Documentation



Tests as Documents

what we're describing

```
describe("an unstarted auto") {
```

```
    val auto = Auto()
```

the generalized behavior it supports

```
    it("idles engine when started") {
```

```
        auto.depressBrake()
```

```
        auto.pressStartButton()
```

```
        auto.RPM() shouldBe 1000 +- 50
```

```
}
```

```
}
```

one example of that behavior

Seek to first understand through the tests.

Behavior-Driven Structuring

```
describe("given some context") {  
    describe("when some event occurs") {  
        it("then can be verified") {  
            // ...  
        }  
    }  
}
```

BDD Structuring Example

```
describe("given a checked-out material") {  
    val material = new Material(AgileJava)  
    val dueDate = material.borrow(PatronId)  
  
    describe("when returned late") {  
        material.returnIt(dueDate.plusDays(2))  
  
        it("is marked available") {  
            material.isAvailable shouldBe (true)  
        }  
        it("generates late fine") {  
            material.fine shouldBe (2 * Material.FineAmount)  
        }  
    }  
}
```

FunSpec Fixtures

Supporting functional tests (why?):

```
// ...
import org.scalatest.fixture

class PortfolioTest extends fixture.FunSpec with // ...
{
  type FixtureParam = PortfolioData
  // ...
  def withFixture(test: OneArgTest) = {
    var multipleHoldings = PortfolioData()
    multipleHoldings = purchase(multipleHoldings, "BAYN", BayerSharesPurchased)
    multipleHoldings = purchase(multipleHoldings, "IBM", IbmSharesPurchased)
    test(multipleHoldings)
  }
  // ...
}
```

■ <http://doc.scalatest.org/1.7.2/org/scalatest/fixture/FunSpec.html>

Using FunSpec Fixtures

```
describe("a portfolio with multiple holdings") {
  describe("value") {
    it("is zero when created") { _ => // or not using them
      portfolioValue(PortfolioData(), mock[StockService]) shouldBe 0
    }

    it("accumulates prices for all symbols") { portfolioData =>
      stockService.price("BAYN") shouldReturn BayerPrice
      stockService.price("IBM") shouldReturn IbmPrice

      portfolioValue(portfolioData, stockService)
        .shouldBe(BayerPrice * BayerSharesPurchased
                  + IbmPrice * IbmSharesPurchased)
    }
  }
}
```

Multiple FunSpec Fixtures

```
class PortfolioTest extends fixture.FunSpec
  with fixture.ConfigMapFixture // ...

{
  def withOnePurchase(test: PortfolioData => Any) = {
    var holdings = PortfolioData()
    holdings = purchase(holdings, "BAYN", BayerSharesPurchased)
    test(holdings)
  }

  def withMultiplePurchases(test: PortfolioData => Any) = {
    var data = PortfolioData()
    data = purchase(data, "BAYN", BayerSharesPurchased)
    data = purchase(data, "IBM", IbmSharesPurchased)
    test(data)
  }
}
```

Using Config Maps

```
describe("a portfolio") {
    it("is zero when created") { _ =>
        portfolioValue(PortfolioData(), mock[StockService]) shouldBe 0
    }

    it("returns the number of shares purchased") { configMap =>
        withOnePurchase { portfolioData =>
            shares(portfolioData, "BAYN") shouldBe BayerSharesPurchased
        }
    }

    it("accumulates prices for all symbols") { configMap =>
        withMultiplePurchases { portfolioData =>
            stockService.price("BAYN") shouldReturn BayerPrice
            stockService.price("IBM") shouldReturn IbmPrice

            portfolioValue(portfolioData, stockService)
                .shouldBe(BayerPrice * BayerSharesPurchased + IbmPrice * IbmSharesPurchased)
        }
    }
}
```

Iterative Naming

- Re-consider name continually

```
it("does something")
```

```
it("verifies engine start")
```

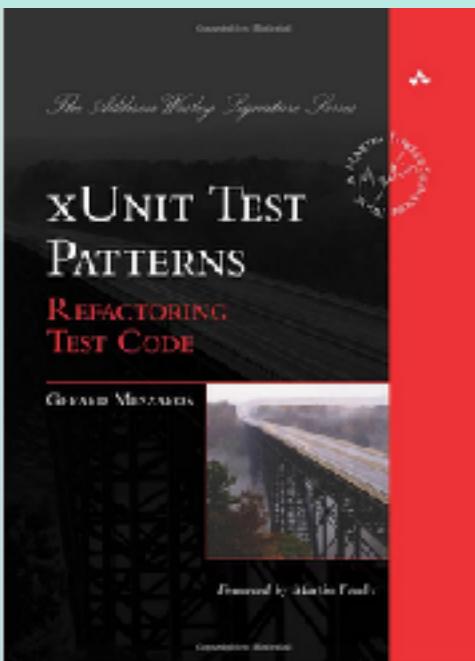
```
it("verifies engine start idle speed")
```

```
it("has low idle on engine start")
```

- Review often and holistically!

Sustainable Tests

*The long
answer:*



A quicker route:

- Single behavior tests
- AAA
- Correlate result with context
- Test abstraction

Exercise: Test Smells

Find and fix test smells.
Paraphrase cleaned tests
to your pair.



Further instructions: com.langrsoft.pos.CheckoutTest

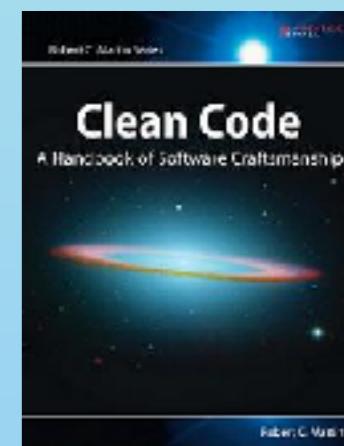
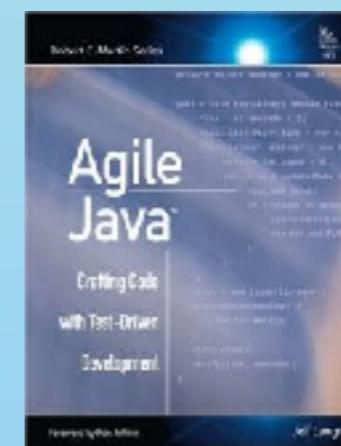
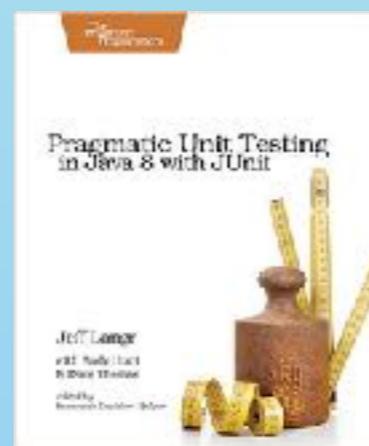
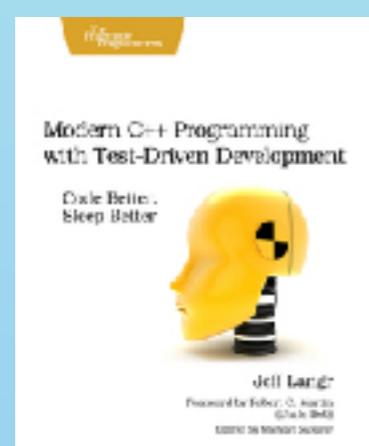
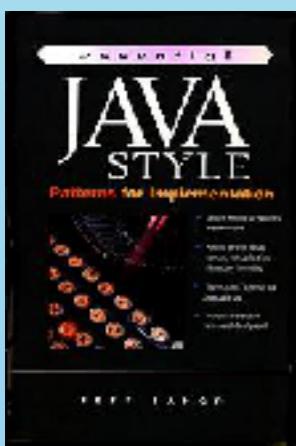
Continual Design



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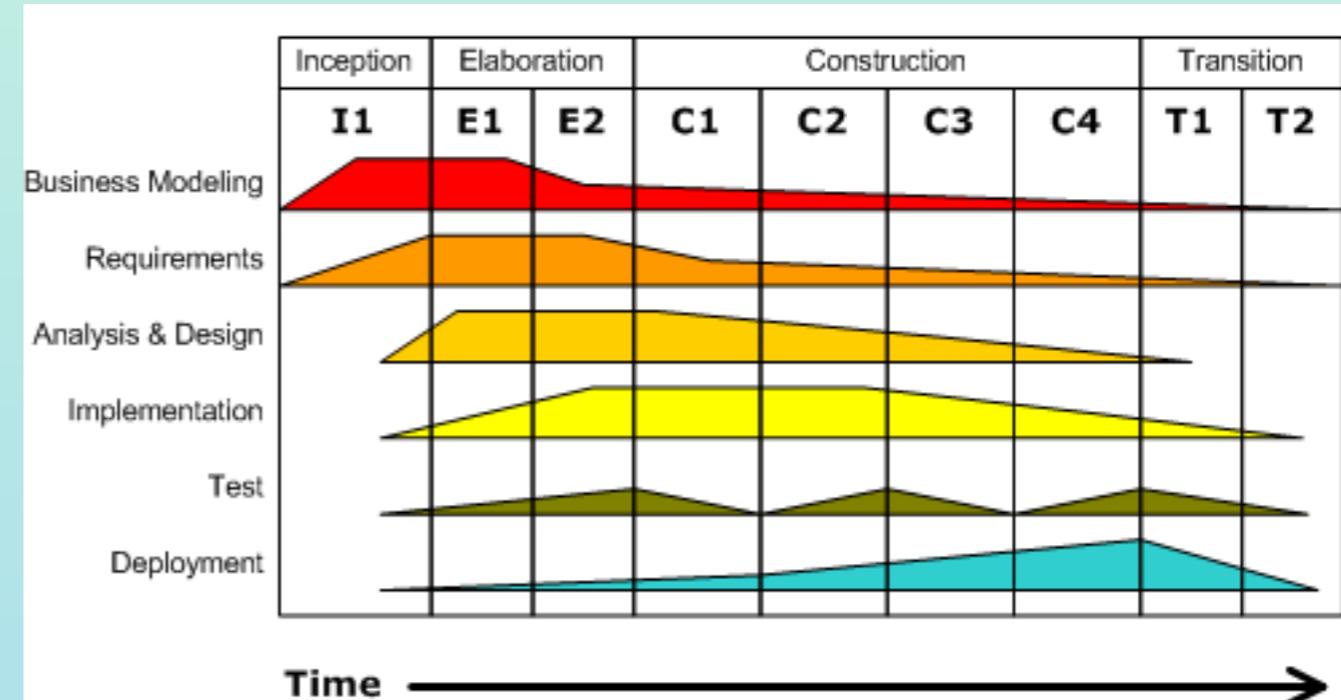
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Software Development

■ Activities:

- Analysis, design, coding, testing, review, documentation, planning, deployment, ...

