

ADVANCED TEST DRIVEN DEVELOPMENT

ROBERT C. MARTIN
(UNCLE BOB)



WHY TDD?





Civilization depends upon us.

in ways it doesn't yet understand.

In ways *we* don't yet understand.



WE
RULE
THE
WORLD

**WE ARE HEADED TOWARDS A
DISASTER**



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JAMES CORDEN

My joy at being part of the funniest play of the year

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ESTHER RANTZEN

Old folk need to get web-wise

Your Money page 30

The Daily Telegraph



Tuesday, November 8, 2011

telegraph.co.uk

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VW CHEATS EPA, EMITS NOXIOUS FUMES

By James Minty
Deputy Political Editor

THERE IS now being fresh questions about her judgment last night after it emerged that she extricated a secret selection of Britain's border controls without having obtained information about the security implications of the move.

A hostile dossier of documents showed that in July the Home Secretary authorised UK Border Agency staff not to carry out full checks on the passports of thousands of thousands of people arriving at British airports and ports from six countries.

In September, Mrs May disclosed the dossier - which was never made public - to members of the House despite having only "very limited information" about the consequences of the change.

The leaked dossier suggested officials

had been given discretion to defer to other passport controls without seeking ministerial approval. Last night the Home Office admitted this was a long-standing practice to allow staff to deal with emergency visitors.

In the House of Commons yesterday, Mrs May came under intense pressure as she was accused by Labour of giving the "green light" to a secret dossier controls and fighting Conservative questioned her judgment.

She insisted she had been told she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the relaxed checking system she put in place.

The Daily Telegraph reported yesterday that in July Mrs May ordered the UKBA's Border Force to waive the checks applied to people entering Britain with European

passports. As that "green scheme" evolved, border staff then waived the checks applied to non-Europeans as well.

Mrs May metasas Border Clerk, the senior-most head of the Border Force, confirming that several situations without proper notice.

"The paper record will show without doubt that the situation of checks that remained was not sanctioned by me," she told MPs, adding that Mr Clark could face criminal charges for his actions.

"A normal officer would have had to ask us if we will never know how many people crossed the country who should have been prevented from doing so," Mrs May said.

The Home Secretary insisted MPs that under her rules foreigners had still been checked against a Watchdog Index of suspicious individuals and criminals.

The second relaxation of passport rules

began at an unknown point during Mrs May's authorized pilot. She said she only learnt of it because she was informed by senior officials.

Before the pilot was due to conclude in mid-September, Mrs May decided to allow another six-week relaxation of passport rules.

A Home Office official said Mrs May took that decision based on "very limited information" about the pilot in September.

"It was a very limited exercise, no one decided to release more information," the official said. "There was not enough data as she introduced the pilot."

Mrs May's pilot allowed border officials not to check the electronic chips in members' passports, which contains photographs and other "biometric" data about holders.

Unlike simple photographs, that information is almost impossible to forge. Mrs

May's decision to allow the chips to go unchecked was criticised by Philip Hollobone, a Conservative MP. "I and my constituents would want every biometric chip to be checked," he told her.

Yvette Cooper, the Labour shadow home secretary, condemned Mrs May's handling of Britain's borders to Ring MPs that the July decision to banish passport controls had been the second mistake.

Mrs Cooper said: "The truth is that instead of allowing the checks process to continue all previous ministers had recommended to do this. Home Secretary decided to water these down as official government policy, even though she never told this House."

She added: "She has blamed officials for relaxing the checks. Another thing she intended. But she gave the green light. Continued on Page 5



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BUG: KNIGHT CAPITAL LOSES

\$450M IN 45 MINUTES!

By James Minty
Deputy Political Editor

THEIR IS MAY now facing fresh questions about her judgment last night after it emerged that she extracted a secret selection of Britain's border controls without having obtained information about the security implications of the move.

A hostile dossier of documents showed that in July the Home Secretary authorised UK Border Agency staff not to carry out full checks on the passports of thousands of thousands of people arriving at British airports and ports from six countries.

In September, Mrs May disclosed the decision – which was never made public – to end her six-month despite having only “very limited information” about the consequences of the change.

The leaked dossier suggested officials

had been given discretion to defer to a series of controls without ministerial approval. Last night the House Officer identified this was a long-standing practice to allow staff to deal with emergency cases.

In the House of Commons yesterday, Mrs May came under intense pressure as she was accused by Labour of giving the “green light” to a secret checklist controls and fighting Conservative questioned her judgment.

She insisted she had not been told what she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the relaxed checking system she put in place.

The inquiry into the dossier has found that she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the relaxed checking system she put in place.

The Daily Telegraph reported yesterday that in July Mrs May ordered the UKBA's Border Force to make the checks applied to people entering Britain with European

passports. As that “green scheme” evolved, border staff then relaxed the checks applied to non-EU passport holders.

Mrs May met with Border Clerk, the operational head of the Border Force, considering that secret situation without her minister.

The paper revealed all this without concluding that the situation of checks that remained was not sanctioned by her, she told MPs, adding that Mr Clark could have committed charges for his actions.

“As a result of this, I would have had to believe that we will never know how many people crossed the country who should have been prevented from doing so,” Mrs May said.

The Home Secretary insisted MPs that under her rules foreigners had still been checked against a Watchdog Index of suspicious individuals and criminals.

The second relaxation of passport rules

began at an unknown point during Mrs May’s ministerial pilot. She said she only learnt of it because she was informed by senior officials.

Before the pilot was due to conclude in mid-September, Mrs May decided to allow another six-week relaxation of passport rules.

A House Officer official said Mrs May took that decision based on “very limited information” about the pilot in September.

“It was a very limited exercise, no one decided to release more information,” the official said. “There was not enough data as she concluded the pilot.”

Mrs May’s pilot allowed border officials not to check the electronic chips in members’ passports, which contains photographs and other “biometric” data about citizens.

Unlike simple photographs, that information is almost impossible to forge. Mrs

May’s decision to allow the chips to go unchecked was criticised by Philip Hollobone, a Conservative MP. “I and my constituents would want every biometric chip to be checked,” he told her.

Tony Cooper, the Labour shadow home secretary, condemned Mrs May’s handling of Britain’s borders to Ring. MPs that the July decision to ban passport controls had been the second mistake.

Mrs Cooper said: “The truth is that instead of allowing the checks process years ago, all previous ministers had considered to do this. Home Secretary decided to water these down as official government policy, even though she never told this House.”

She added: “She has blamed officials for relaxing the checks. Another thing she intended. But she gave the green light. Continued on Page 5



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HEALTHCARE.GOV

By James Minty
Deputy Political Editor

THE HOME SECRETARY was facing fresh questions about her judgment last night after it emerged that she extracted a secret selection of Britain's border controls without having obtained detailed information about the security implications of the move.

A hostile Commons Select Committee has demanded that in July the Home Secretary instructed UK Border Agency staff not to carry out full checks on the passports of thousands of thousands of people arriving at British airports and ports from six countries.

In September, Mrs May disclosed the change – which was never made public – to one of her six countries despite having only “very limited information” about the consequences of the change.

The stated reason of suggested officials

had been a desire to reduce the volume of controls without risking ministerial approval. Last night the Home Office admitted this was a long-standing practice to allow staff to deal with emergency work.

In the House of Commons yesterday, Mrs May came under intense pressure as she was accused by Labour of giving the “green light” to a secret checklist controls and fighting Conservative questioned her judgment.

She insisted she had no intention but admitted she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the selected checking system she put in place.

The Daily Telegraph reported yesterday that in July Mrs May ordered the UKBA's Border Force to reduce the checks applied to people entering Britain with European

passports. As that “green scheme” could not be used until the checks applied to non-Europeans were introduced.

Mrs May met with Border Clerk, the operational head of the Border Force, considering that secret selection without proper review.

The paper revealed all those without doubt guilty that the selection of checks that remained was not justified by law, she told MPs, adding that Mr Clark could face criminal charges for his actions.

“As a result of this stand border officials we will never know how many people crossed the country who should have been prevented from doing so,” Mrs May said.

The Home Secretary insisted MPs that under her rules foreigners had still been checked against a Watchdog Index of suspicious individuals and criminals.

The second selection of passport-holders

began at an unknown point during Mrs May’s authorized pilot. She said she only learnt of it last week when she was informed by senior officials.

Before the pilot was due to conclude in mid-September, Mrs May decided to allow another six-week selection of passport-holders.

A Home Office official said Mrs May took that decision based on “very limited information” about the pilot in September.

“It was a very limited exercise, so the decision to extend more information,” the official said. “There was not enough data on the outcome of the pilot.”

Mrs May’s pilot allowed border officials to check off electronic chips in modern passports, which contains photographs and other “biometric” data about holders.

Unlike simple photographs, that information is almost impossible to forge. Mrs

May’s decision to allow the chips to go unchecked was criticized by Philip Hollobone, a Conservative MP. “I and my constituents would want every biometric chip to be checked,” he told her.

Yvette Cooper, the Labour shadow home secretary, condemned Mrs May’s handling of Britain’s borders to Ring. MPs that the July decision to limit passport controls had left the second selection.

Mrs Cooper said: “The truth is that instead of allowing the checks process to cover all previous mistakes had remained to do this Home Secretary decided to water down the strict official government policy, even though she never told this House.”

She added: “She has blamed officials for failing to check the chips. Another thing she intended. But she gave the green light. Continued on Page 5



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TENS OF THOUSANDS DIE IN SOFTWARE CATASTROPHE

By James Minty
Deputy Political Editor

THERE IS now being fresh questions about her judgment last night after it emerged that she extracted a secret selection of Britain's border controls without having obtained detailed information about the security implications of the move.

A leading lawmaker claimed that in July the Home Secretary authorised UK Border Agency staff not to carry out full checks on the passports of thousands of thousands of people arriving at British airports and ports from six countries.

In September, Mrs May disclosed the decision – which was never made public – to end her six-month despite having only “very limited information” about the consequences of the change.

The stated reason of suggested officials

had been a desire to reduce the amount of control without risking ministerial approval. Last night the Home Office admitted this was a long-standing practice to allow staff to deal with emergency.

In the House of Commons yesterday, Mrs May came under intense pressure as she was accused by Labour of giving the “green light” to a software catastrophe and failing Conservative questioned her judgment.

She insisted she had been told she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the relaxed checking system she put in place.

The Daily Telegraph reported yesterday that in July Mrs May ordered the UKBA's Border Force to waive the checks applied to people entering Britain with European

passports. As that “green scheme” could not be used until the checks applied to non-Europeans were introduced.

Mrs May named Bowe Clark, the operational head of the Border Force, as the person who advised her to proceed without further review.

The paper revealed all those without credibility that the situation of checks that remained was not monitored by me,” she told MPs, adding that Mr Clark could have taken steps to stop his actions.

“As a result of this stand border officials we will never know how many people crossed the country who should have been prevented from doing so,” Mrs May said.

The Home Secretary insisted MPs that under her rules foreigners had still been checked against a Watchdog index of suspicious individuals and criminals.

The second relaxation of passport rules

began of six unknown point during Mrs May’s authorized pilot. She said she only learnt of it because she was informed by senior officials.

Before the pilot was due to conclude in mid-September, Mrs May decided to allow another six-week relaxation of passport rules.

A Home Office official said Mrs May took that decision based on “very limited information” about the pilot in September.

“It was a very limited exercise, no one decided to release more information,” the official said. “There was not enough data as she concluded the pilot.”

Mrs May’s pilot allowed border officials not to check the electronic chips in members’ passports, which contains photographs and other “biometric” data about holders.

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May’s decision to allow the chips to go unchecked was criticised by Philip Hollobone, a Conservative MP. “I and my constituents would want every biometric chip to be checked,” he told her.

Taffe Cooper, the Labour shadow home secretary, condemned Mrs May’s handling of Britain’s borders to Ring. MPs that the July decision to ban passport controls had been the second mistake.

Mrs Cooper said: “The truth is that instead of allowing the checks process years all previous ministers had recommended to do this Home Secretary decided to water these down as official government policy, even though she never told this House.

She added: “She has blamed officials for relaxing the checks. Another thing she intended. But she gave the green light. Continued on Page 5



HOW
COULD
YOU...



...HAVE
LET
THIS
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CONGRESS PASSES SWEEPING SOFTWARE REGULATIONS

By James Minty
Deputy Political Editor

THEIR IS ONE being fresh questions about her judgment but might offer a reassurance that she extricated a secret selection of Britain's border controls without having obtained information about the security implications of the move.

A detailed document showed that in July the Home Secretary authorised UK Border Agency staff not to carry out full checks on the passports of thousands of thousands of people arriving at British airports and ports from six countries.

In September, Mrs May disclosed the decision - which was never made public - for such six countries despite having only "very limited information" about the consequences of the change.

The stated document suggested officials

had been given discretion to defer to other passport controls without ministerial approval. Last night the Home Office clarified this was a long-standing practice to allow staff to deal with emergency cases.

In the House of Commons yesterday, Mrs May came under intense pressure as she was accused by Labour of giving the "green light" to racial discrimination and frightening Conservative questioned her judgment.

She insisted she had not been told what she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the selected checking system she put in place.

The inserted clause showed her officials had calculated she did not know how many suspected terrorists, criminals and illegal immigrants had been able to enter the country under the selected checking system she put in place.

The Daily Telegraph reported yesterday that in July Mrs May ordered the UKBA's Border Force to waive the checks applied to people entering Britain with European

passports. As that "green scheme" could not be used until the checks applied to non-Europeans were introduced.

Mrs May named David Clark, the now-pivotal head of the Border Force, as the person in charge of the operation without further question.

"The government will show without doubt that the situation of checks that remained was not monitored by me," she told MPs, adding that Mr Clark could face criminal charges for his actions.

"As a result of these stand-alone regulations we will never know how many people entered the country who should have been prevented from doing so," Mrs May said.

The Home Secretary insisted MPs that under her rules foreigners had still been checked against a Watchdog Index of suspicious individuals and criminals.

The second relaxation of passport rules

began at an unknown point during Mrs May's authorized pilot. She said she only learnt of it because she was informed by senior officials.

Before the pilot was due to conclude in mid-September, Mrs May decided to allow another six-week relaxation of passport rules.

A Home Office official said Mrs May took that decision based on "very limited information" about the pilot in September.

"It was a very limited exercise, no one decided to release more information," the official said. "There was not enough data as she concluded the pilot."

Mrs May's pilot allowed border officials not to check the electronic chips in members' passports, which contains photographs and other "biometric" data about holders.

Unlike simple photographs, that information is almost impossible to forge. Mrs

May's decision to allow the chips to go unchecked was criticised by Philip Hollobone, a Conservative MP. "I and my constituents would want every biometric chip to be checked," he told her.

Travis Cooper, the Labour shadow home secretary, condemned Mrs May's handling of Britain's borders to Ring. MPs said the July decision to banish passport controls had helped the second relaxation.

Mrs Cooper said: "The truth is that instead of allowing the checks process to run as all previous ministers had intended to do, this Home Secretary decided to water them down as official government policy, even though she never told this House."

She added: "She has blamed officials for relaxing the checks. Another thing she intended. But she gave the green light. Continued on Page 5



THE THREE LAWS OF TEST DRIVEN DEVELOPMENT.



ARBITRARY DISCIPLINE

- Like a surgeon scrubbing for surgery.
- Like a pilot following a checklist.

THE WORD “UNIT”

- There is no good definition of unit in unit-test.
- Some people call them micro-tests or programmer-tests.
- They are tests written by programmers for programmers.

THE FIRST LAW

- You are not allowed to write any production code until you have written a unit test that fails due to its absence.

THE SECOND LAW

- You are not allowed to write more of a unit test than is sufficient to fail. Failing to compile is failing.

THE THIRD LAW

- You are not allowed to write more production code than is sufficient to cause the currently failing test to pass.

THE IMPOSSIBLY TINY LOOP

- This just sounds dumb.
- Boring, tedious, slow, awful.
- Interrupts true thought.
- Always in the way.

BUT, IMAGINE...

- A team of people working this way.
 - Pick one at random.
 - Everything worked a minute ago!

HOW MUCH DEBUGGING WOULD YOU DO?

- Are you good at the debugger?
 - This is not a skill to be desired!
 - The three laws reduce debugging time.

THE CODE EXAMPLES

- Have you integrated a third party package.
 - You read the code examples, not the manual.
- Unit tests are the code examples for the whole system

DOCUMENTS!

- Written in a language you understand.
- Utterly unambiguous.
- So formal they execute.
- They cannot get out of sync with the application.
- Easy to understand. Not a system.

TEST AFTER THE FACT?

- Boring.
 - You've already tested manually.
- The function that's hard to test...
 - Leave a hole in the test suite.
 - And if you do it...
- Do you shrug when your tests pass?

TEST FIRST

- Fun. You *make* it work!
- You can't write the function that's hard to test.
- System is testable.
- System is decoupled.
- You trust the tests!

SO THE THREE LAWS GIVE YOU:

- Reduced debug time.
- A stream of “perfect” documentation.
- Fun.
- Decoupled design.

TRUSTED TESTS MEAN REDUCED FEAR!

- That's the real reason we do TDD.
- The three laws give us a test suite we trust.
- We don't fear changing the code.
- We can clean it.

OBJECTIONS HEARD (BUT NOT BELIEVED)

- “I know how to just write the class, but I don’t know how to test it.”
- “We have to write twice as much code and provide two people to do it.”
- “I have to debug twice as much code.”
- “We have a testing department.”
- “I can test my code after I write it.”

DISCUSSION

- Fears, concerns, confounds and blockages.
 - Organizational Resistance
 - Crushing Deadlines
 - Testing Taliban
 - Test After
 - Sole TDDer

PROFESSIONALISM RANT.

- Laborers take orders.
- Professionals “Profess”
 - Hired for knowledge and expertise
- Managers will push, and want push-back.
 - Professionals push back.

WHO ELSE HAS OUR PROBLEM.

- We produce complex documents full of arcane symbols.
- Must be correct or terrible things happen.

ACCOUNTANTS!

- The right digit, in the right place, at the right time...
- Brings the company down and sends the executives to jail.

HOW DO ACCOUNTANTS PREVENT THIS?

- They have a discipline.
- 500 years old.
- Double Entry Bookkeeping.

DOUBLE ENTRY BOOKKEEPING.

- Every transaction is entered twice.
- Once under Assets. Once under Liabilities and Equities.
- The two sides are summed.
- The sums are subtracted on the balance sheet.
- The result must be zero.

THE PROCEDURE

- Accountants are taught to enter transactions one at a time.
- For obvious reasons.

TDD IS DOUBLE ENTRY BOOKKEEPING.

- The practices are the same.
- They are done for the same reason.
- Every behavior is entered twice.
 - Once as a test, again as production code.
- The two entries must agree.

IF ACCOUNTANTS CAN DO IT...

- Accountants have schedules and deadlines just like us.
- Our documents are not less important than the accountant's.
- If they can do it...

CLEAN TESTS



WHAT DOES THIS TEST DO?

```
@Test
public void tableWithSymbolSubstitution() throws Exception {
    getResultsForPageContents(
        "!|DT:fitnesse.slim.test.TestSlim|\n" +
        "|string|getStringArg?|\n" +
        "|Bob|$V=|\n" +
        "|$V|$V|\n" +
        "|Bill|$V|\n" +
        "|John|$Q|\n"
    );
    TableScanner ts = getScannedResults();
    Table dt = ts.getTable(0);
    assertEquals("$V<-[Bob]", unescape(dt.getCellContents(1, 2)));
    assertEquals("$V->[Bob]", unescape(dt.getCellContents(0, 3)));
    assertEquals("<span class=\"pass\">$V->[Bob]</span>", unescape(dt.getCellContents(1, 3)));
    assertEquals("[Bill] <span class=\"fail\">expected [$V->[Bob]]</span>", unescape(dt.getCellContents(1, 4)));
    assertEquals("[John] <span class=\"fail\">expected [$Q]</span>", unescape(dt.getCellContents(1, 5)));
}
```

PROBLEMS WITH THIS TEST.

- More than one logical assert.

```
@Test
public void tableWithSymbolSubstitution() throws Exception {
    getResultsForPageContents(
        "!|DT:fitnesse.slim.test.TestSlim|\n" +
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}
```

PROBLEMS WITH THIS TEST.

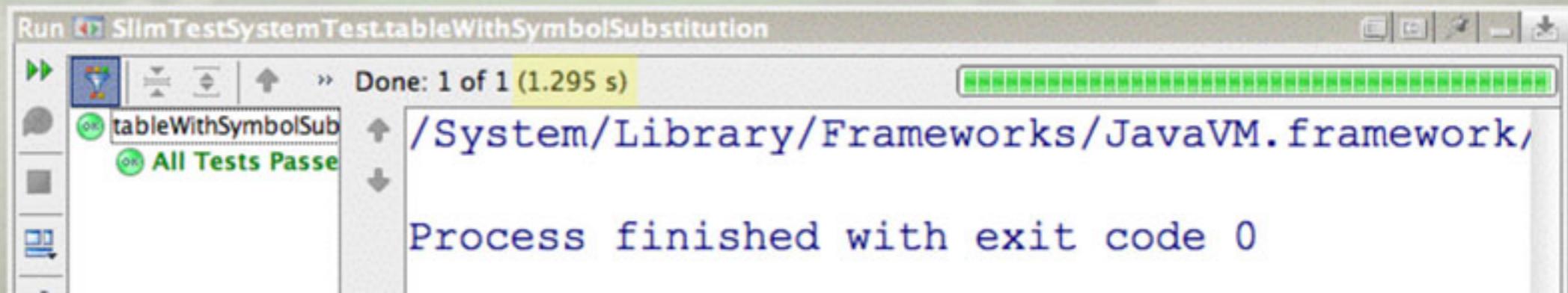
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}
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- More than one logical assert
- Accidental Complexity

PROBLEMS WITH THIS TEST.

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}
```

- More than one logical assert.
- Accidental Complexity
- Too Slow



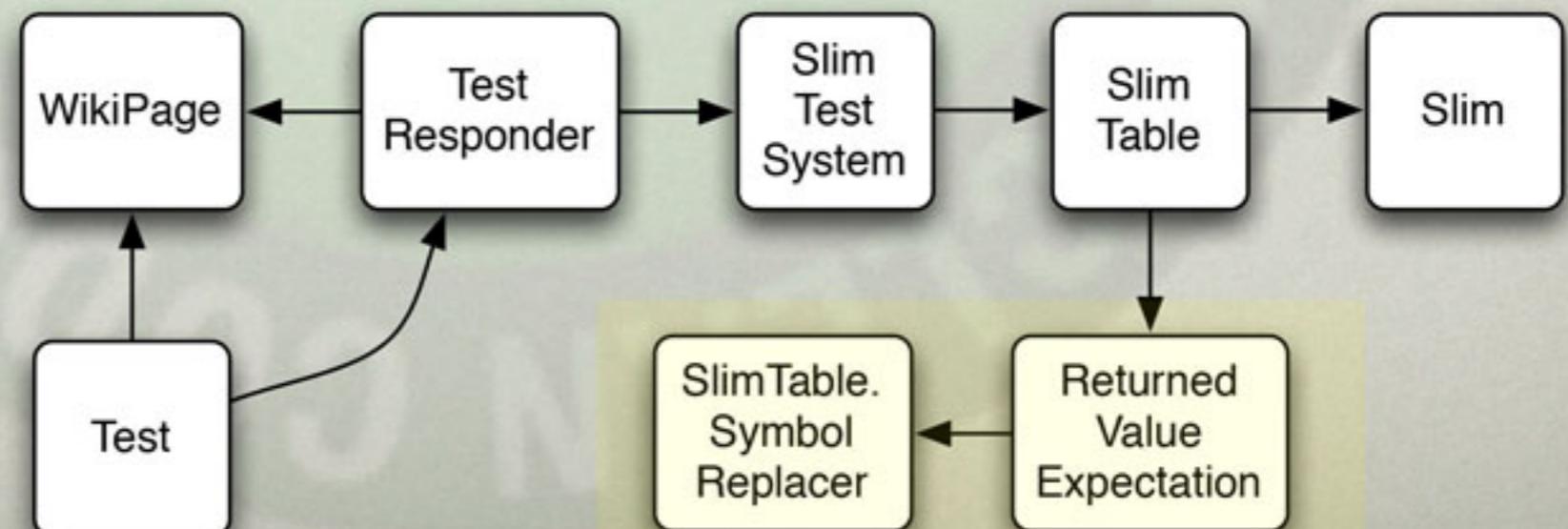
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```

- Accidental Complexity

- Too Slow

- Wide Scope



PROBLEMS WITH THIS TEST.

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}
```

- Accidental Complexity
- Too Slow
- Wide Scope
- Colloquialisms

BETTER TESTS

The screenshot shows an IDE interface with a code editor and a test results window.

Code Editor Content:

```
1 @Test
2 public void matchedSymbolIsReplaced() throws Exception {
3     testContext.setSymbol("S", "Value");
4     assertExpectationMessage("$S", "Value", "pass($S->[Value])");
5 }
6
7 @Test
8 public void mismatchedSymbolIsReplaced() throws Exception {
9     testContext.setSymbol("S", "Value");
10    assertExpectationMessage("$S", "WrongValue", "[WrongValue] fail(expected [$S->[Value]])");
11 }
```

Test Results Window:

- Test Name: ReturnedValueExpectationTest.mismatchedUnboundSymbolsNotReplaced
- Status: Done: 1 of 1 (0.268 s)
- Output: /System/Library/Frameworks/JavaVM.framework/Versions/1.6.0/Home/bin/java -Dfi
- Details:
 - mismatchedUnboundSymbolsNotReplaced: All Tests Passed

- One Logical Assert
- No Accidental Complexity
- Fast
- Narrow Scope
- Meaningful Values

COMPOSED ASSERTION

```
private void assertExpectationMessage(String expected, String value, String message) throws Exception {  
    TableScanner ts = new HtmlTableScanner("<table><tr><td>x</td></tr></table>");  
    Table t = ts.getTable(0);  
    SlimTable slimTable = new DecisionTable(t, "id", testContext);  
    SlimTable.Expectation expectation = slimTable.makeReturnedValueExpectation("instructionId", 1, 2);  
    assertEquals(message, HtmlTable.colorize(expectation.evaluationMessage(value, expected)));  
    assertEquals(message, expectation.getEvaluationMessage());  
    assertEquals(2, expectation.getRow());  
    assertEquals(1, expectation.getCol());  
    assertEquals("instructionId", expectation.getInstructionTag());  
}
```

- Changes many asserts into one.
- Hides accidental complexity.

COMPOSED TEST RESULT

```
@Test  
public void turnOnHeaterAndBlowerIfTooCold() throws Exception {  
    tooCold();  
    assertEquals("HBchl");  
}
```

```
public String getState() {  
    String state = "";  
    state += heater ? "H" : "h";  
    state += blower ? "B" : "b";  
    state += cooler ? "C" : "c";  
    state += hiTempAlarm ? "H" : "h";  
    state += loTempAlarm ? "L" : "l";  
    return state;  
}
```

- A test result that merges many variables into one.
 - e.g. Booleans into an integer or a string.
- Human interpretation should be simple.
- Changes many asserts into one.