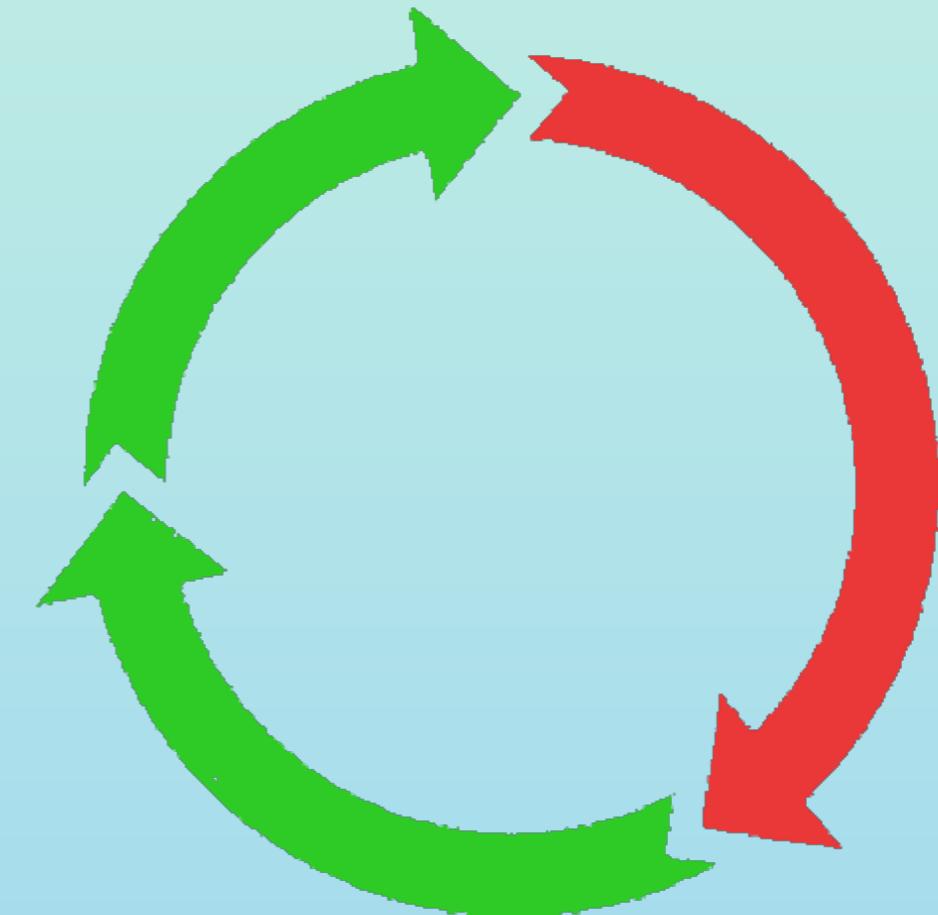


■ Agile:

- *All activities all the time*

TDD: Continual ...

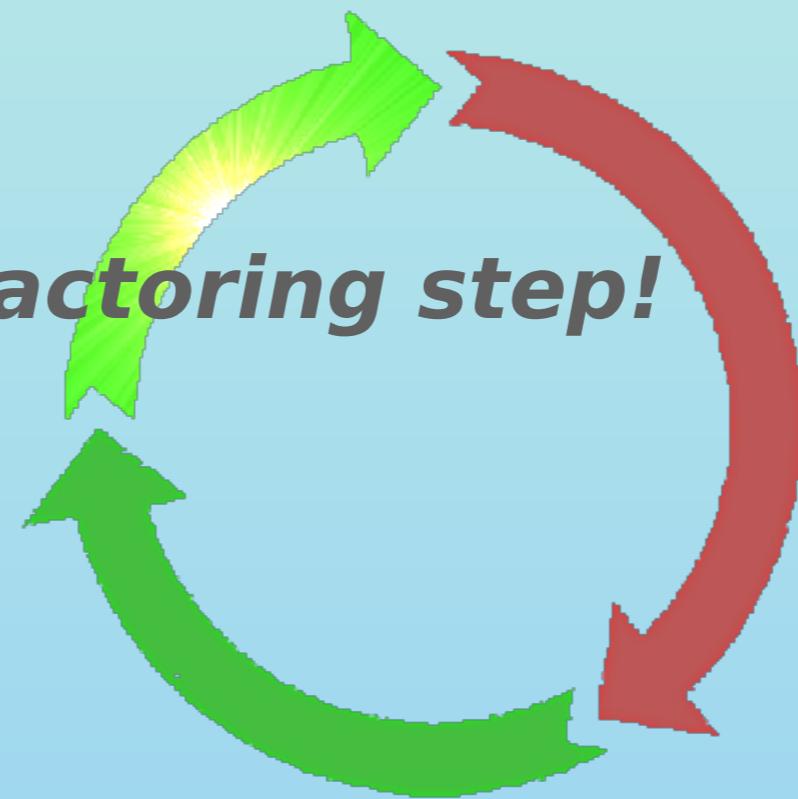
- Testing
- Coding
- Design
- Documentation
- Review



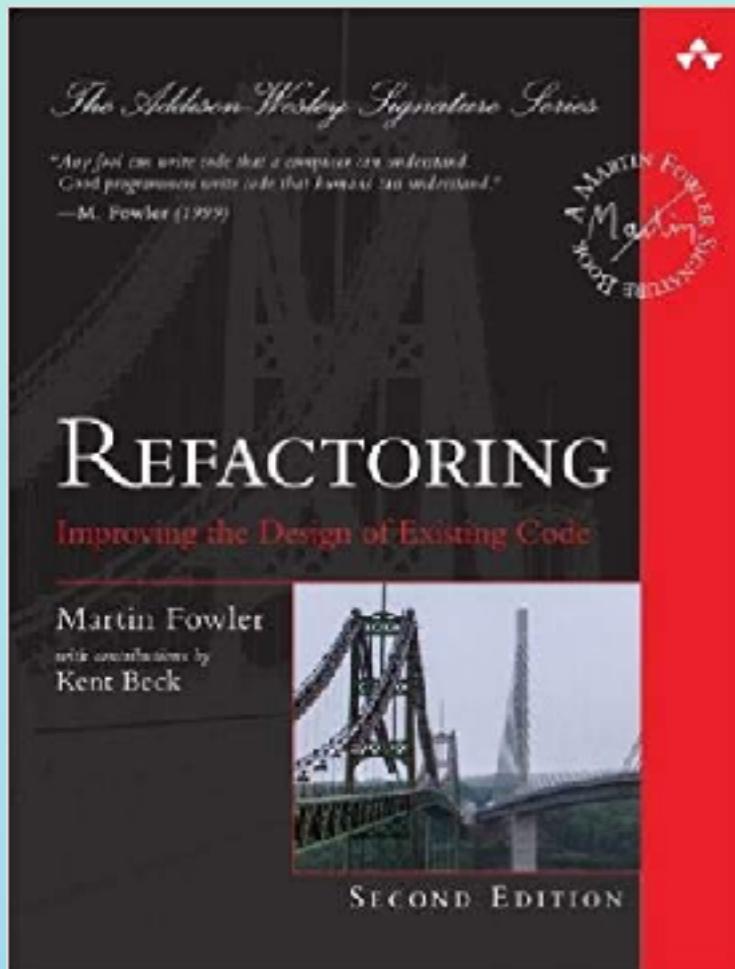
Continual Design

- Always retain an optimal design
- Entropy is unavoidable

Never skimp on the refactoring step!



Refactoring



Same "*externally recognized*" behavior

Code Smells

- Comments
- Duplicate Code
- Feature Envy
- Large Class
- Long Method
- Long Parameter List
- Primitive Obsession
- Shotgun Surgery
- Speculative Generality
- Switch Statements
- . . . and many more



"A complete code smells reference:"
<https://github.com/lee-dohm/code-smells>

The Nature of the Smell

Aroma?



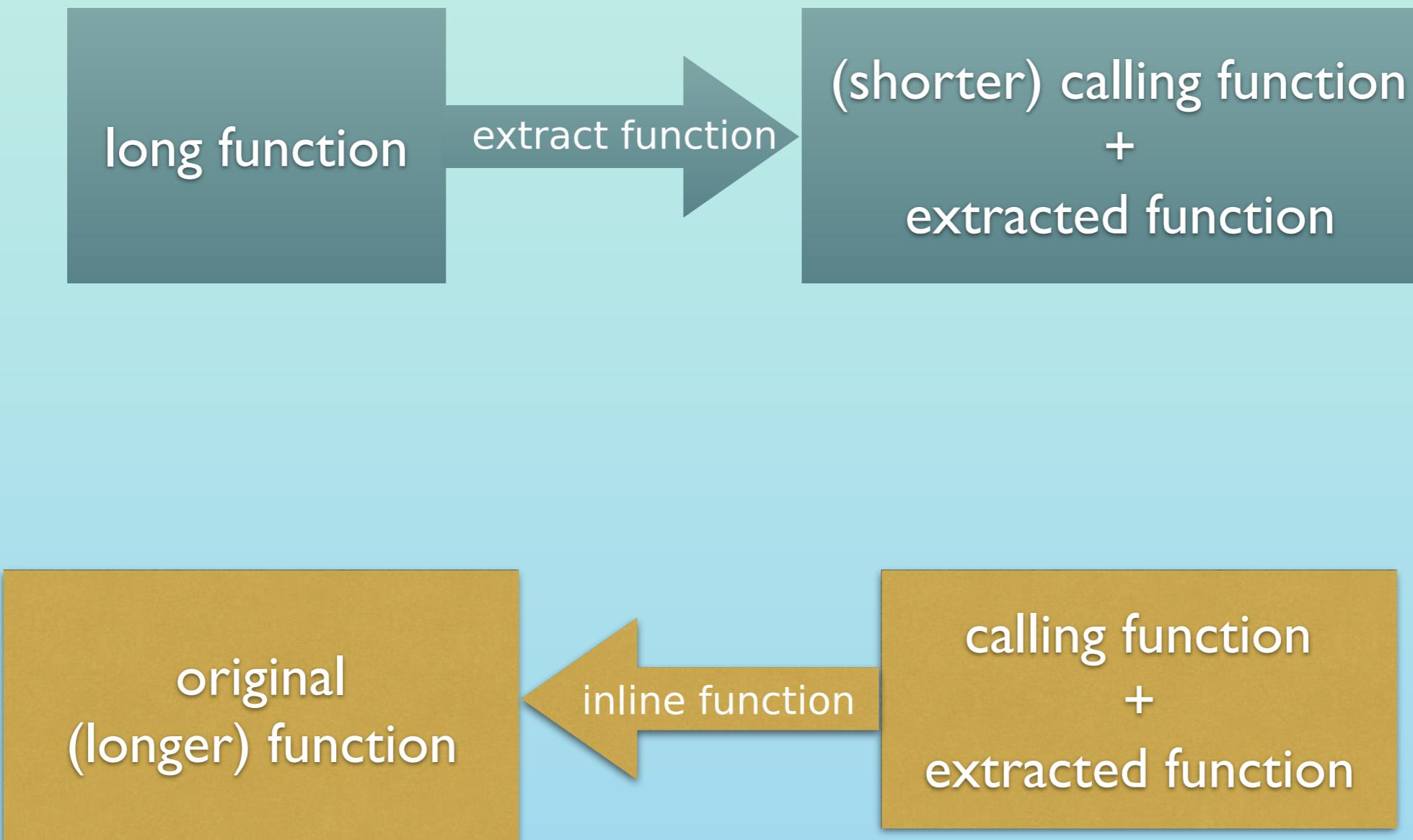
Stench?