STUBBING VS MOCKING

TESTING BEHAVIOR VS

STATE

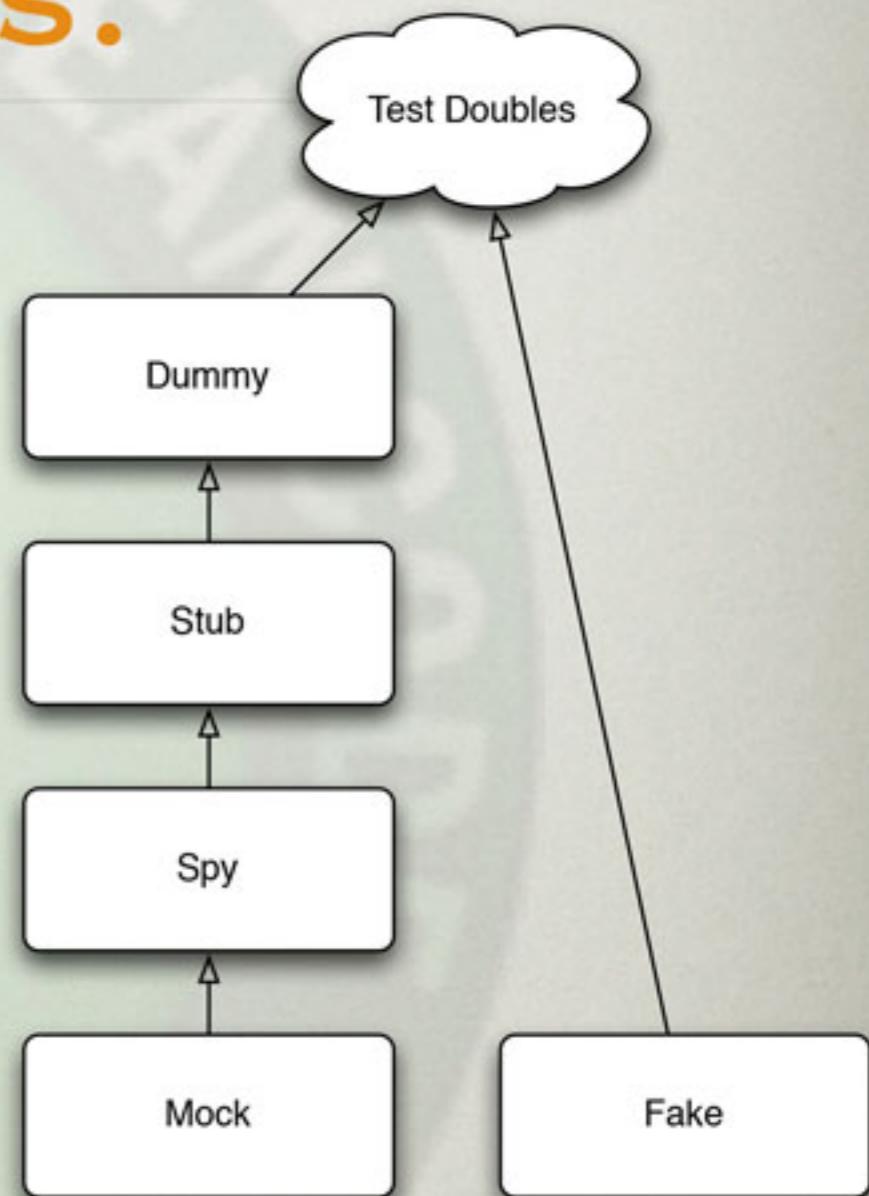


MOCKS, SPIES, STUBS, AND TEST DOUBLES.

- Dummy
 - Do nothing. Return degenerate values.

```
public interface Authenticator {  
    Boolean authenticate(String username,  
                        String password);  
}
```

```
public class AuthenticatorDummy implements Authenticator {  
    public Boolean authenticate(String username, String password) {  
        return null;  
    }  
}
```

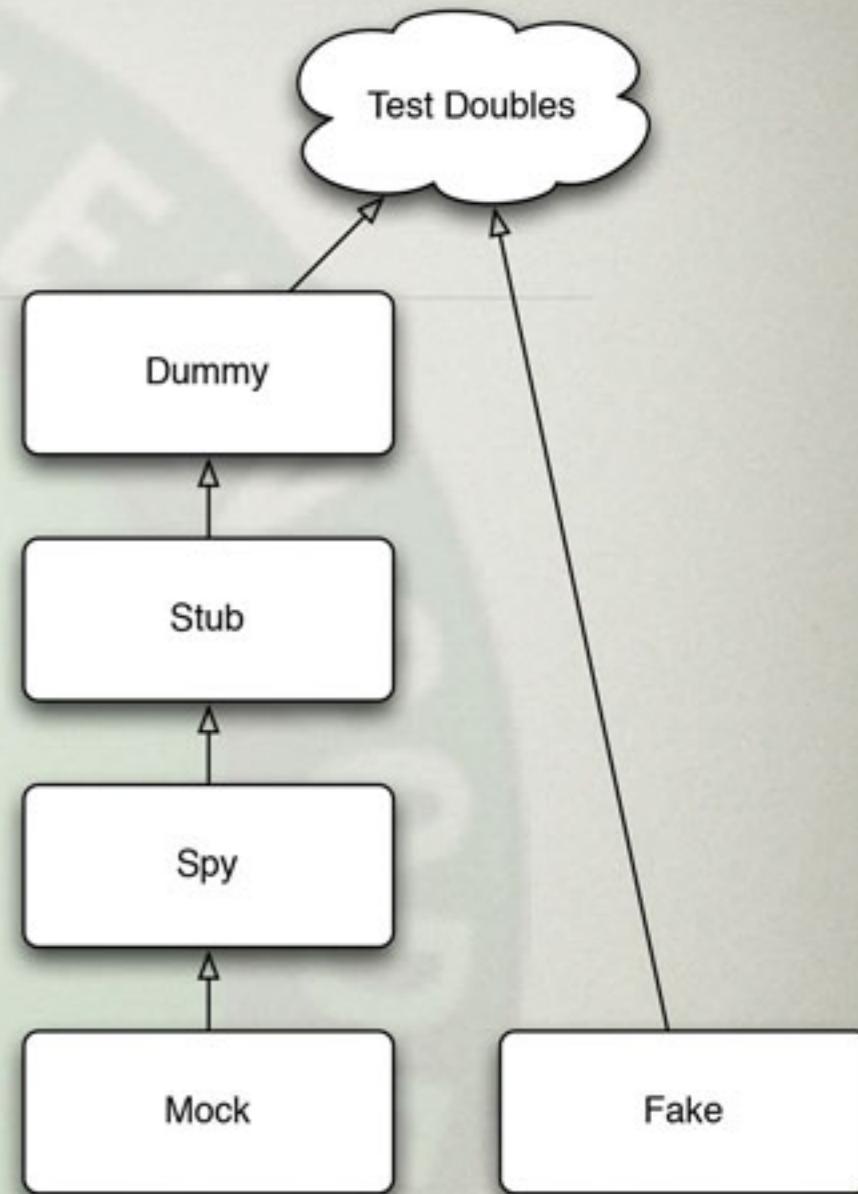


USING A DUMMY

```
public class LoginPageTest {  
    @Test  
    public void canCancelLoginPage() throws Exception {  
        LoginPage page = new LoginPage(new AuthenticatorDummy());  
        page.show();  
        boolean success = page.sendEvent(CLOSE);  
        assertTrue(success);  
    }  
}
```

STUBS

- A Dummy that returns Test Specific Values.



```
public class RejectingAuthenticatorStub implements Authenticator {  
    public Boolean authenticate(String username, String password) {  
        return false;  
    }  
}  
  
public class PromiscuousAuthenticatorStub implements Authenticator{  
    public Boolean authenticate(String username, String password) {  
        return true;  
    }  
}
```

USING STUBS

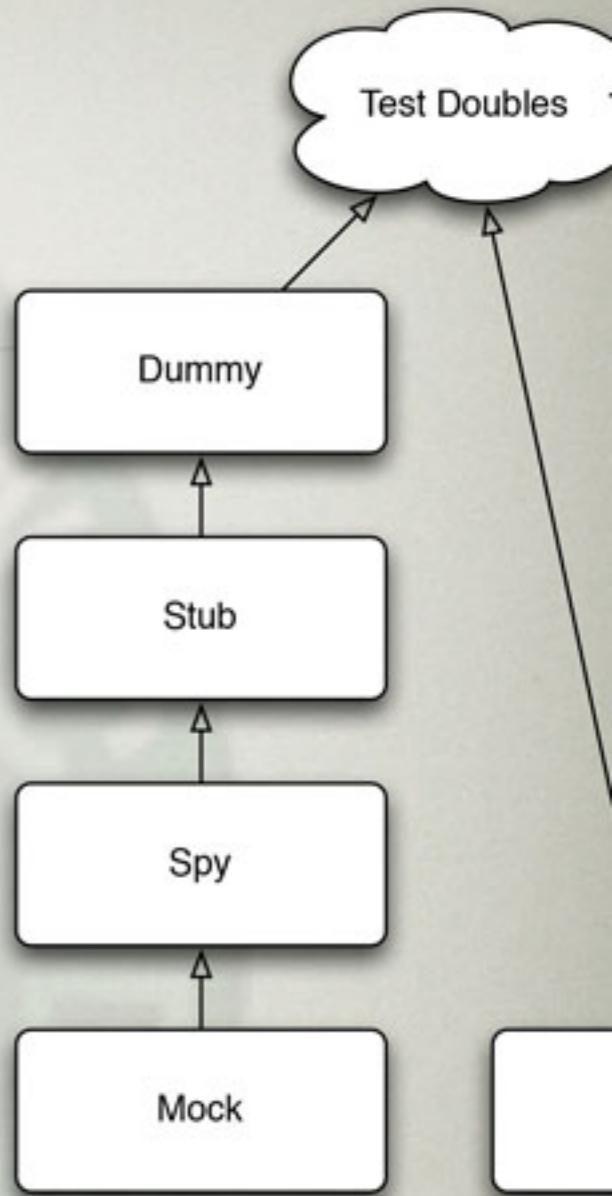
```
@Test  
public void canLogin() throws Exception {  
    LoginPage page = new LoginPage(new PromiscuousAuthenticatorStub());  
    page.show();  
    boolean success = page.submit("some user name", "some password");  
    assertTrue(success);  
}
```

```
@Test  
public void failsLogin() throws Exception {  
    LoginPage page = new LoginPage(new RejectingAuthenticatorStub());  
    page.show();  
    boolean success = page.submit("some user name", "some password");  
    assertFalse(success);  
}
```

SPIES

- Stub that remembers facts about the method calls.

```
public class AuthenticatorSpy implements Authenticator {  
    private Boolean result = null;  
    private int count = 0;  
    private String lastUsername;  
    private String lastPassword;  
  
    public String getLastUsername() { return lastUsername; }  
  
    public String getLastPassword() { return lastPassword; }  
  
    public int getCount() { return count; }  
  
    public void setResult(Boolean result) { this.result = result; }  
  
    public Boolean authenticate(String username, String password) {  
        count++;  
        lastUsername = username;  
        lastPassword = password;  
        return result;  
    }  
}
```



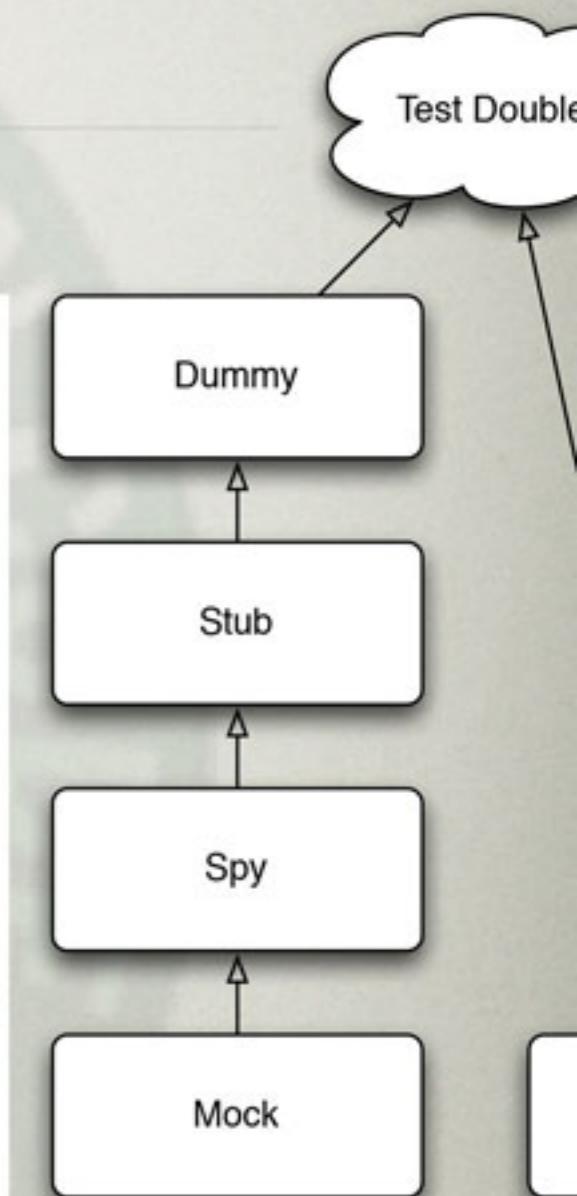
USING SPIES

```
@Test  
public void authenticatorCalledCorrectly() throws Exception {  
    AuthenticatorSpy spy = new AuthenticatorSpy();  
    LoginPage page = new LoginPage(spy);  
    spy.setResult(true);  
    page.show();  
    boolean success = page.submit("user", "pw");  
    assertTrue(success);  
    assertEquals(1, spy.getCount());  
    assertEquals("user", spy.getLastUsername());  
    assertEquals("pw", spy.getLastPassword());  
}
```

MOCK

- Spy that knows how methods *should* be called.

```
public class AuthenticatorMock extends AuthenticatorSpy {  
    private String expectedUsername;  
    private String expectedPassword;  
    private int expectedCount;  
  
    public AuthenticatorMock(String expectedUsername,  
                            String expectedPassword,  
                            int expectedCount) {  
        this.expectedUsername = expectedUsername;  
        this.expectedPassword = expectedPassword;  
        this.expectedCount = expectedCount;  
    }  
  
    public boolean validate() {  
        return getCount() == expectedCount &&  
               getLastPassword().equals(expectedPassword) &&  
               getLastUsername().equals(expectedUsername);  
    }  
}
```

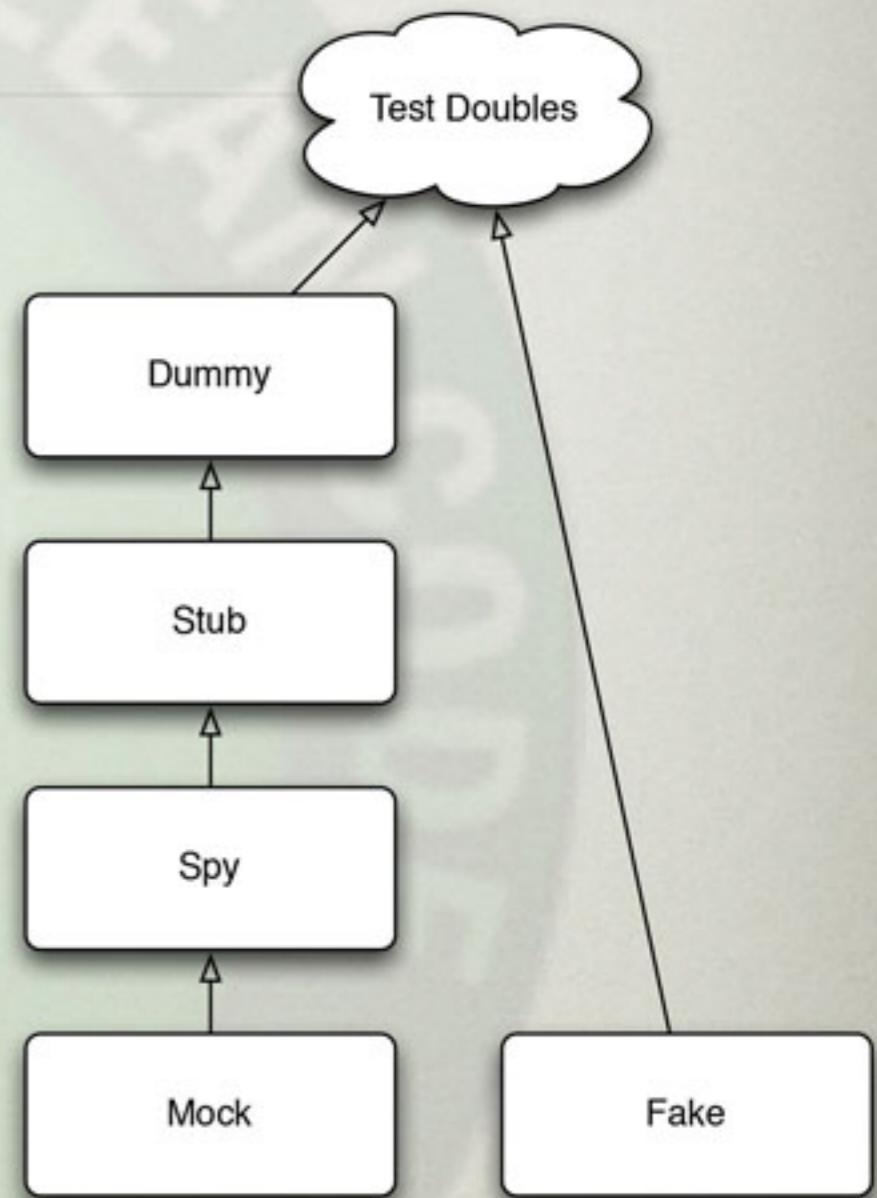


USING A MOCK

```
@Test  
public void authenticatorCallValidated() throws Exception {  
    AuthenticatorMock mock = new AuthenticatorMock("Bob", "xyzzy", 1);  
    LoginPage page = new LoginPage(mock);  
    mock.setResult(true);  
    page.show();  
    boolean success = page.submit("Bob", "xyzzy");  
    assertTrue(success);  
    assertTrue(mock.validate());  
}
```

FAKE

- A Simple Simulator.



```
public class AuthenticatorFake implements Authenticator{  
    public Boolean authenticate(String username, String password) {  
        return (username.equals("unclebobmartin") &&  
            password.equals("xyzzy"));  
    }  
}
```

TESTING STATE (CLASSICAL TESTING)

- Very traditional
 - Arrange, Act, Assert.
 - What you assert is the state of the outcome.
 - You have no idea HOW the outcome was achieved.

```
public void testChangingMethod() throws Exception {  
    builder.setMethod("POST");  
    String text = builder.getText();  
    assertHasRegexp("POST / HTTP/1.1\r\n", text);  
}
```

TESTING BEHAVIOR (MOCKISM)

- Typically using a Mock or a Spy
 - Or business objects that spy on themselves.
- Tests the algorithmic steps were taken
 - By checking whether certain methods were called in certain ways

```
@Test
public void credentialsShouldBeNullIfNoServiceName() throws Exception {
    NegotiateAuthenticator authenticator = new NegotiateAuthenticator(manager, properties);
    assertNull(authenticator.getServerCredentials());
    verify(manager, never()).createName(anyString(), (Oid) anyObject(), (Oid) anyObject());
}
```

THE TDD UNCERTAINTY PRINCIPLE

- Testing State leaves you uncertain that all answers will be correct.
- Mocking provides certainty but leads to Fragile Tests.
- Fragility increases with certainty.

WISDOM

- Avoid Test Doubles except when crossing architectural boundaries.
- Avoid Mocking tools unless you need superpowers.

F.I.R.S.T



F.I.R.S.T.

F.I.R.S.T Principles②

Fast: test runs < 1 second.

Isolated: fault is clearly isolated

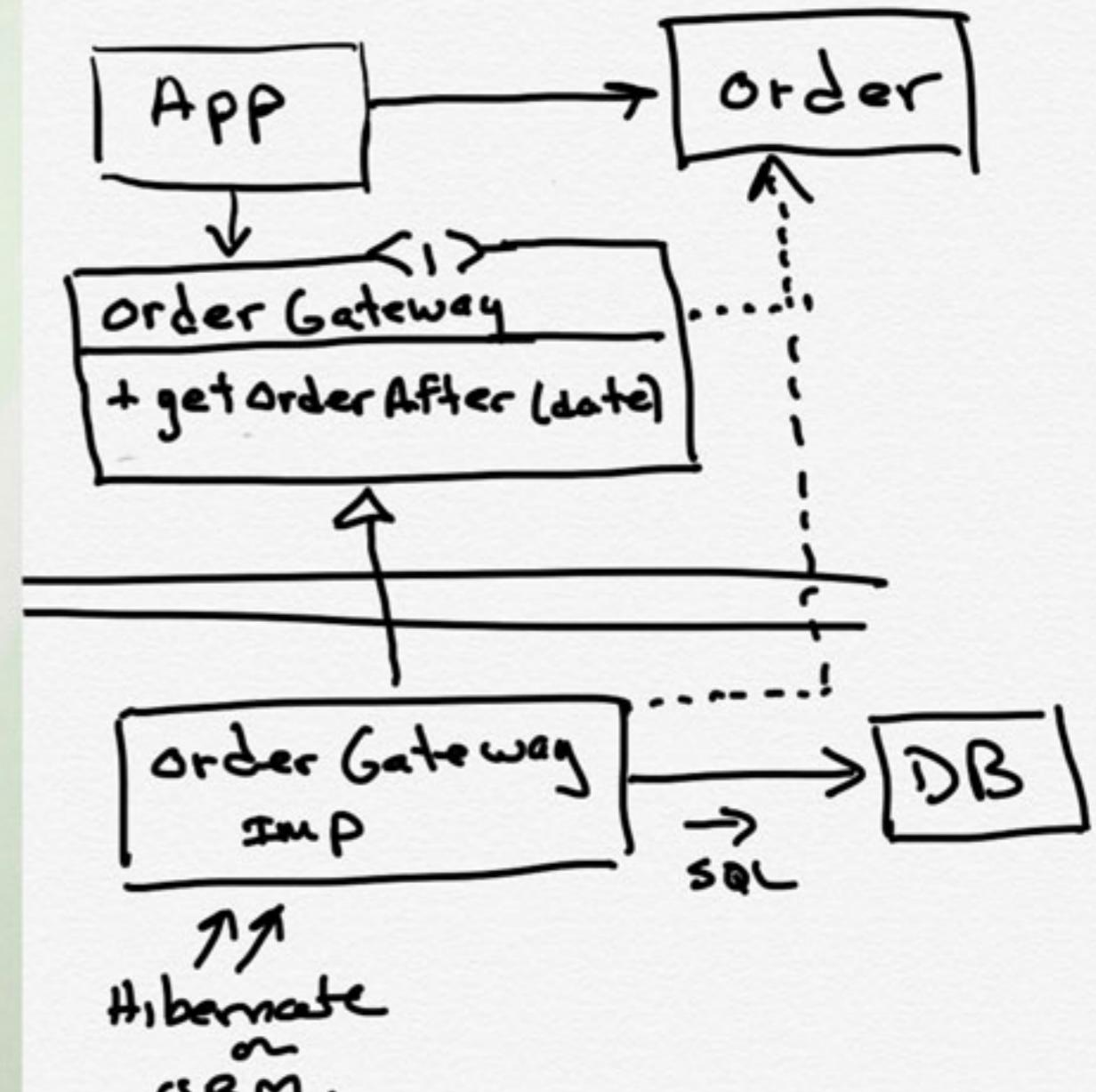
Repeatable: constant behavior

Self-verifying: pass OR fail

Timely: 1 code change = 1 test

FAST

- Database isolation
 - Hypersonic
 - Stored Procedures
 - Query Gateways.
- Web Container Isolation



ISOLATED & INDEPENDENT

- Tests do not depend upon each other.
Each tests can stand alone.
- Tests can be run in any order.
- Junit does not guarantee order.
- Be careful of static variables.

REPEATABLE

- Tests should not be dependent upon environmental issues.
- Should run the same in the lab, and at 30,000 feet over the Atlantic.
- Never subject to network timing, memory usage, other processes, etc.
- There should never be an excuse for a failure.

SELF VERIFYING

- The test has a binary result. Pass/Fail.
- No interpretation is required.

TIMELY

- Tests are written first, before the code that passes them. (most of the time).

THE REAL MEANING OF “FIRST”

- The Tests Come First.
 - They are written first.
 - They are refactored first.
 - They are higher priority than the application code.
- Because without the tests
 - The code must rot.

TEST DESIGN



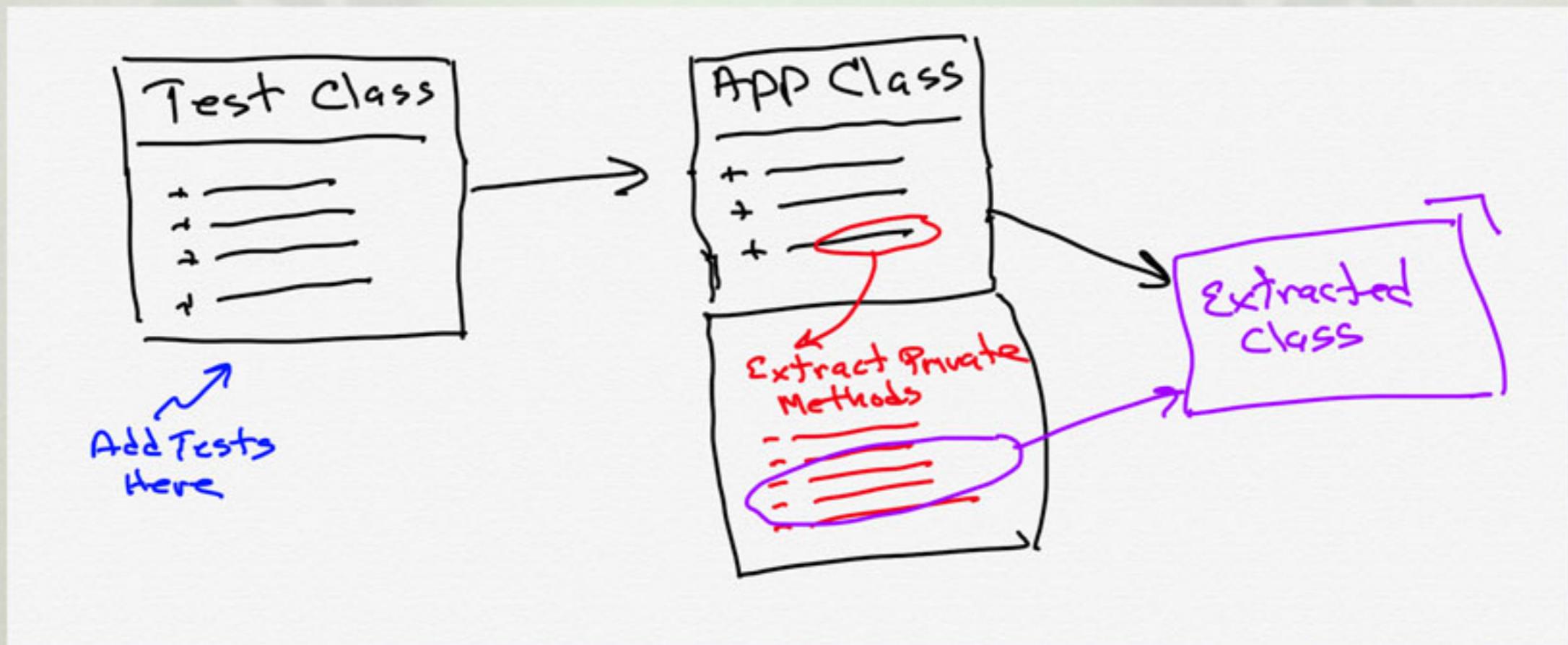
DECOPUPLE TESTS FROM APPLICATION CODE.