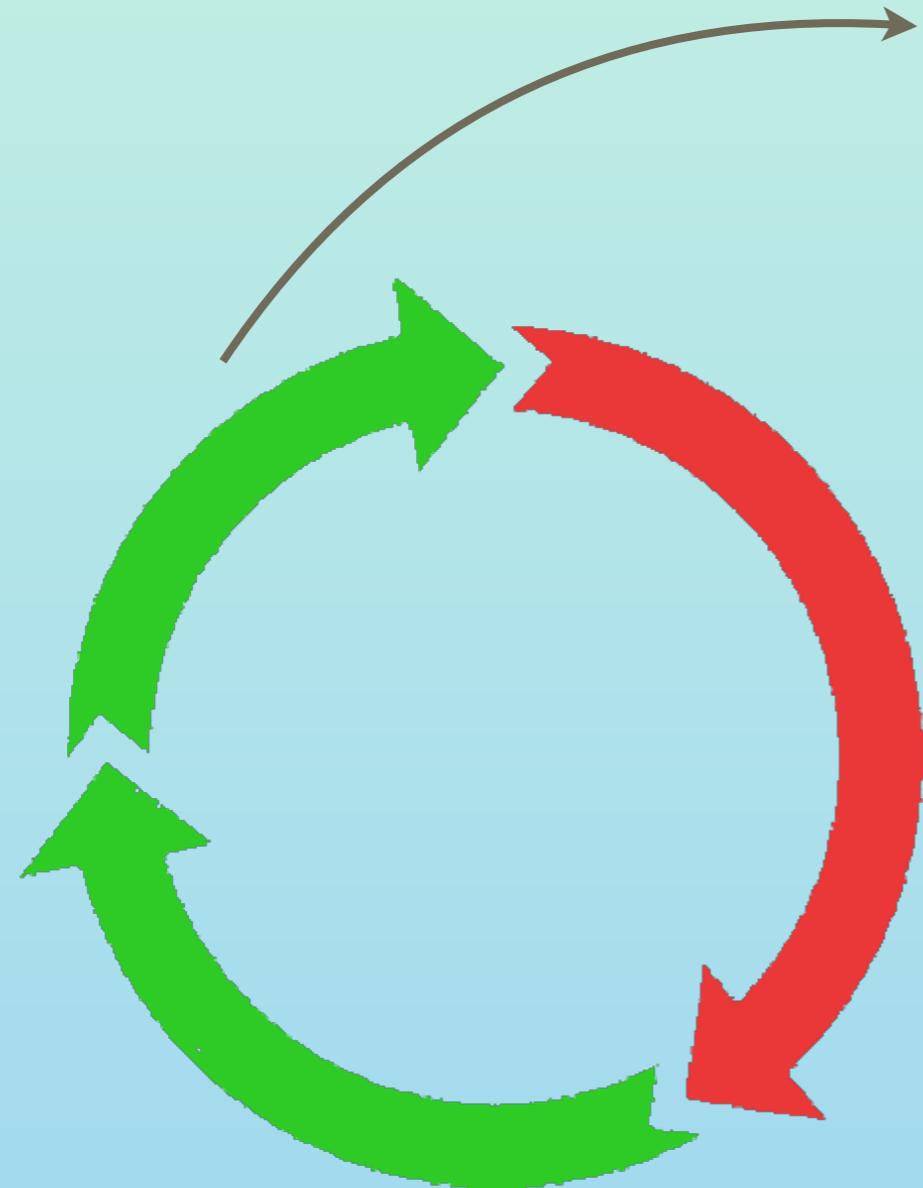
"beagle smelling roses," courtesy Grangernite, <https://www.flickr.com/photos/lidoty/2573672102>
<https://creativecommons.org/licenses/by/2.0/>

adapted from "Yum, that smells good!", courtesy Tankboy,
<https://www.flickr.com/photos/tankboy/284958387>; <https://creativecommons.org/licenses/by-sa/2.0/>

For (almost) Every Transform...



Refactoring Opportunities



small cleanup
verify
small cleanup
verify
...

One thing at a time!

Break things once in a while.

Refactoring: Extract Function

```
def uglyFunction() = {  
    // stuff a  
    ...  
    // stuff b  
    ...  
    // some smaller behavior  
    doSomething()  
    doSomethingElse()  
    // ...  
    // stuff c  
    // ...  
}
```



```
def lessUglyFunction() = {  
    // stuff a    ...  
    // stuff b  
    ...  
    someSmallerBehavior()  
    // ...  
    // stuff c  
    // ...  
}  
  
def someSmallerBehavior() = {  
    doSomething()  
    doSomethingElse()  
}
```

Why?

Single-Line Extract?

```
catch {  
  case e: RuntimeException => {  
    val msg =  
      s"${new DateTime(): ${System}-${Module}} HIGH ${trunc(e.getMessage, 80)}"  
    logError(msg)  
    throw new RuntimeException(errMsg, e) } }
```



```
catch {  
  case e: RuntimeException => {  
    logError(format(e, "HIGH"))  
    throw new RuntimeException(format(e, "HIGH"), e)  
  }  
}
```

```
private def format(e: RuntimeException, severity: String) = {  
  s"${new DateTime(): ${System}-${Module}} $severity ${trunc(e.getMessage, 80)}"  
}
```

Exercise: Extract Function



- In `com.langrsoft.pos.CheckoutRoutes`:
 - Start with a single-line function extract on `createReceipt`
 - Apply additional function extracts
 - Otherwise focus on renaming and eliminating lies

[[TODO]] Refactoring-Inhibiting Temp

```
checkout.items.forEach(item => {
  let price = item.price;
  const isExempt = item.exempt;
  if (!isExempt && discount > 0) {
    const discountAmount = discount * price;
    const discountedPrice = price * (1.0 - discount);

    totalOfDiscountedItems += discountedPrice;

    let text = item.description;
    const amount = parseFloat(Math.round(price * 100) / 100).toFixed(2)
    const amountWidth = amount.length;
    let textWidth = LineWidth - amountWidth;
    messages.push(pad(text, textWidth) + amount);

    total += discountedPrice;

    const discountFormatted = '-' + parseFloat(Math.round(discountAmount * 100) / 100).toFixed(2)
    textWidth = LineWidth - discountFormatted.length;
    text = ` ${discount * 100}% mbr disc`;
    messages.push(` ${pad(text, textWidth)}${discountFormatted}`);

    totalSaved += discountAmount;
}
```

[[TODO]] Refactoring: Replace Temp With Query

```
const discountAmount = discount * price;  
// . . .  
  
// discount line  
const discountFormatted = '-' + parseFloat(Math.round(discountAmount * 100) / 100).toFixed(2)  
textWidth = LineWidth - discountFormatted.length;  
text = ` ${discount * 100}% mbr disc`;  
messages.push(`${pad(text, textWidth)}${discountFormatted}`);  
  
totalSaved += discountAmount;
```



```
// discount line  
const discountFormatted =  
  '-' + parseFloat(Math.round(discountAmount(discount, price) * 100) / 100).toFixed(2)  
textWidth = LineWidth - discountFormatted.length;  
text = ` ${discount * 100}% mbr disc`;  
messages.push(`${pad(text, textWidth)}${discountFormatted}`);  
  
totalSaved += discountAmount(discount, price);  
// ...  
});  
  
const discountAmount = (discount, price) => discount * price;  
// . . . . .
```

Replace Temp With Query

Steps:

- Make temp const
- Extract Function on the rhs
- Replace temp references with the query
- Remove temp

Why?

Concerns?

Can we go the other way?

Exercise: Replace Temp with Query



- In com.langrsoft.pos.CheckoutRoutes
 - Apply Replace Temp with Query in postCheckoutTotal as appropriate
 - Extract as many additional functions as you can

[[TODO]] Code Smell: Feature Envy

```
class WrongPlace {
    client() {
        const x = enviousFunction()
        ...
    }

    enviousFunction() {
        const there = new GreenerGrass()
        const result = there.doStuff(this.someValue)
        there.doMoreStuff(result)
        return there.answer()
    }
}
```

Why is this a problem?

[[TODO]] Refactoring: Move Function

```
class WrongPlace {  
    client() {  
        const x = new GreenerGrass().homebodyMethod(this.someValue)  
        ...  
    }  
}  
  
class GreenerGrass {  
    homebodyMethod(someValue) {  
        var result = doStuff(someValue)  
        doMoreStuff(result)  
        return answer()  
    }  
    ...  
}
```

What must you also do when you move a function?