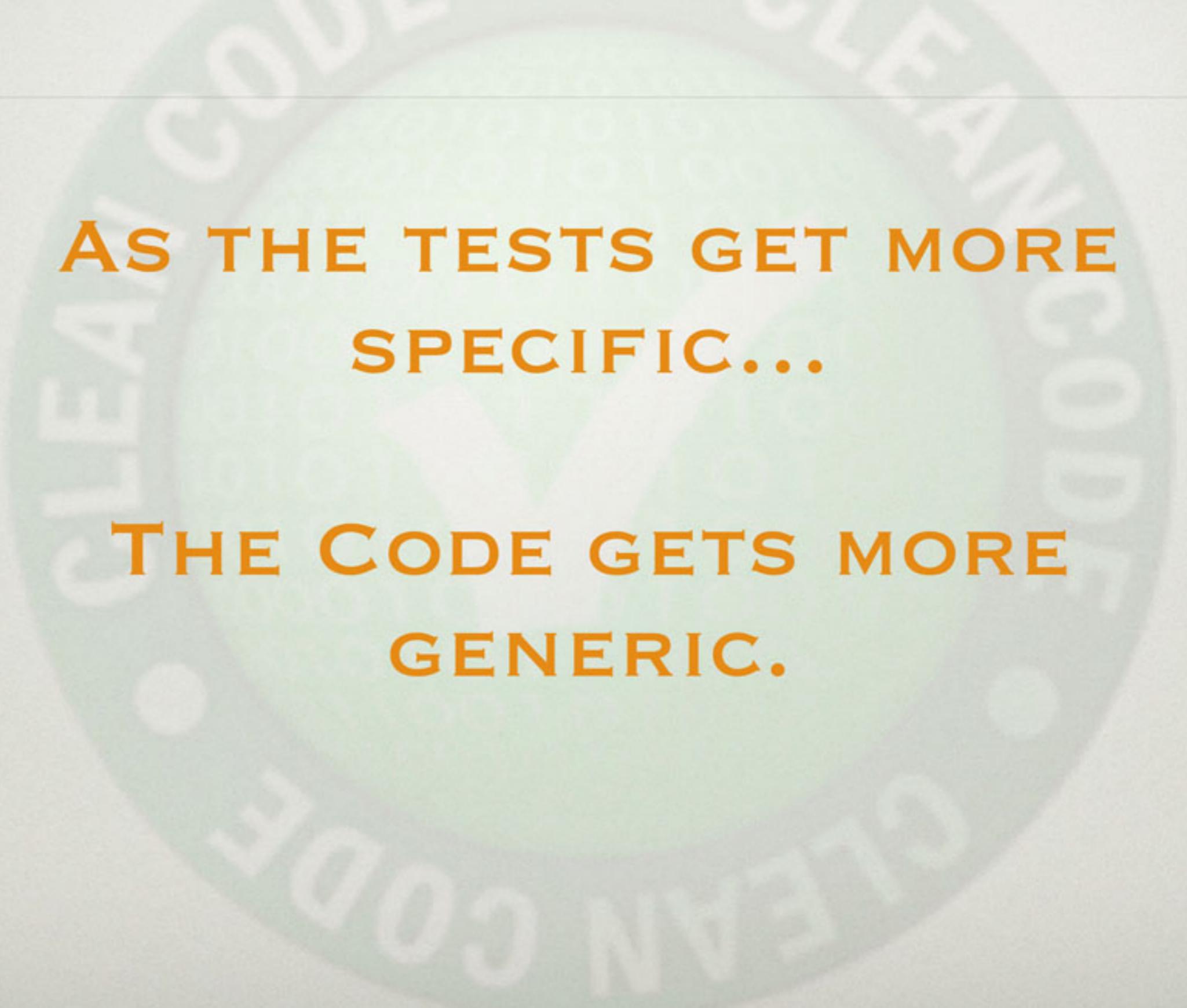
- Otherwise the tests become fragile.
- All the same principles apply.
- Use a testing API to isolate the tests from the code.
- Do not allow the tests to be too intimate with the code.

DECOPUPLE THE STRUCTURE

- Do not create a test class for each production class!
- This couples the structure and creates fragility.

ADD TESTS, BUT EXTRACT FUNCTIONS AND CLASSES.





**AS THE TESTS GET MORE
SPECIFIC...**

**THE CODE GETS MORE
GENERIC.**

Tests

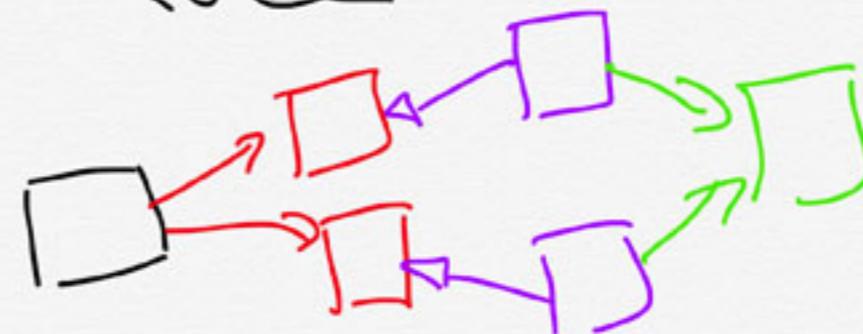


Each new Test
Makes the Test
Suite More Specific



The Two Designs DIVERGE

Code



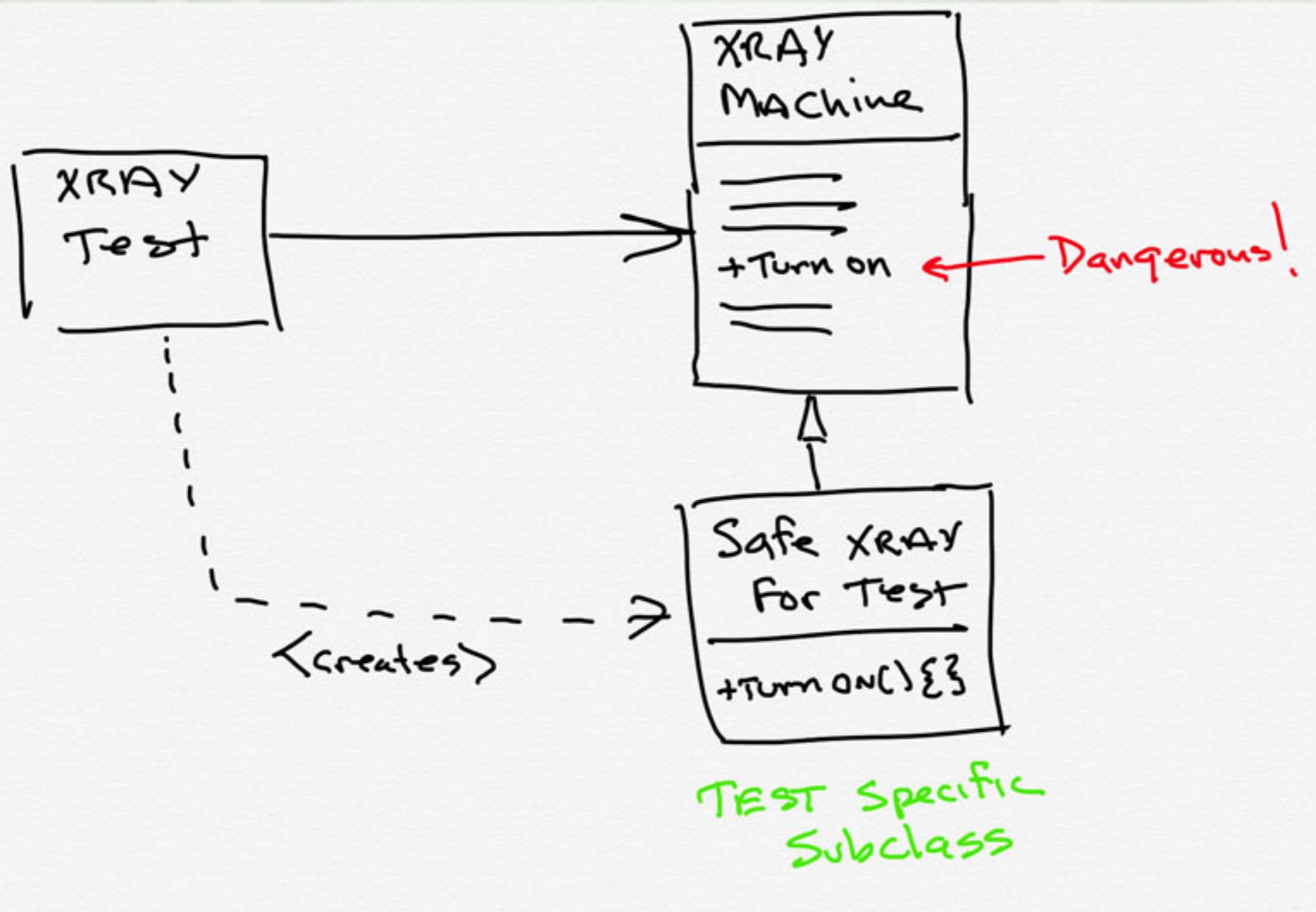
Every Refactoring
makes the code
More generic



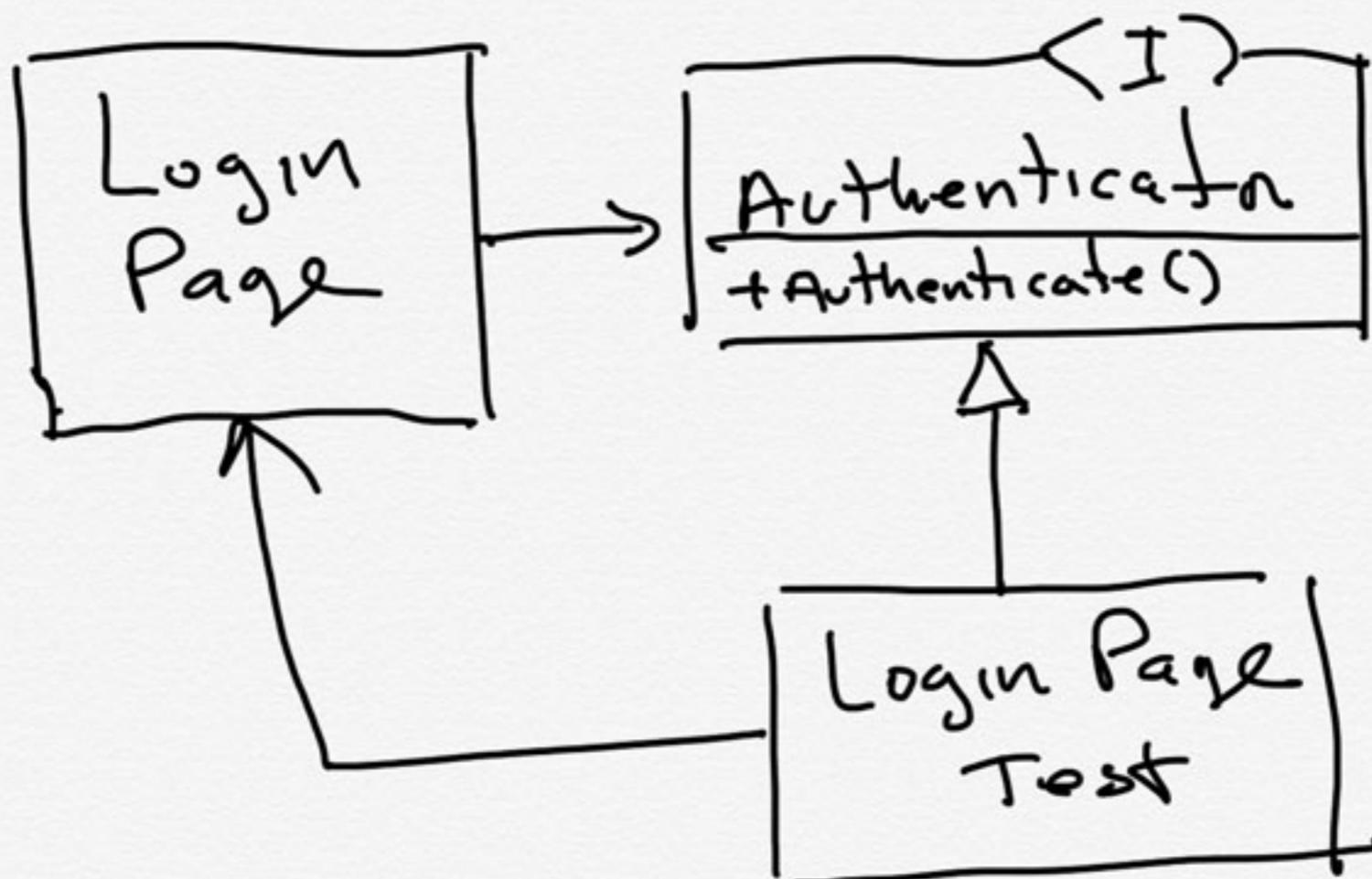
TEST PATTERNS



TEST SPECIFIC SUBCLASS

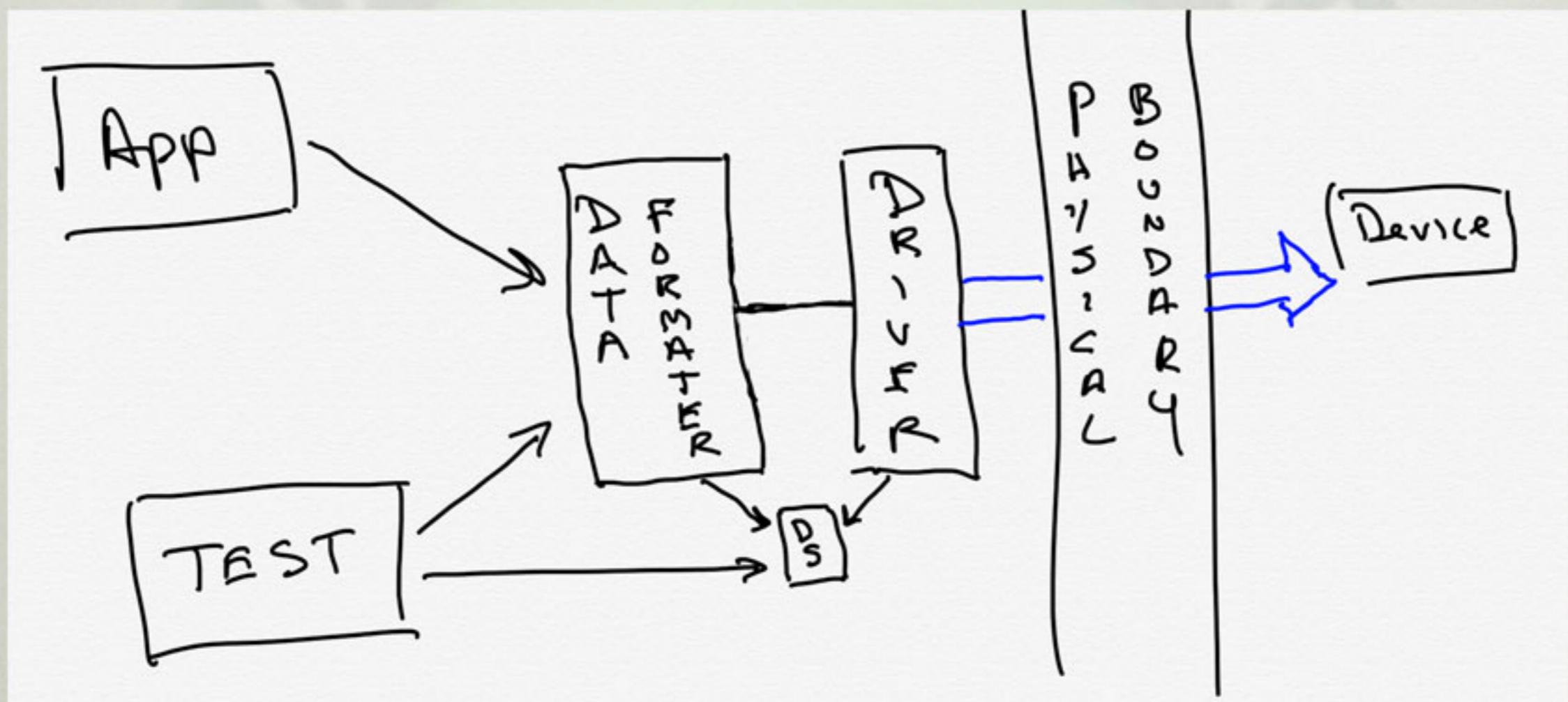


SELF-SHUNT



Self Shunt.

HUMBLE OBJECT



TEST CONVENTIONS



TEST NAMES

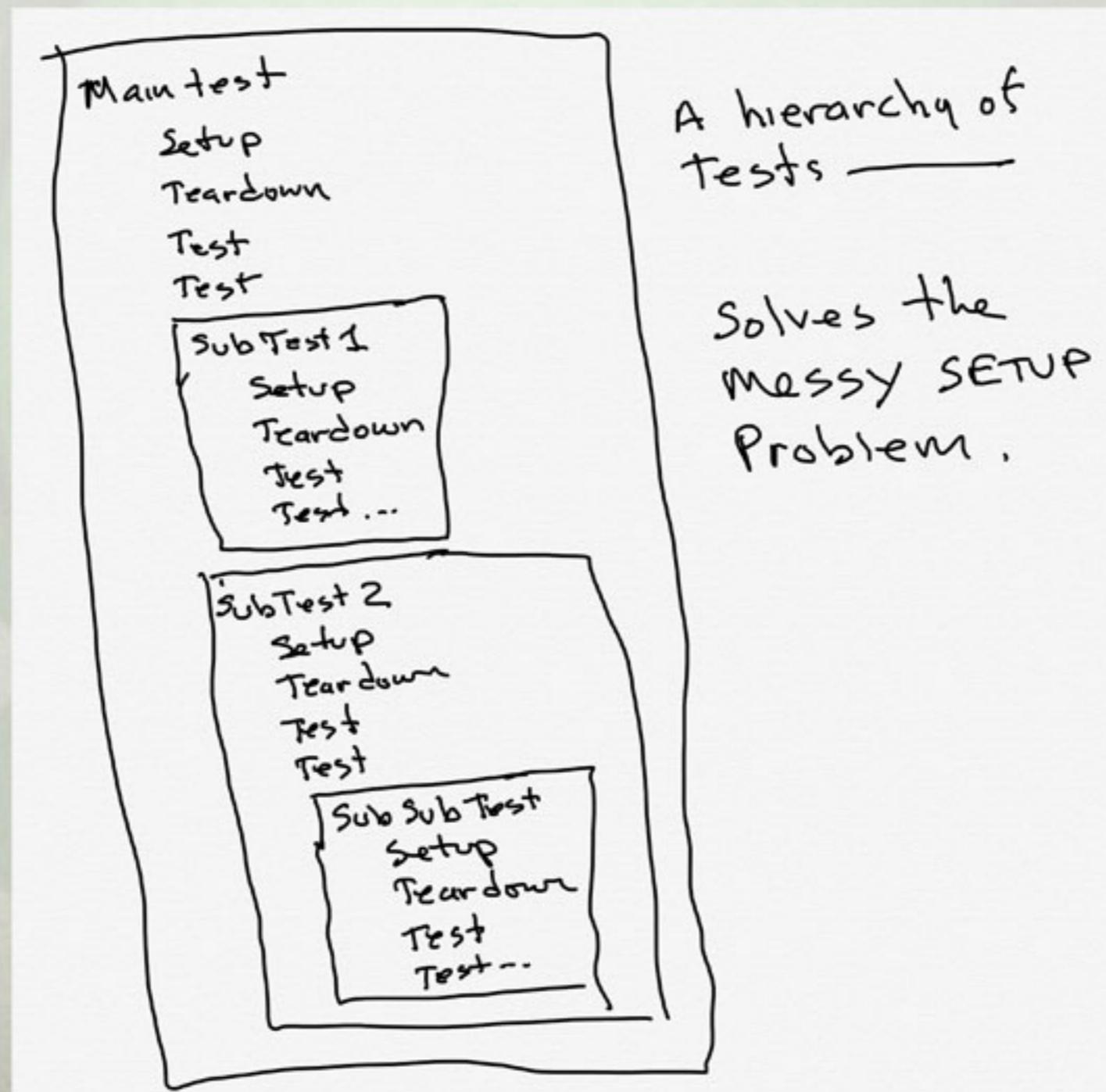
- The WHEN_THEN convention
 - **unboundSymbol_notReplaced**
 - **boundSymbol_replaced**
 - **nullBuffer_noAction**
 - **nullSymbol_noAction**
- <http://weblogs.asp.net/rosherove/archive/2005/04/03/TestNamingStandards.aspx>

TESTING PRIVATE OR PROTECTED METHODS.

- **Principle #1: Don't Test Private or Protected Methods.**
 - Test public and extract private and protected methods.
 - Extracted methods are already tested.
- **Principle #2: Testing Trumps Privacy**
 - If you have a private method that needs testing, make it protected and put the test in the same package.
 - Or, better yet, extract the private method into it's own class where it can be public.
- **Principle #3: Testing privates implies a design error.**
 - You can't test through public interface.
 - Therefore private method does more than public can ask

HIERARCHICAL TESTS

- Junit: HierarchicalContextRunner



COVERAGE AND METRICS



COVERAGE

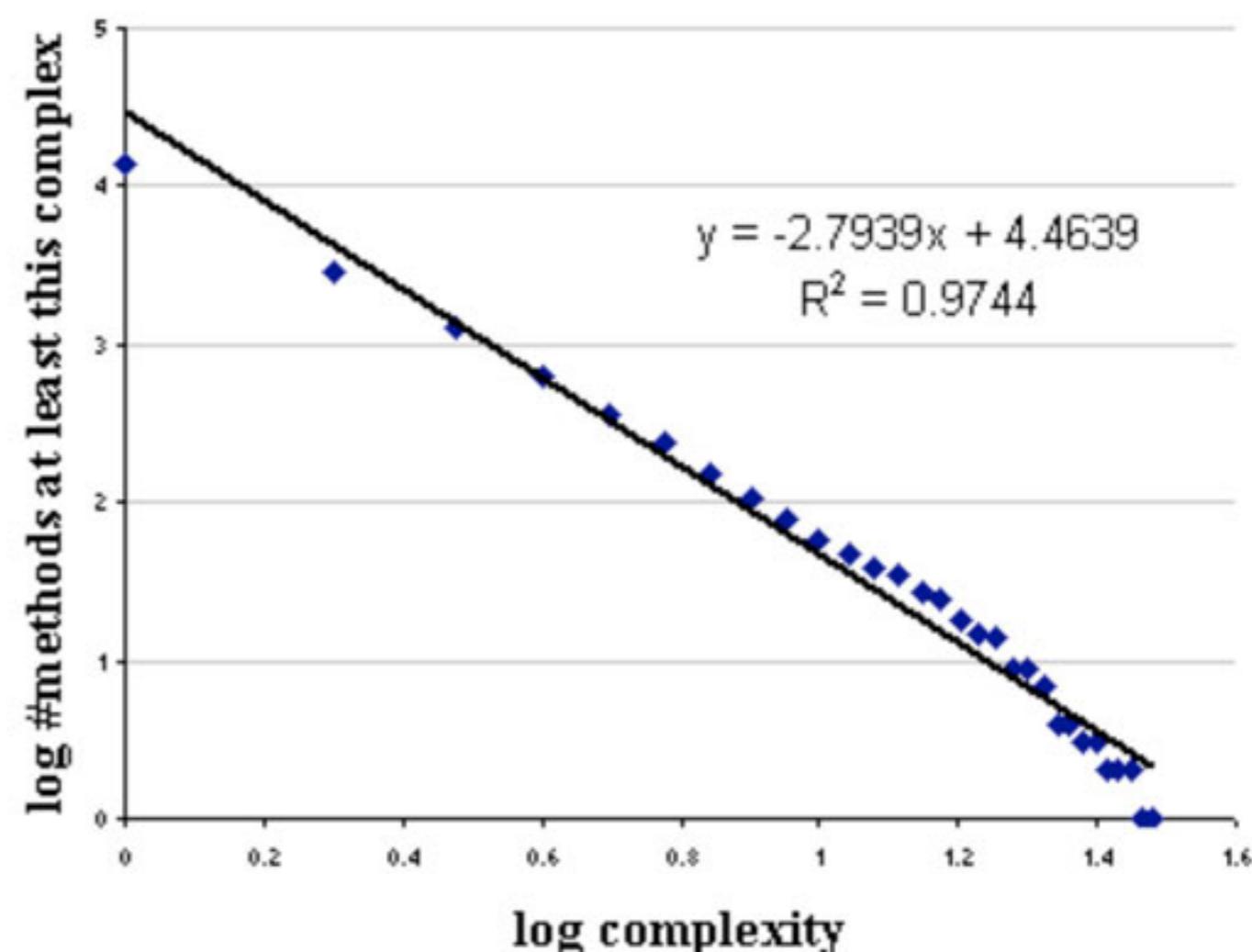
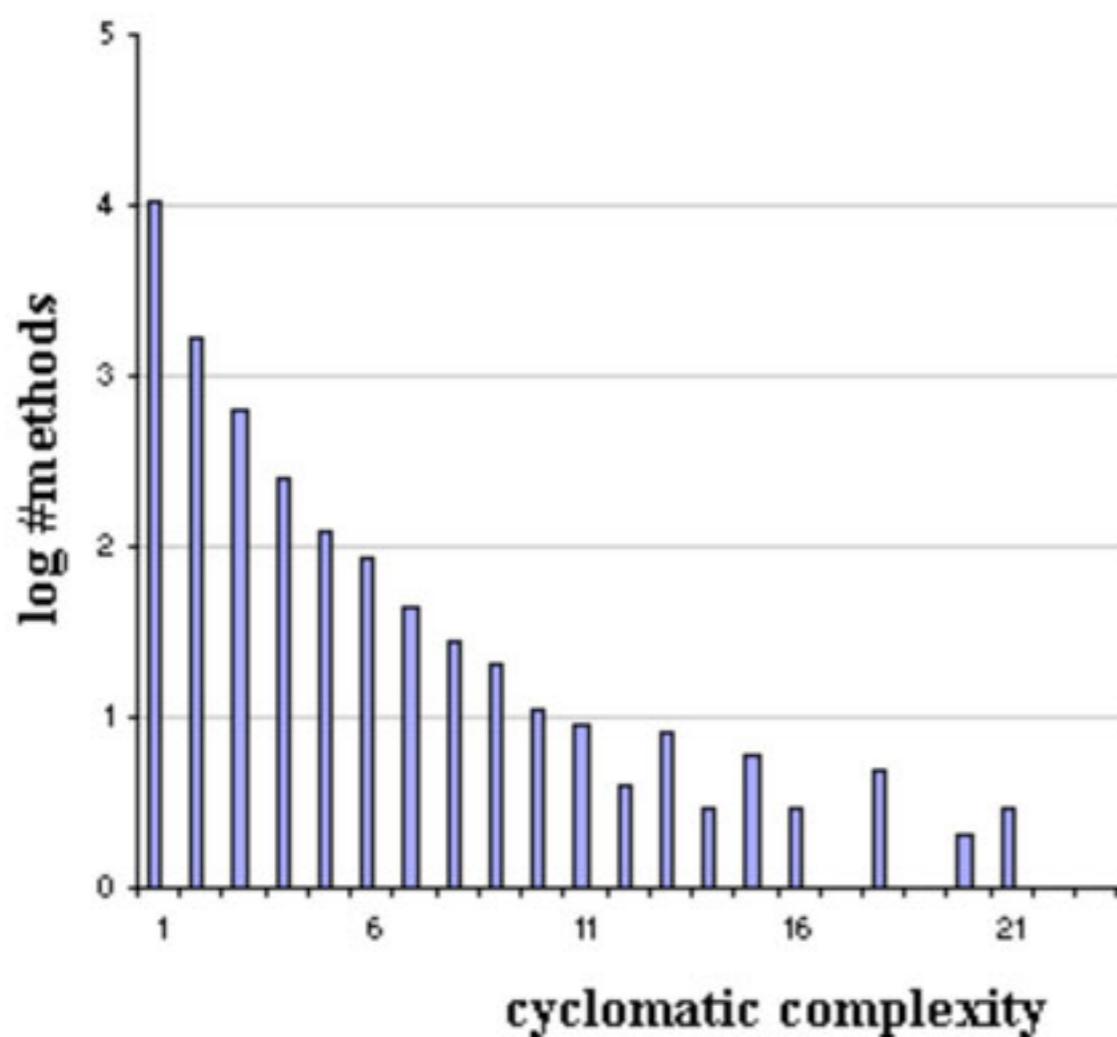
- **Goal is 100%**
 - Asymptotic
 - FitNesse is at 90% (Probably more)
- **Coverage should be measured, plotted, and visible**
 - Everyone should see the current test coverage numbers
- **Coverage should not be mandated**
 - Leads to false positives, e.g. “no asserts”
- **Tests should be regularly reviewed**
 - To make sure they assert what is covered

MUTATION TESTING

- pitest.org.
- Tool runs coverage. Sees tests pass.
- Tool makes one semantic mutation (byte code)
 - Re-runs tests and coverage.
 - Marks mutation as “living” if tests pass.
 - Repeat for all possible semantic mutations.
- Finds all unasserted code.