Exercise: Move Function

- In com.langrsoft.pos.CheckoutRoutes
- Move at least 2 envious functions to better (or new!) homes
- Ensure you've added documentation (i.e tests)!



Macro Refactorings



Might need to backtrack!

Planning: Up-Front Design

■ Not just once!

- Planning: project, release, iteration, day, task, test
- Any estimation

■ Minimal: sketches & conversations

- Not detailed specs



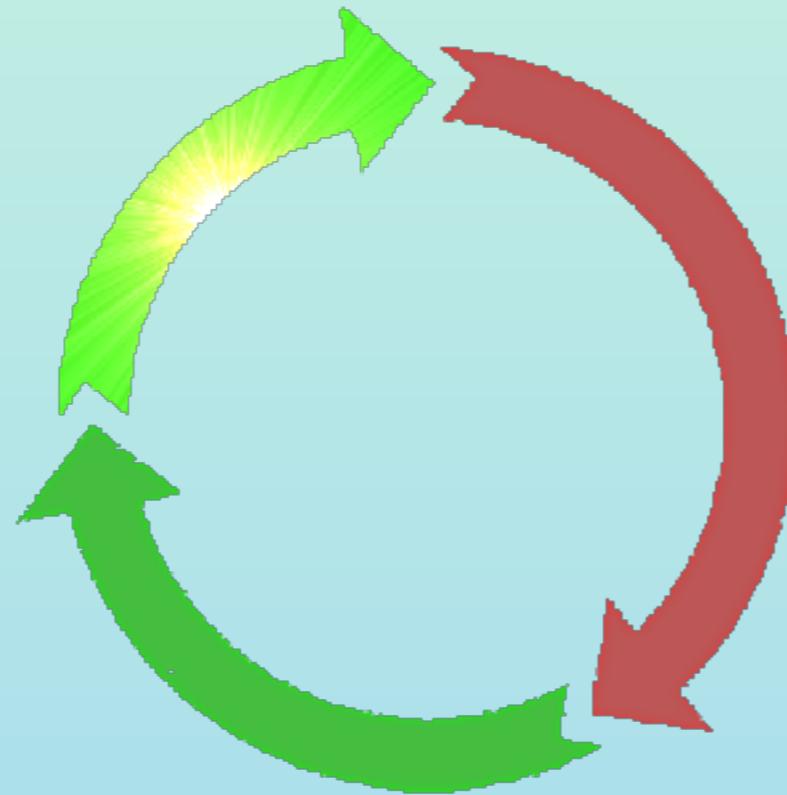
Premature Generalization

- Need might never materialize
- Details might change
- Interim complexity \$



Refactoring Guidelines

Single-goal



Run *all* tests

It's your responsibility

Never skip!

Design Drivers / Guidelines

- Code smells
- SOLID
- Design patterns
- GRASP
- Simple design
- DRY
- ...

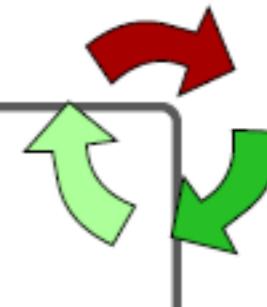


It's all good!

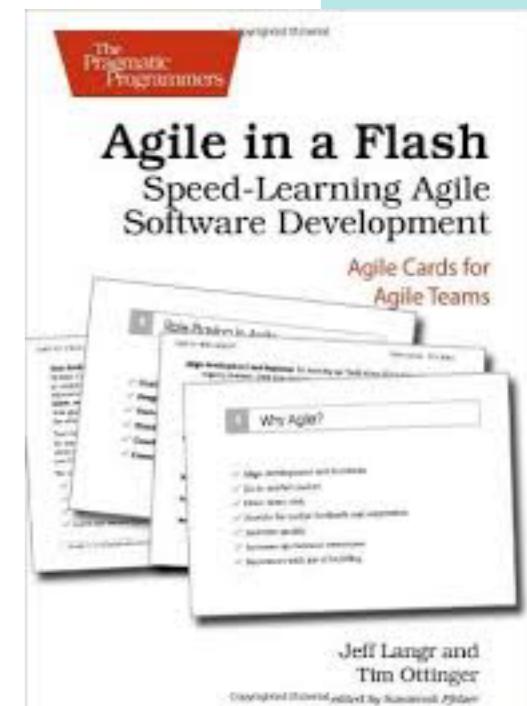
Does everything point to the same place?

41

Build Superior Systems with Simple Design



- All tests must pass
- No code is duplicated
- Code is self-explanatory
- No superfluous parts exist



Kent Beck's (ordered) rules for emergent design

Exercise: Simple Design Rules

- In com.langrsoft.pos.CheckoutRoutes
 - Stamp out duplication!
 - Strive for rapid readability
 - Have you gone too far?

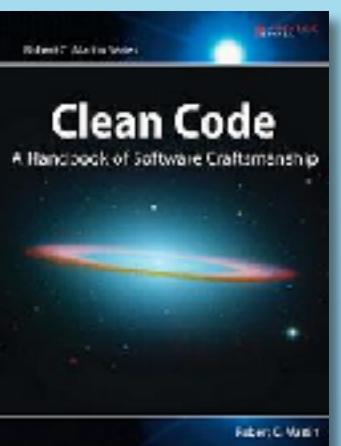
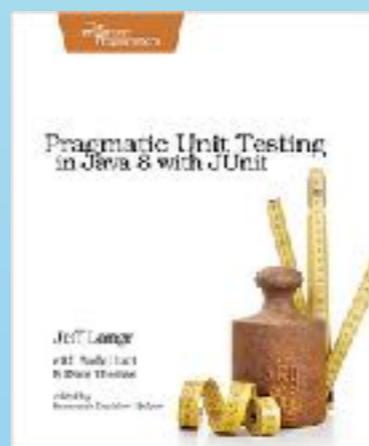
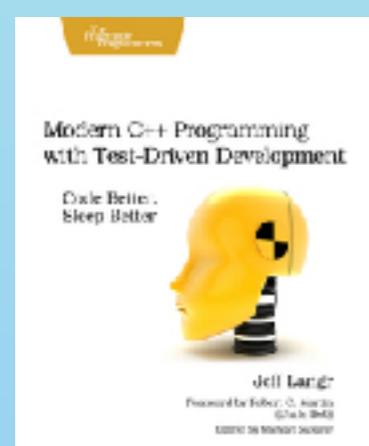
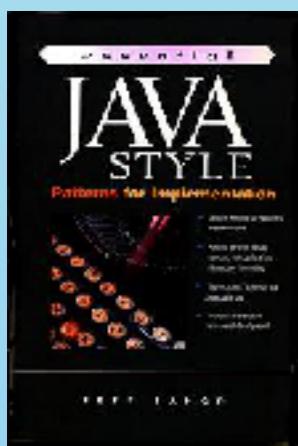


Test Doubles

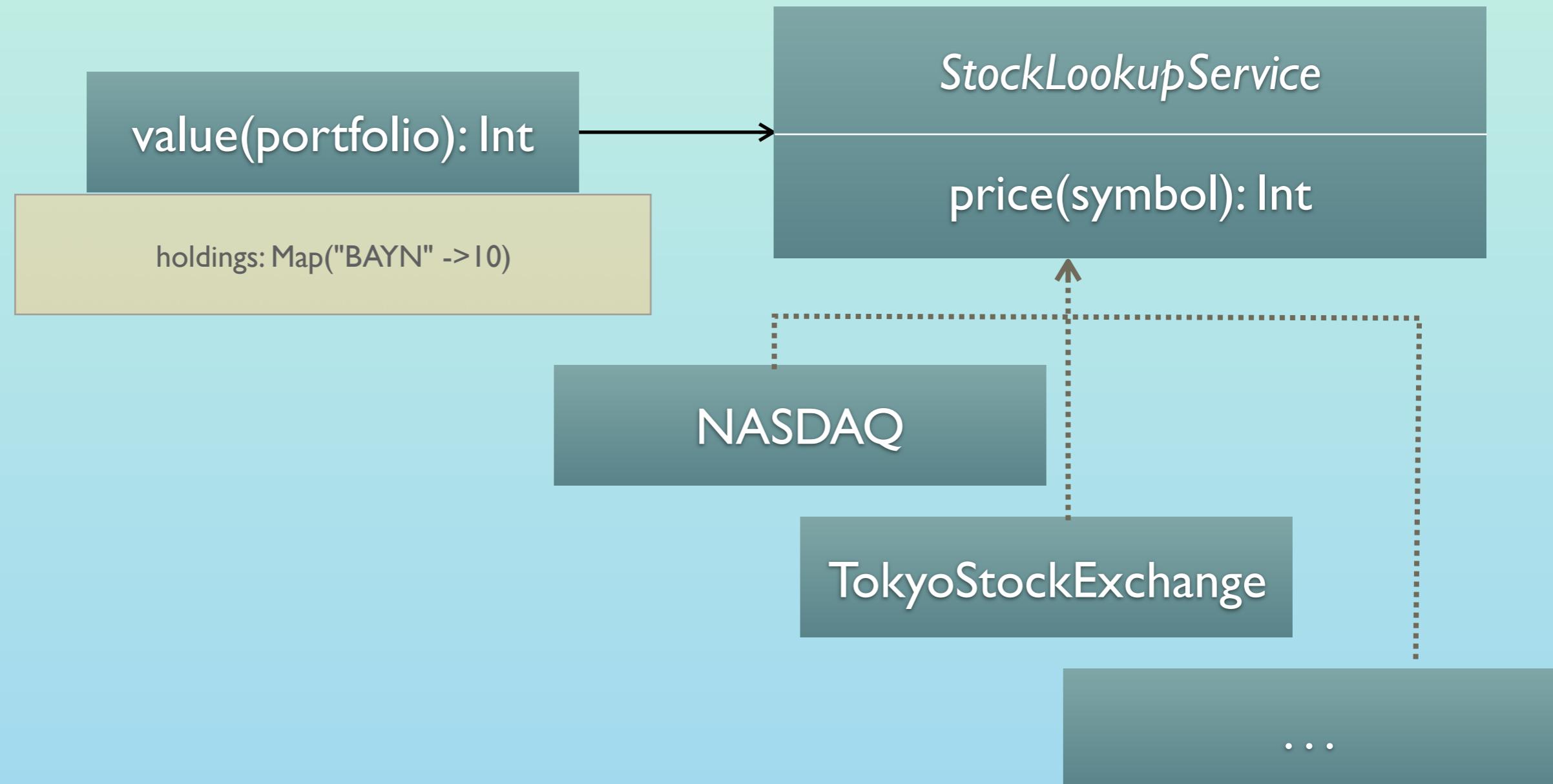


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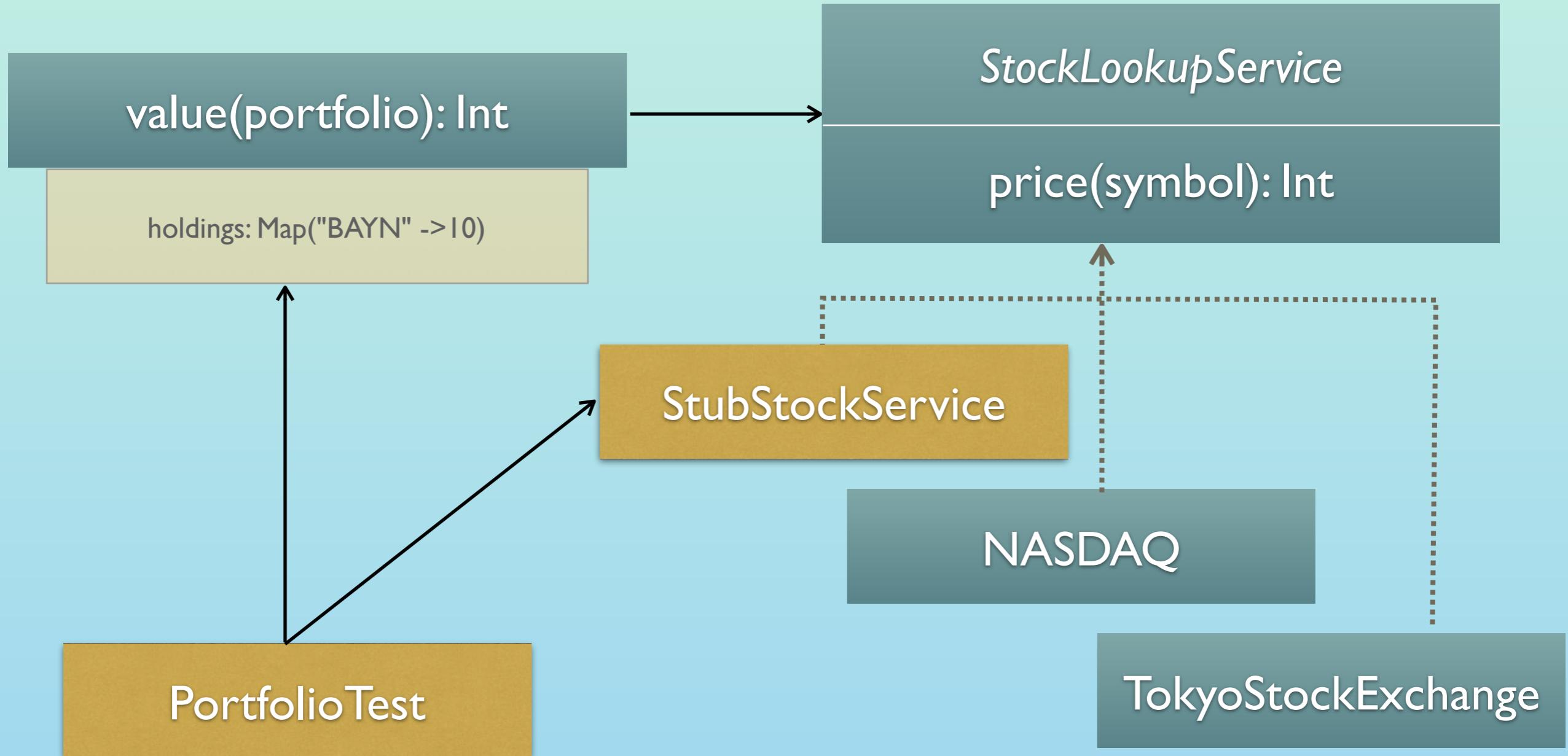
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Testing Challenge: Portfolio



Using a Test Double



Portfolio Value...

StockService:

```
trait StockService { def price(symbol: String): Int }
```

```
it("is share value after purchase single share") {
    val stockService = new StockService {
        override def price(symbol: String): Int = BayerPrice
    }

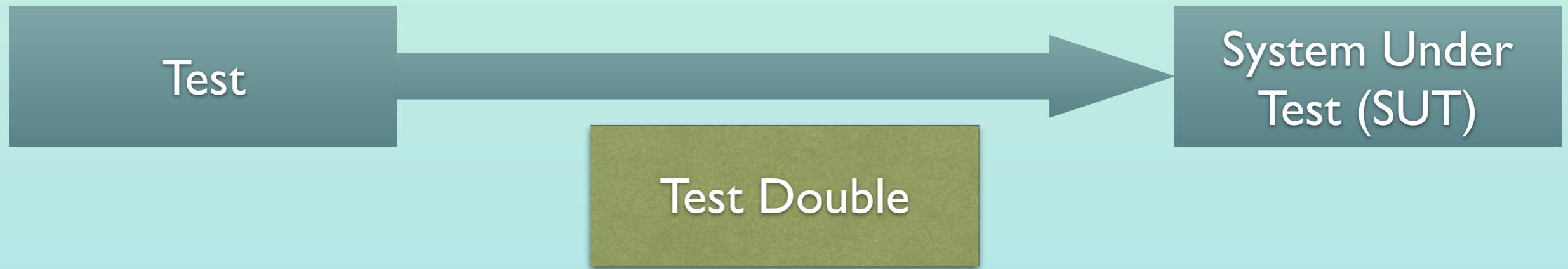
    portfolio.purchase("BAYN", 1)

    portfolio.value(stockService) shouldBe BayerPrice
}
```

Incremental implementation in Portfolio:

```
def value(service: StockService) = {
    val soleSymbol = symbols.keySet.head
    service.price(soleSymbol)
}
```

Test Double Injection Techniques



Function argument
Constructor
Factory method override
Cake pattern
Thin cake pattern
Structural typing
Implicit declarations
Using the reader monad

Guice
MacWire
Mockito
Spring

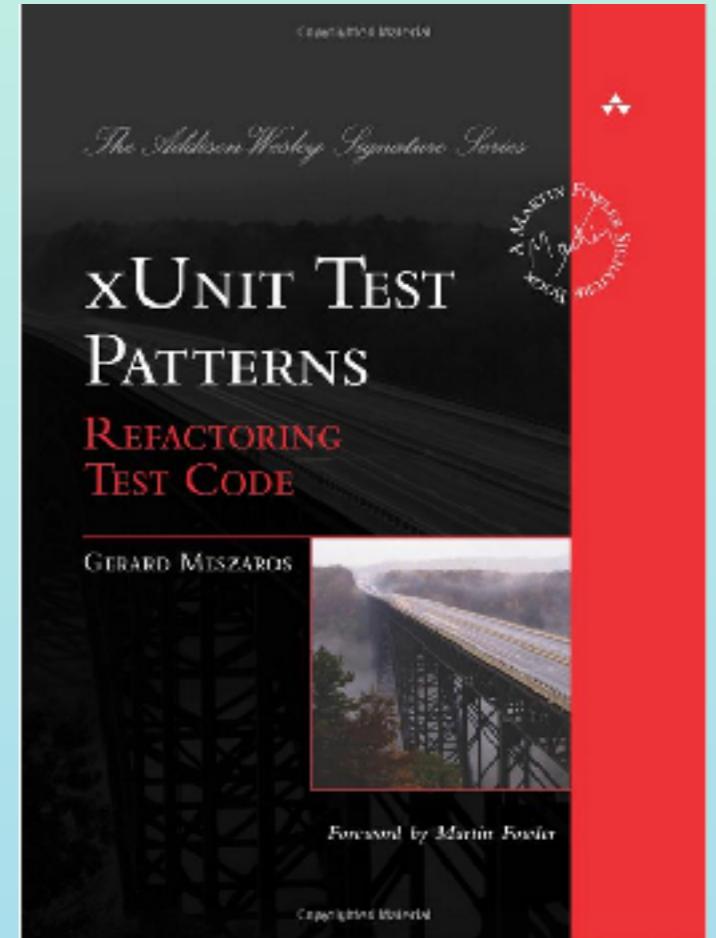
Test Double Terms

Stub: dumb emulation

Spy: captures values to verify

Mock: self-verifies

Fake: whole collaborator emulation



Mock Tools



(and *mockito-scala*)

EASYMOCK

ScalaMock (paul butcher)

jMock



JMockit

History suggests more & changes coming!

Mockito / Mockito-Scala

<http://site.mockito.org>

<https://github.com/mockito/mockito-scala>



Mockito-Scala: A Simple Stub

```
class PortfolioTest extends FunSpec with IdiomaticMockito
// ...
```

```
val stockService = mock[StockService]
val portfolio = new Portfolio(stockService)
stockService.price("BAYN") shouldReturn BayerPrice
stockService.price("IBM") shouldReturn IbmPrice
```

```
portfolio.purchase("BAYN", 10)
portfolio.purchase("IBM", 20)
```

```
portfolio.value shouldBe BayerPrice * 10 + IbmPrice * 20
```

<https://static.javadoc.io/org.mockito/mockito-core/2.7.7/org/mockito/Mockito.html>

Exercise: Mockito



Replace your hand-crafted test double
with a Mockito-defined stub

Mock Tools Are Trackers

In the debugger:

- .mockitoInterceptor
- .handler
- .mockHandler
- .invocationContainer
- .registeredInvocations
- .invocations

Constructor Injection

```
val stockService = mock[StockService]  
val portfolio: Portfolio = new Portfolio(stockService)
```

```
class Portfolio(stockService: StockService) {  
    // ...  
}
```

Mockito Injection

```
import org.mockito.{InjectMocks, Mock, MockitoAnnotations, // ...}  
// ...  
class PortfolioTest extends FunSpec // ... {  
  @InjectMocks var portfolio: Portfolio =_  
  @Mock var stockService: StockService =_  
  
  before {  
    portfolio = new Portfolio  
    MockitoAnnotations.initMocks(this)  
  }  
  // ...
```

```
class Portfolio {  
  var stockService: StockService =_  
  // ...
```

Mockito: Exceptions

```
it("sets price to 0 when price lookup throws") {  
    stockService.price("IBM") shouldThrow(new RuntimeException)  
  
    portfolio.purchase("IBM", 20)  
  
    portfolio.value shouldBe 0  
}
```

Exercise: Exceptions



When calculating the portfolio value,
use zero dollars for the current stock price
if the symbol lookup throws an error.