BRAITHWAITE'S CORRELATION

- <http://peripateticaxiom.blogspot.com/2006/05/complexity-and-test-first-0.html>
- Slope of the linear regression of the Pareto distribution of Cyclomatic Complexity over Methods. <grin>
 - TDD > 2.0?
 - non TDD < 2.0?
 - Low slope means few large complicated methods.
 - High slow means many large complicated methods.



BEHAVIOR DRIVEN DEVELOPMENT



THE DIFFERENCE BETWEEN TDD AND BDD

- {} -- The empty set. BDD == TDD
- OK, there is a difference in Phraseology
 - Given/When/Then
 - The State Machine Analogy
 - Arrange, Act, Assert
- BDD is TDD with an emphasis on *Readability*

CUCUMBER SYNTAX

- Feature: Search courses

In order to ensure better utilization of courses

Potential students should be able to search for courses

Scenario: Search by topic

Given there are 240 courses which do not have the topic "biology"

And there are 2 courses A001, B205 that each have "biology" as one of the topics.

When I search for "biology"

Then I should see the following courses:

Course code	
A001	
B205	

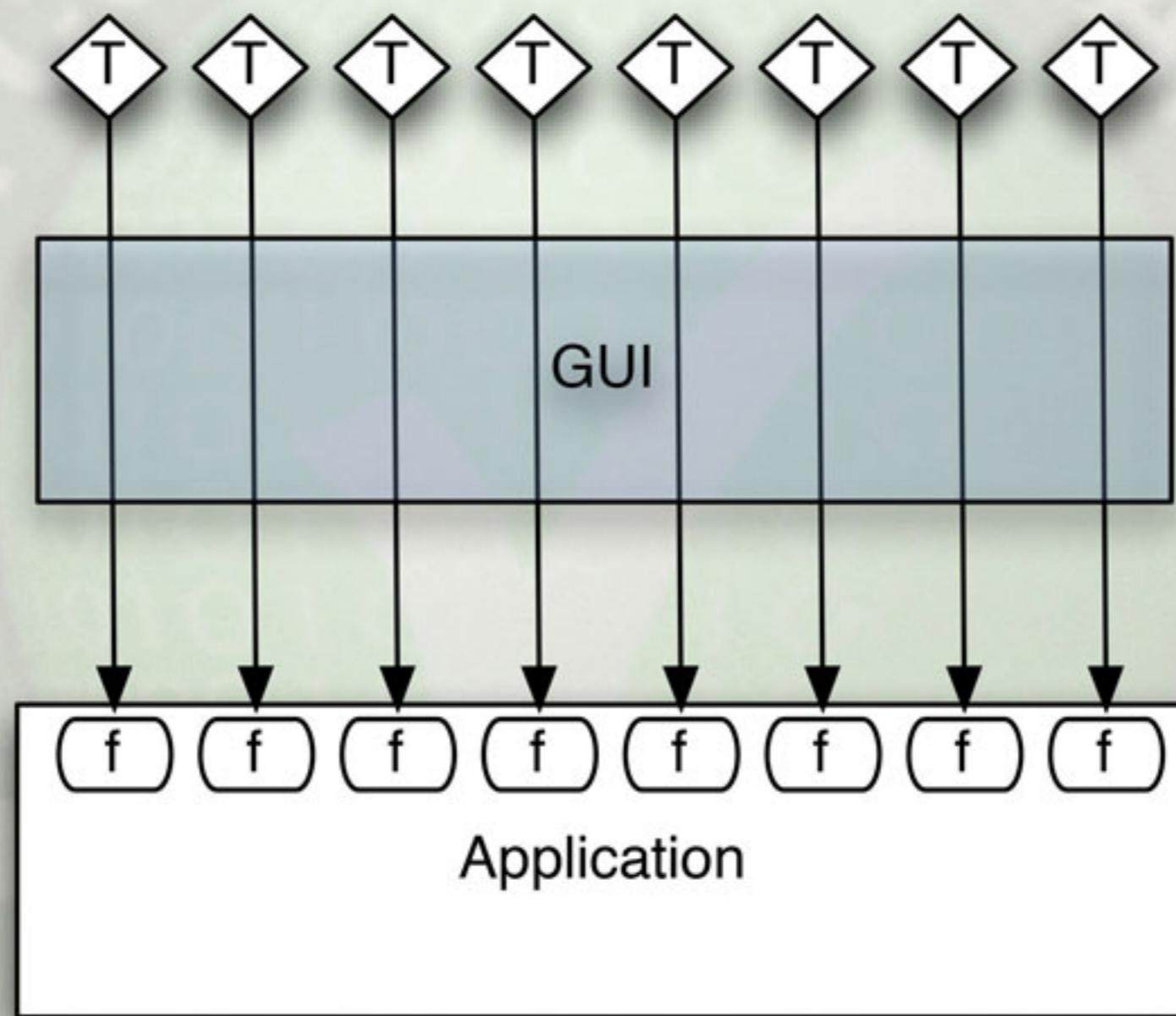
GUI TESTING



HARD

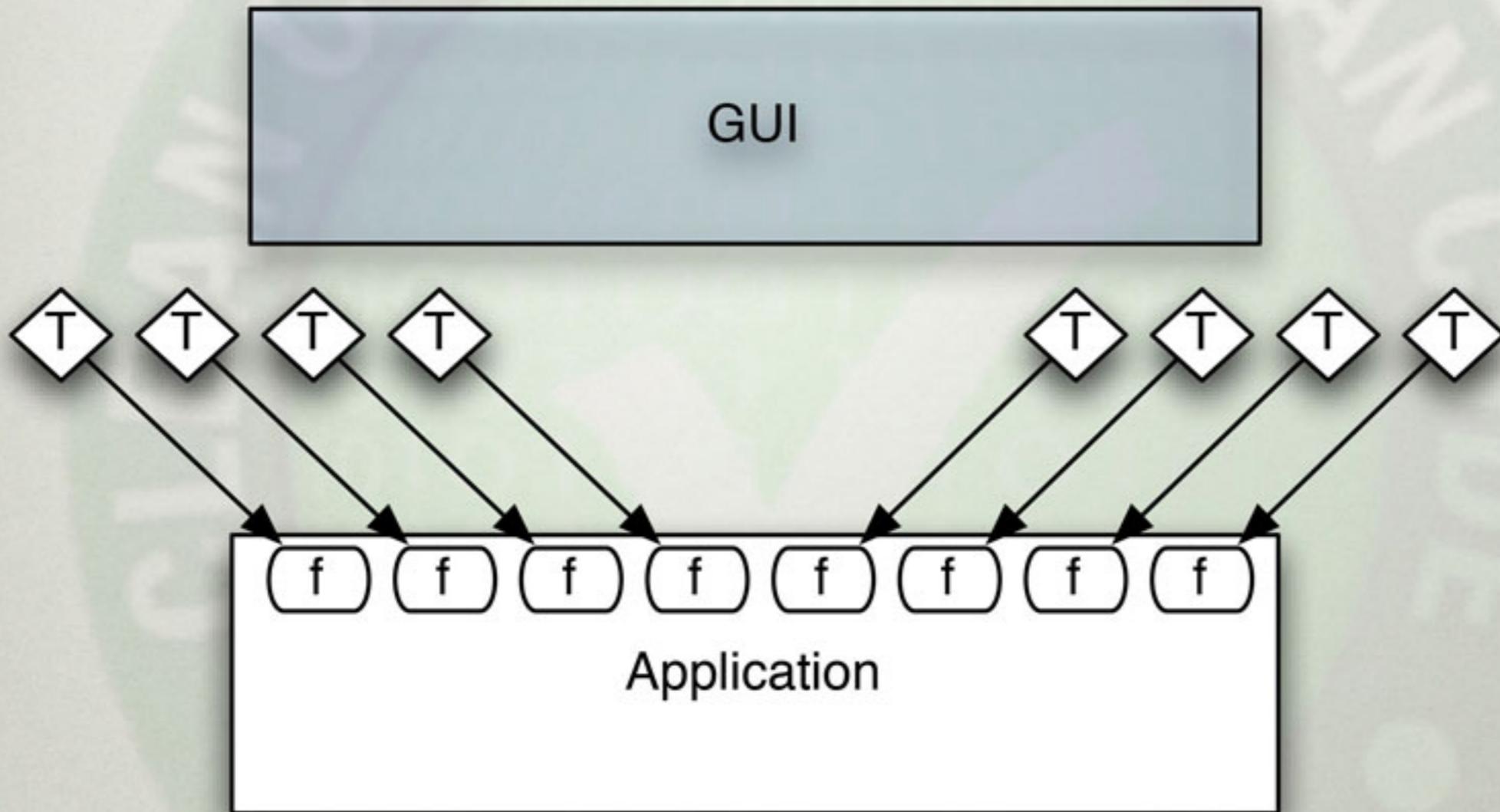
- I usually don't test GUI code.
- I use Humble Objects instead. (coming)
- I verify GUI by eye.
- But sometimes GUI testing is necessary.

TESTING THROUGH THE GUI.



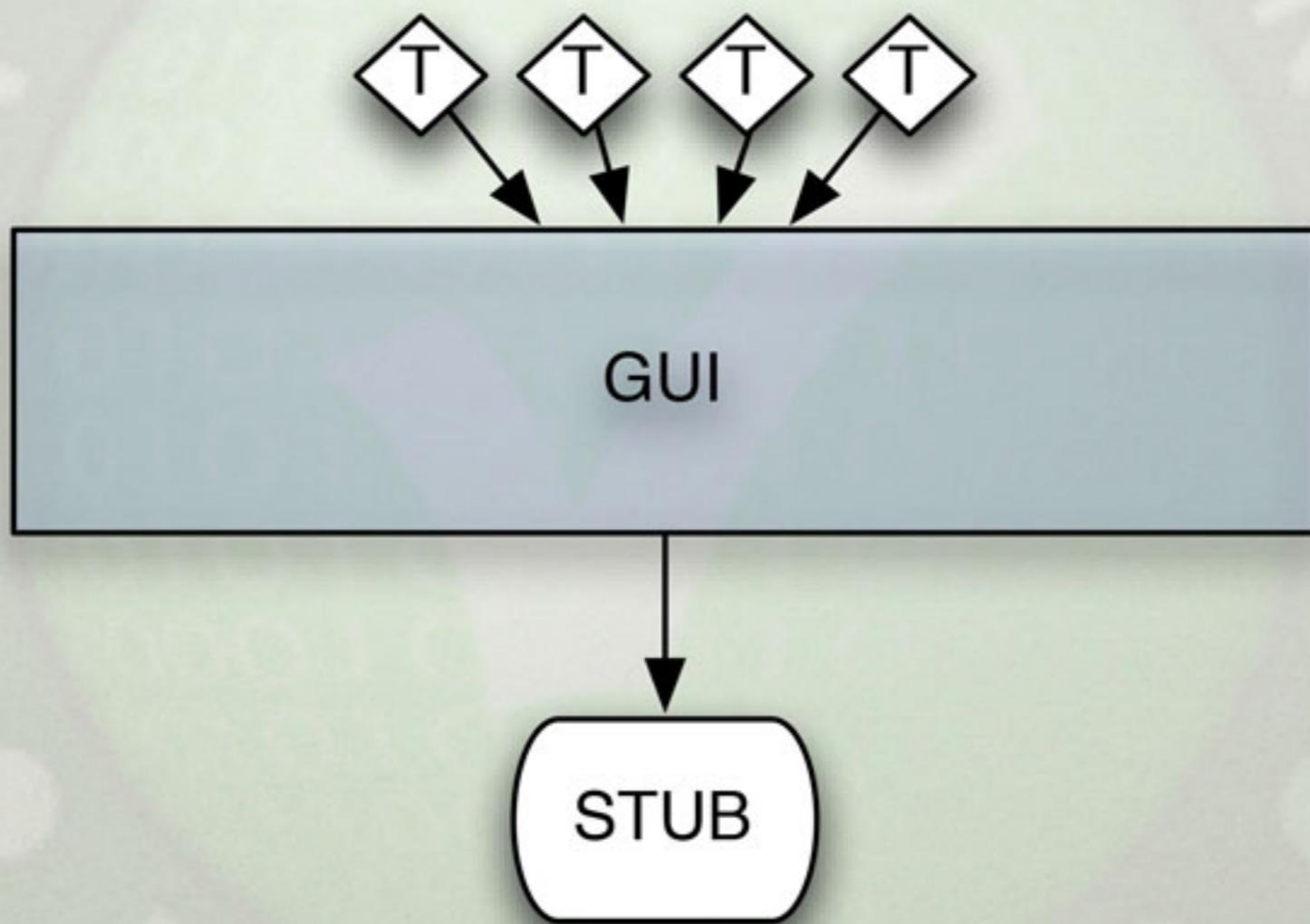
- Couples the tests to the GUI.