Verifying a "Tell"

```
def purchase(symbol: String, sharesToBuy: Integer) =  
  sharesToBuy match {  
    case n if n > 0 =>  
      symbols += symbol -> (sharesToBuy + shares(symbol))  
      auditor.audit(  
        s"Purchased $sharesToBuy shares of $symbol")  
      // ...  
  }
```

How to test-drive the call to audit?

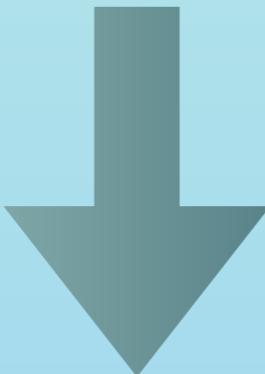
Spying on the Audit Call

```
it("audits on purchase") {  
    val stockService = mock[StockService]  
    val auditor = mock[Auditor]  
    val portfolio = new Portfolio(stockService, auditor)  
  
    portfolio.purchase("BAYN", 10)  
  
    auditor.audit("Purchased 10 shares of BAYN") was called  
}
```

Argument Matching

```
trait Auditor {  
    def audit(symbol: String, timestamp: DateTime)  
}
```

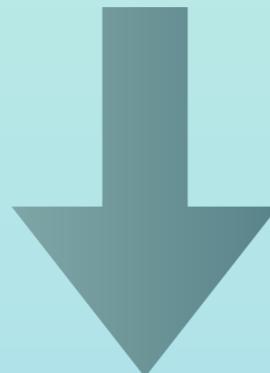
```
auditor.audit("Purchased 10 of BAYN",  
any[DateTime]) was called
```



```
auditor.audit(s"Purchased $sharesToBuy of $symbol",  
new DateTime)
```

Argument Matching... Hmm.

```
auditor.audit("Purchased 10 of BAYN",  
any[DateTime]) was called
```



```
auditor.audit(s"Purchased $sharesToBuy of $symbol",  
null)
```

This passes!

Argument Capture

```
val captor = ArgCaptor[DateTime]
val now = new DateTime

portfolio.purchase("BAYN", 10)

auditor.audit("buy: 10 of BAYN", captor) was called
secondsBetween(captor.value, now) should be < 1
```

Exercise: Spies

Verify that sell transactions are audit-logged.



```
trait Auditor {  
    def audit(  
        symbol: String,  
        shares: Int,  
        transactionType: String,  
        timestamp: DateTime)  
}
```

Mockito-Scala: Still More!

- Expect # of invocations or "never"
- Spies of real objects / partial mocks (avoid!)
- Verification in order
- Mocking consecutive calls
- Support for by-name arguments

See <https://github.com/mockito/mockito-scala>

Cake Pattern

```
trait StockServiceComponent {  
    val service: PriceService  
  
    trait PriceService {  
        def price(symbol: String): Int  
    }  
}
```

```
trait ProdStockServiceComponent  
    extends StockServiceComponent {  
    val service = new ProdPriceService()  
  
    class ProdPriceService() extends PriceService {  
        def price(symbol: String): Int = { /* */ }  
    }  
}
```

```
class Portfolio {  
    this: StockServiceComponent => // "self type;" allows mixing-in a stock service  
  
    // ...  
  
    def value =  
        symbols.keysIterator.foldLeft(0) {  
            (total, symbol) =>  
                total + shares(symbol) * service.price(symbol)  
        }  
}
```

Testing Via the Cake Pattern

```
class PortfolioTest // ...
{
  trait TestStockServiceComponent extends StockServiceComponent {
    val service = new TestPriceService()
    class TestPriceService() extends PriceService {
      def price(symbol: String): Int = {
        symbol match {
          case "BAYN" => BayerPrice
          case "IBM" => IbmPrice
        }
      }
    }
  }

  var portfolio = new Portfolio with TestStockServiceComponent
```

... Using Mockito

```
trait MockitoTestStockServiceComponent extends StockServiceComponent
  with IdiomaticMockito {
  val service = mock[PriceService]
  service.price("BAYN") shouldReturn BayerPrice
  service.price("IBM") shouldReturn IbmPrice
}
```

Cake Is a Mess...

Debatable.

- Violates ISP, SRP, OCP
 - Uses "is a," not "has a" inheritance



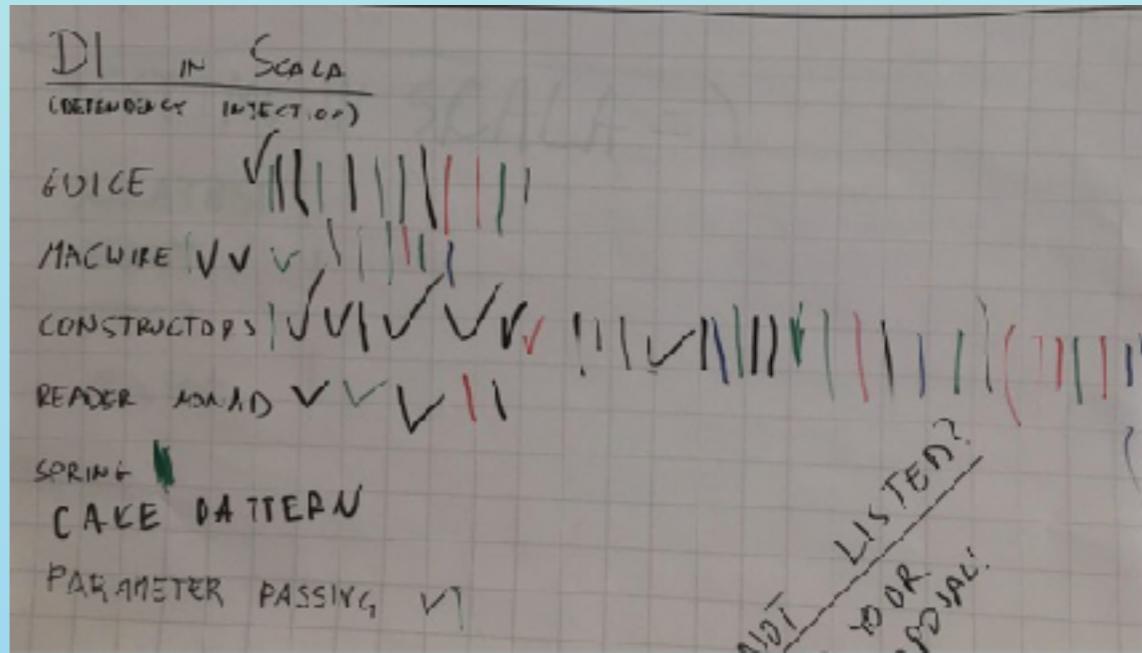
via Bartosz Mikulski: The Cake Pattern Is a Lie:

Some Resources:

<http://di-in-scala.github.io>

<http://jonasboner.com/real-world-scala-dependency-injection-di/>

<https://www.originate.com/thinking/stories/reader-monad-for-dependency-injection/>



Schools of Mock

Classic
("Detroit")

algorithmic approach

verification of state

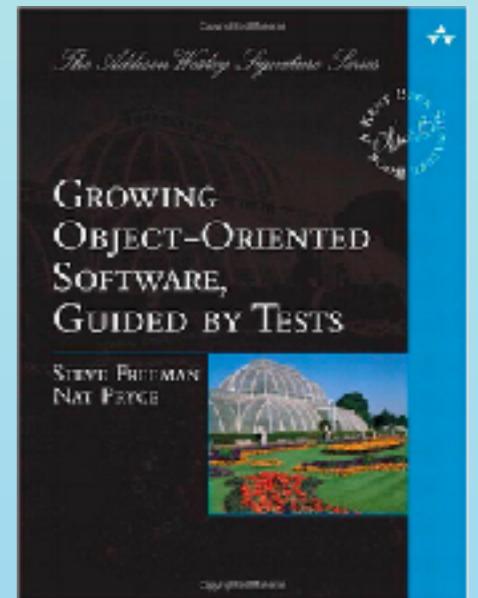
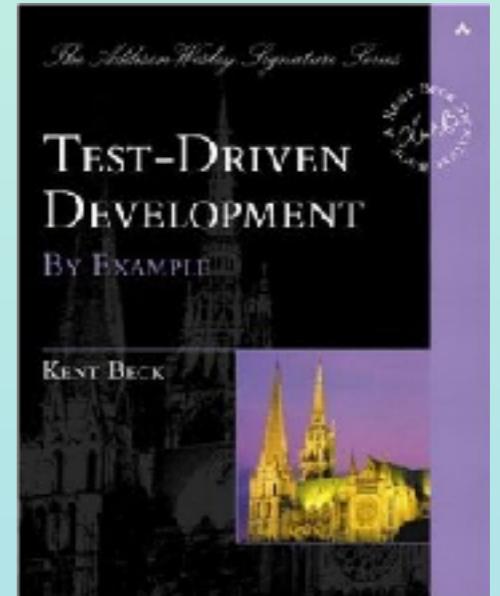
tests drive code from specific to general

London

roles, responsibilities, and interactions

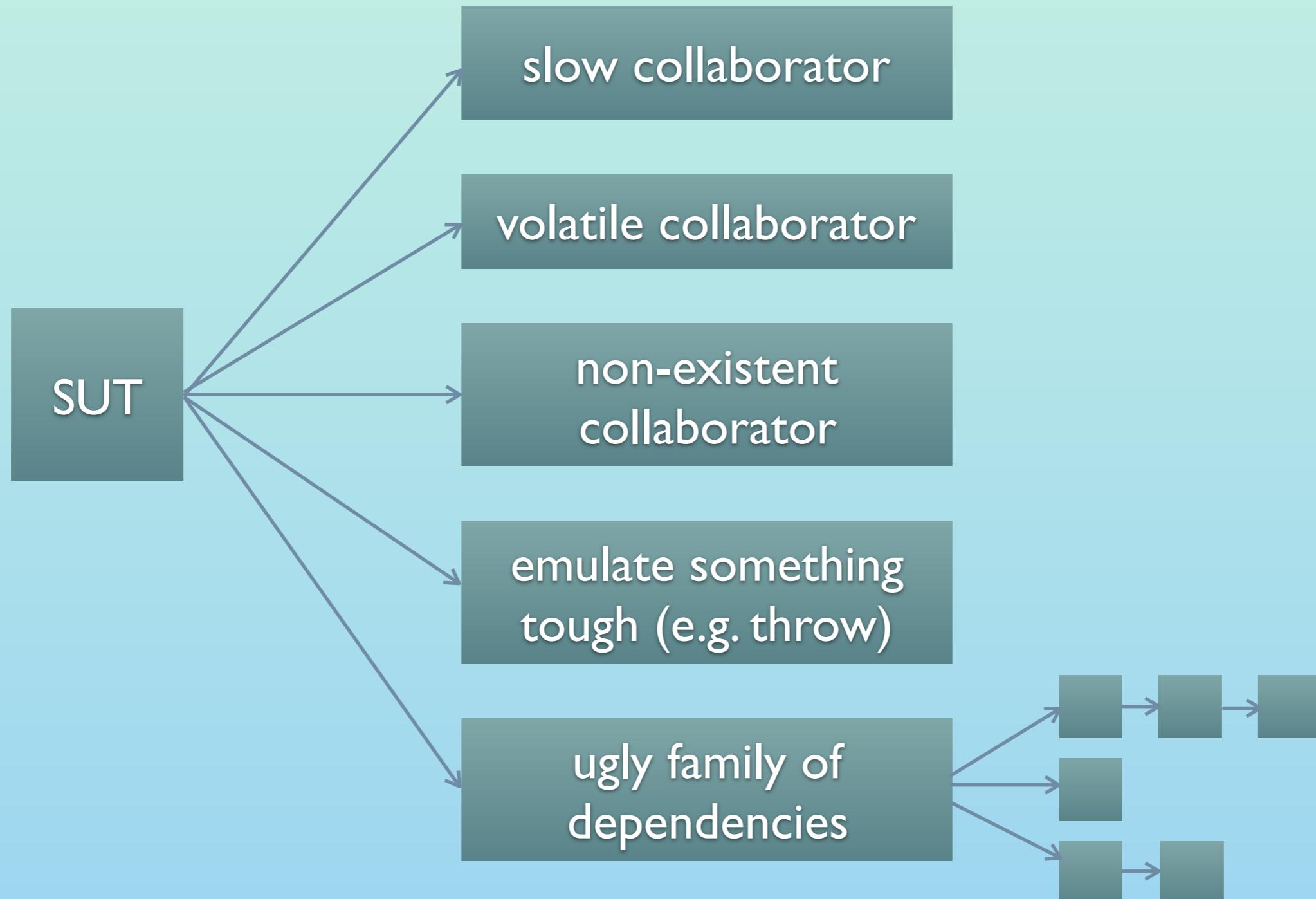
"Fake it until you make it"

drive incrementally from the outside in



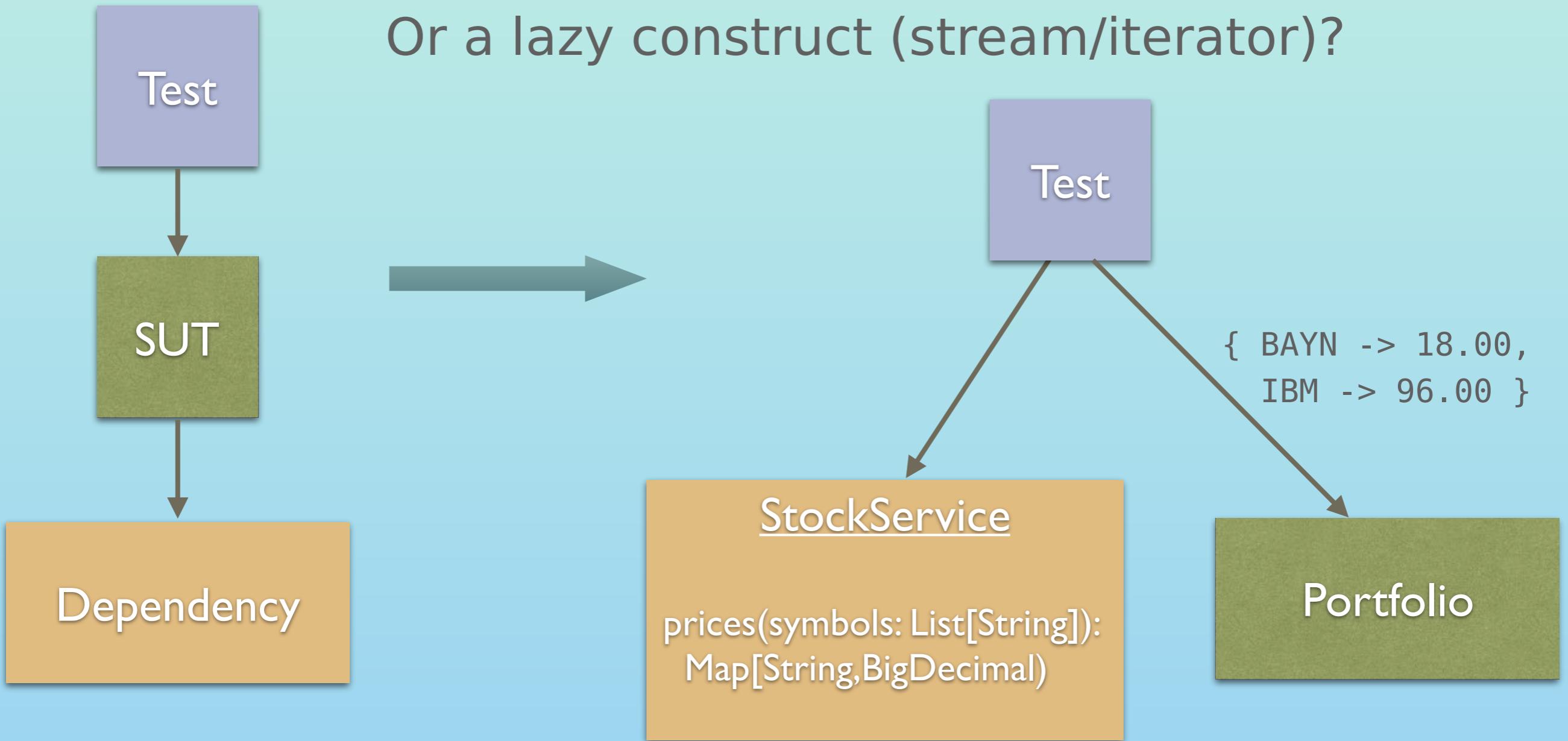
Read Martin Fowler's "Mocks Aren't Stubs"

Classic School: When to Mock



When Not to Mock?

Push the dependency up
Can you inject data instead?
Or a lazy construct (stream/iterator)?



The Pragmatic Mocker

- Writes integration tests where mocks are used
- Watches coupling between tests & implementation
- Seeks to mock only direct collaborators
- Avoids mocking what they don't own
- Avoids fakes (and if necessary, test-drives 'em!)
- Knows their mock tool in & out
- Isolates, minimizes the use of test doubles
 - But prefers testability



Wrap-Up Exercise



- Support voids on checkout



Work outside in:

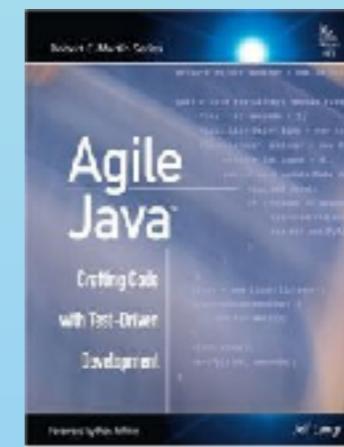
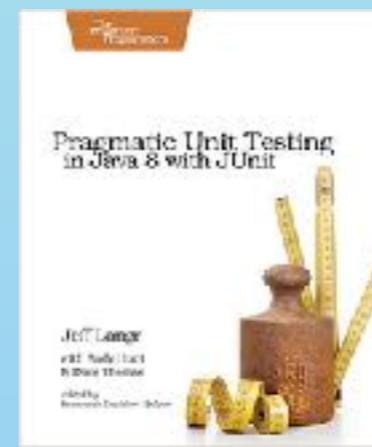
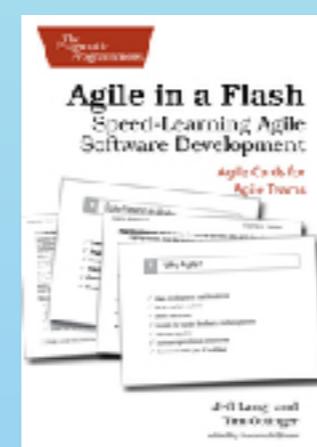
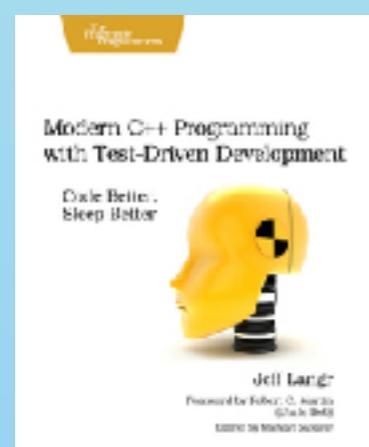
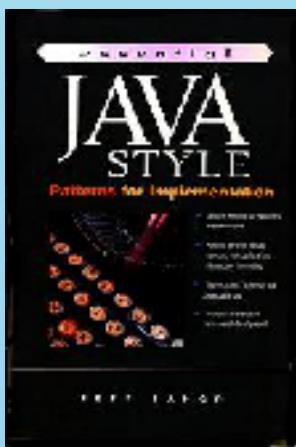
- Stub collaborators until ready to build them out

Growing & Sustaining TDD

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Starting TDD



- TDD-specific team policies/standards
- "Stop the line" CI mentality
- Review the tests, too
- Mob!

Growing TDD

- Sharing sessions
- Competitions
- Coaches & champions
- Dynamic metrics
- Mob!



Sustaining TDD



- TDD-specific reflection/adaptation
 - Continual?
 - Regular reminders: "why?"
 - Dynamic standards
 - Fast tests
 - Read tests as an entry point
 - Refactor, refactor, refactor.
 - Tests too!
 - Mob!