TEST BUSINESS RULES THROUGH THE API



- Decouple the tests from the GUI.

GUI TESTS TEST ONLY GUI

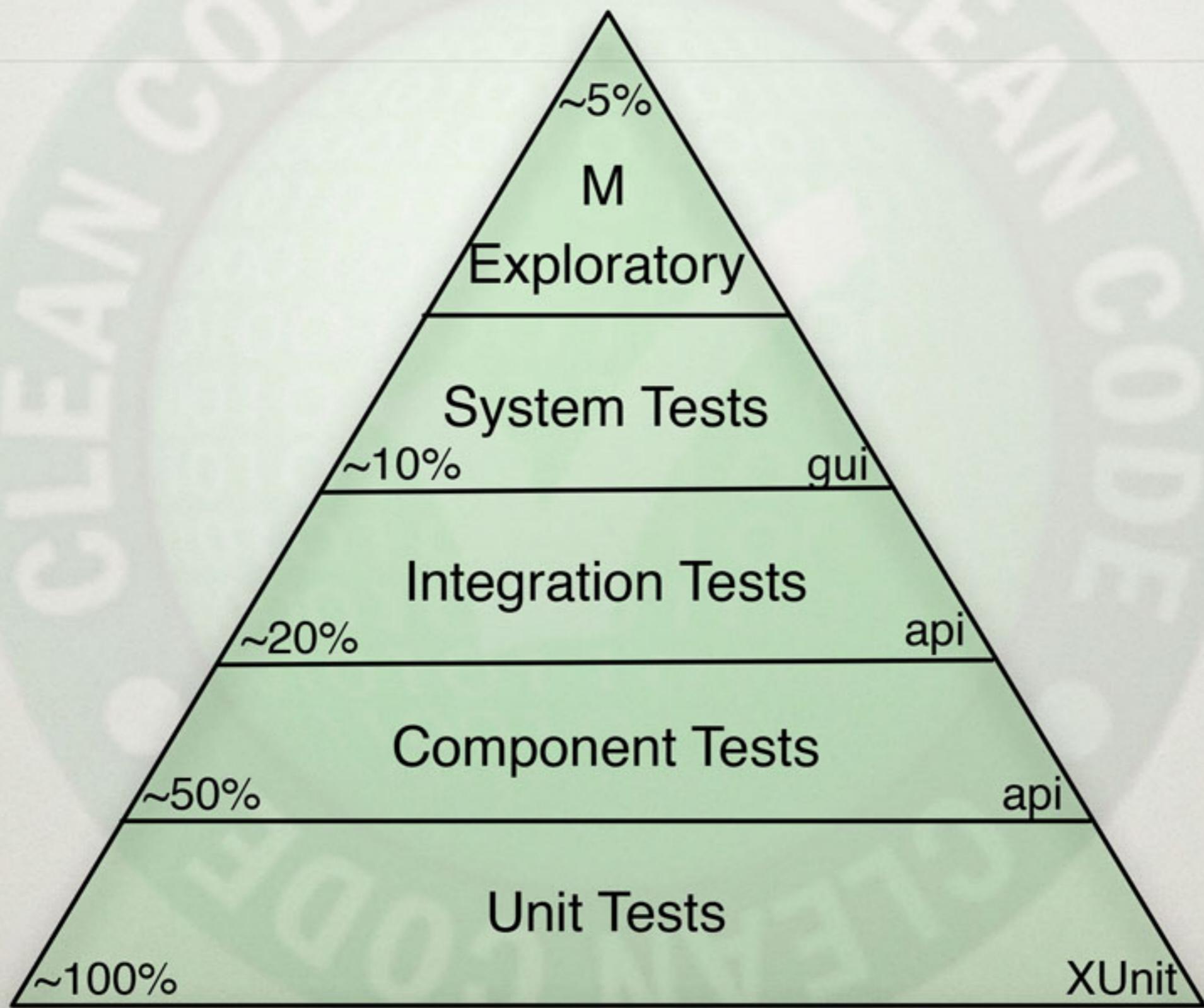


- Stub out the application to prevent testing business rules.

TESTING LEVELS

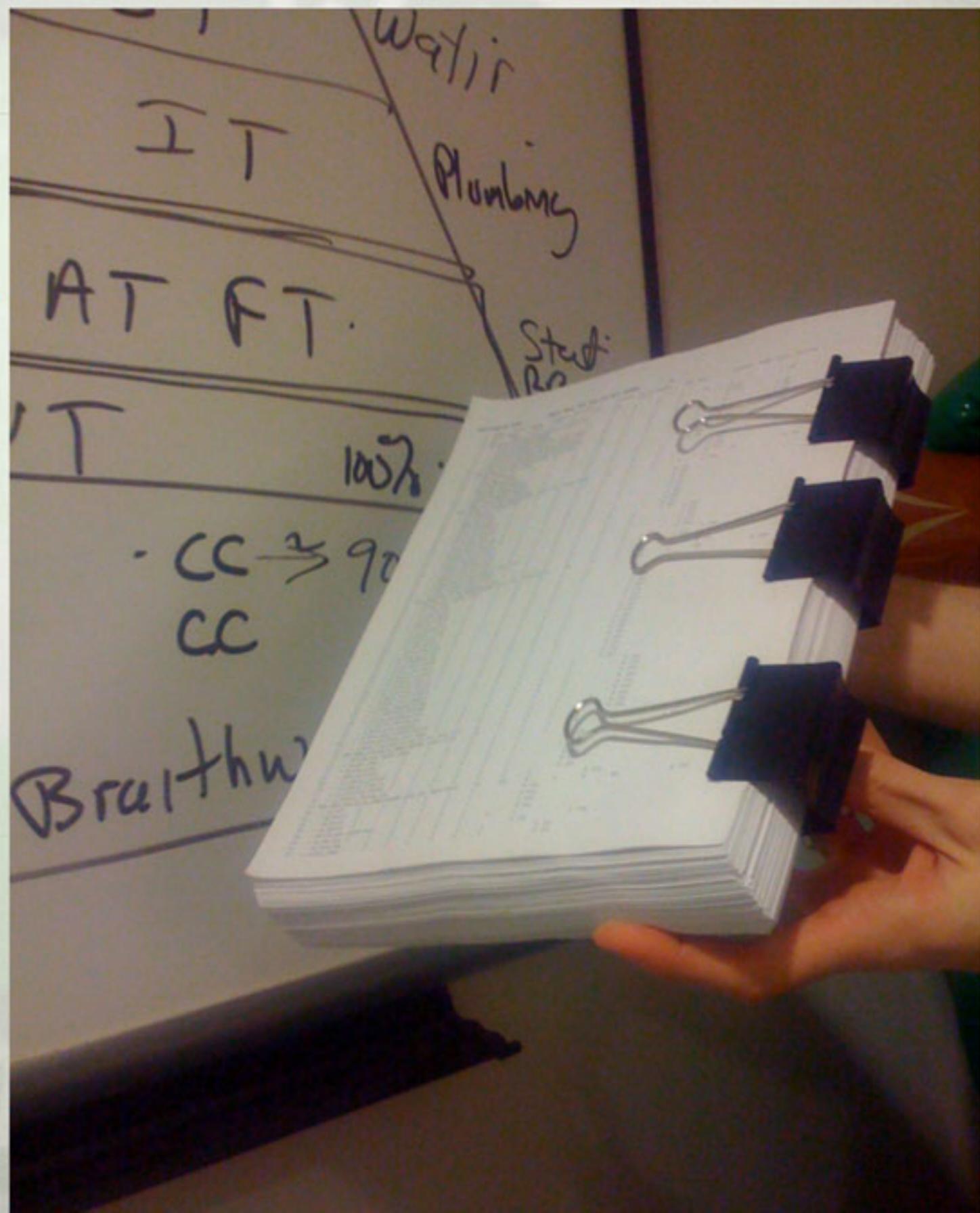


LEVELS OF TESTING.



THE MANUAL DILEMMA

- Contents of Test Plan.
 - 80,000 Manual Tests.
 - \$1,000,000 every 6 months.
 - 50% budget cut

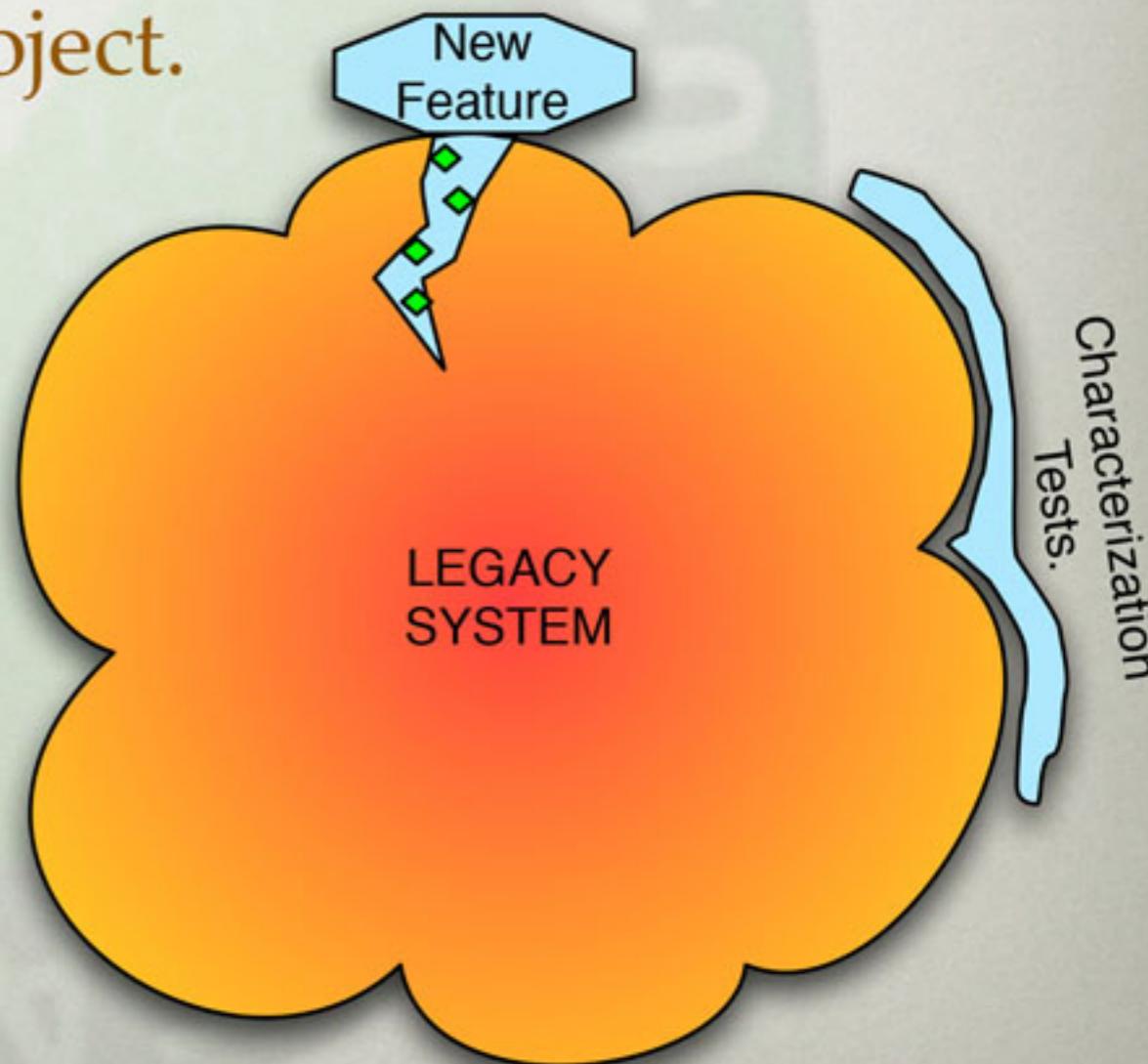
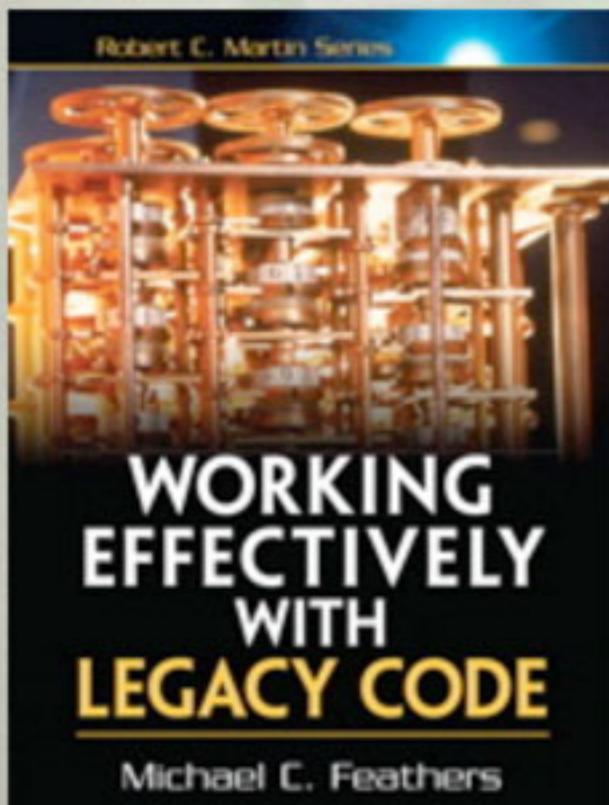


LEGACY CODE



GETTING LEGACY CODE UNDER TEST.

- No Magic Bullet.
- Took years to make the mess.
 - Will take a long time to undo it.
- Don't tackle as a single huge project.
 - Use the 'Boy Scout Rule'



CONVINCING



HOW DO I CONVINCE....

- You can't force people to believe.
- You can be a role model.
- You can exhort and encourage.
- You can give demos.
- You will convince some.
 - But not others.
- Divorce.

FIN

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