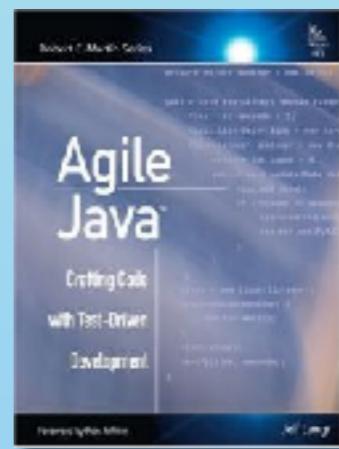
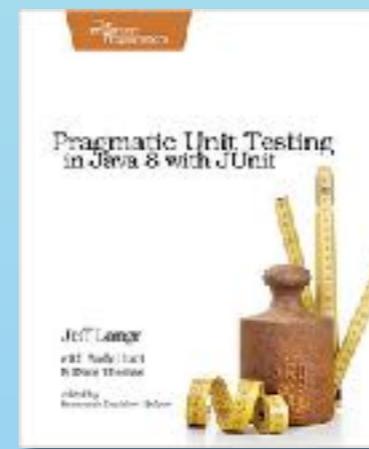
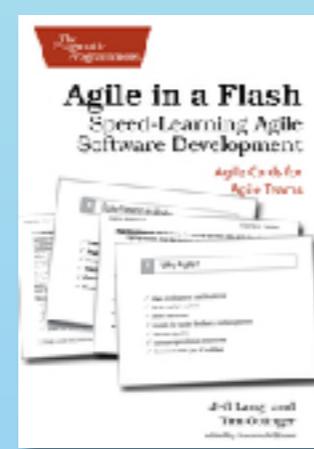
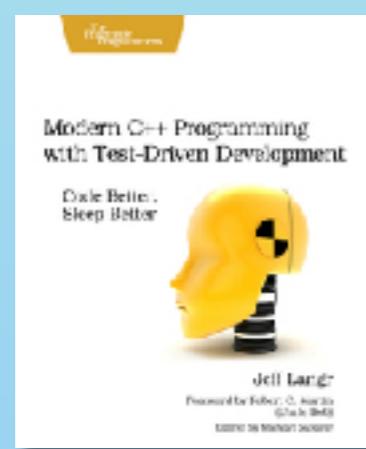
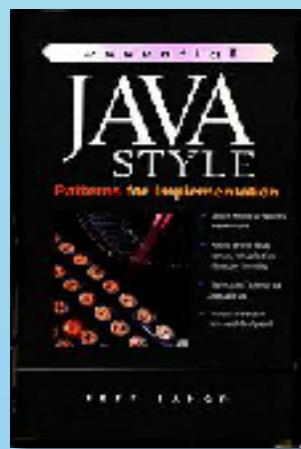
Mastering TDD

TDD is a skill.



Practice, practice, practice.

Miscellaneous Topics



[[TODO]] Asynchronous Testing

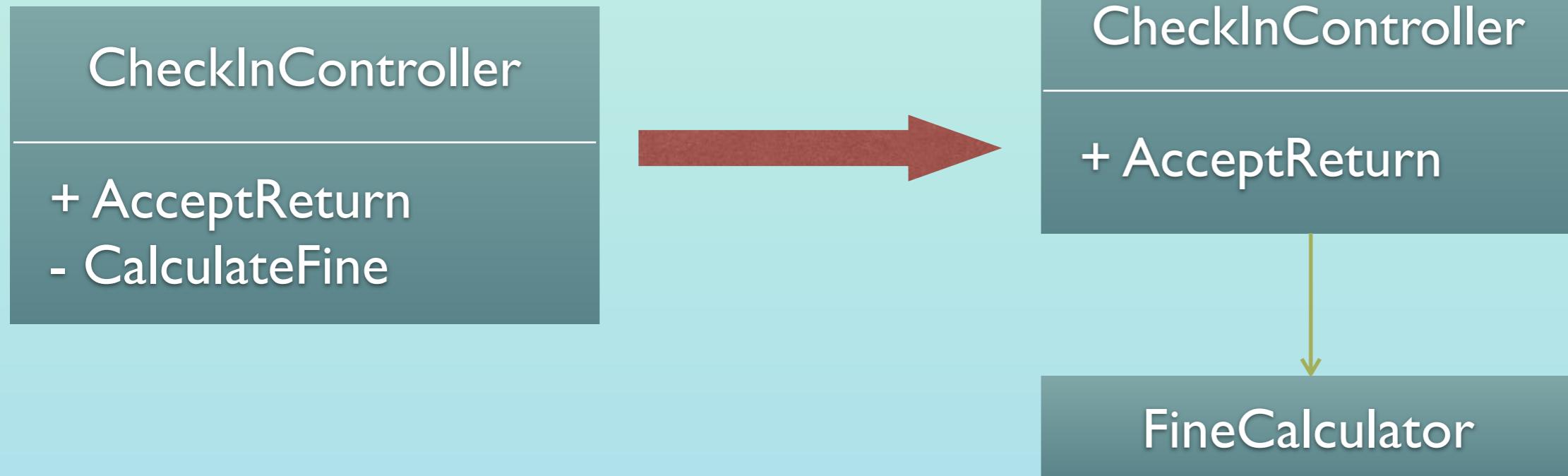
<https://medium.com/@hussachai/beware-the-asyn-test-35c5c848ebe9>

futures

```
val future = testCtrl.makeUser(User("Bill"))
```

```
future.map { res =>
  res.isSuccess
}.await
```

Testing Non-Public Behavior?



Or simply relax access.

Rules of Ten



Green & clean in < 10 (minutes)

Delete and repeat if you're late!
... taking smaller steps this time.

Rules of Ten



Debate stops at 10 (minutes)

"Show me."

Rules of Ten



All unit tests run in < 10 (seconds).

Fixing a Slow Test Run



Warn on tests < ***n*** ms

Fail on tests > ***n*** ms

Running a subset of tests increases risk.

Scratch Refactoring



Discard the results!

Uncle Bob's TPP

Transformations have a preferred ordering, which if maintained by ordering of tests, prevents "long outages" in TDD.

The
Priority
List

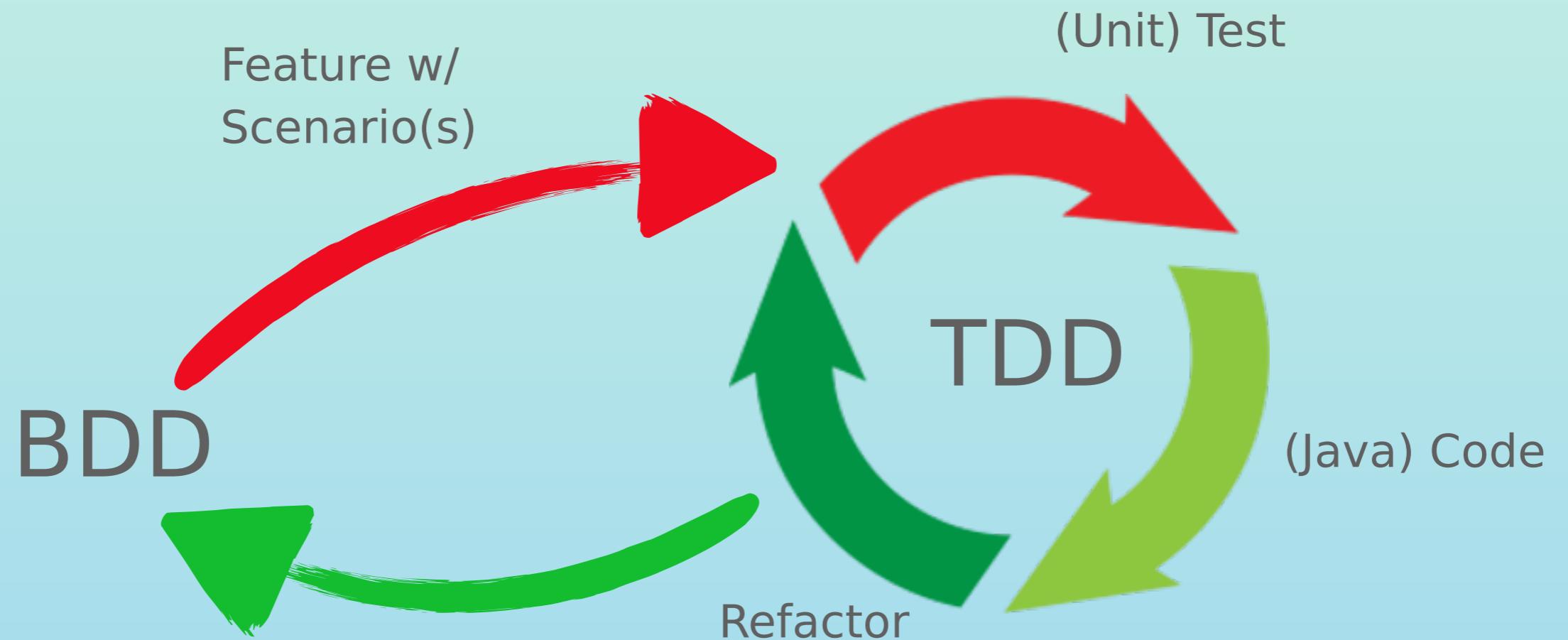
- ({}->**nil**) no code at all->code that employs nil
- (**nil->constant**)
- (**constant->constant+**) a simple constant to a more complex constant
- (**constant->scalar**) replacing a const. with a variable or an argument
- (**statement->statements**) adding more unconditional statements.
- (**unconditional->if**) splitting the execution path
- (**scalar->array**)
- (**array->container**)
- (**statement->tail-recursion**)
- (**if->while**)
- (**statement->recursion**)
- (**expression->function**) replacing expression w/ a function or algorithm
- (**variable->assignment**) replacing the value of a variable.
- (**case**) adding a case (or else) to an existing switch or if

"As the tests get more specific, the code gets more generic."

<http://thecleanncoder.blogspot.com/2011/02/fib-t-p-premise.html>

<https://8thlight.com/blog/uncle-bob/2013/05/27/TheTransformationPriorityPremise.html>

Behavior-Driven Development (BDD)



References / Reading List

"Chat" icon courtesy Gregor Cesnar, Noun Project (Creative Commons)

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Thank you!



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