Beyond Correctness

Can we give feedback on software beauty?

• Guidelines on what is beautiful?
• Qualitative evaluations?
• Quantitative evaluations?

What tools are available for “higher level” evaluation of our code?
Qualitative: “Code smells”

SOFA captures symptoms that often indicate code smells:

• Is it Short?
• Does it do One thing?
• Does it have Few arguments?
• Is it a consistent level of Abstraction?
Why “lots of arguments” smells

• Hard to get good testing coverage
• Hard to mock/stub while testing
• Boolean arguments should be a “yellow flag”
  If function behaves differently based on Boolean argument, maybe it should be 2 functions
• If arguments “travel in a pack”, maybe you need to extract a new object/class
  Same argument for a “pack” of methods
Single level of abstraction

• Complex tasks need divide & conquer
• Like a good news story, classes, methods, etc. should read “top down”
  + Start with a high level summary of key points, then go into each point in detail
  + Each paragraph deals with 1 topic
  – Rambling, jumping between “levels of abstraction” rather than progressively refining
Quantitative: ABC Software Metric

Counts Assignments, Branches, Conditions:

\[
score = \sqrt{A^2 + B^2 + C^2}
\]

function foo()
  const a = eval("1+1");
  if (a === 2) {
    console.log("yay");
  }
}

function foo()
  const a = eval("1+1");
  if (a === 2) {
    console.log("yay");
  }
}

\[
\sqrt{1 + 2^2 + 2^2} = 3
\]

Guidance: \(\leq 20\) per method
Quantitative: Cyclomatic complexity

Linearly-independent paths thru code

\[ \text{score} = E - N + 2P \]

\( E \) edges, \( N \) nodes, \( P \) connected components

```plaintext
function myFunction {
    while(...) {
        ....
        
        if (...) {
            do_something
        }
    }
}
```

Guidance: \( \leq 10 \) per method
Quantitative: Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Tool</th>
<th>Target score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code-to-test ratio</td>
<td>Plato/Jest</td>
<td>≤ 1:2</td>
</tr>
<tr>
<td>C0 (statement) coverage</td>
<td>Jest</td>
<td>70%+</td>
</tr>
<tr>
<td>Assignment-Branch-Condition score</td>
<td>None for JS</td>
<td>&lt; 20 per method</td>
</tr>
<tr>
<td>Cyclomatic complexity</td>
<td>Plato, ESLint</td>
<td>&lt; 10 per method (NIST)</td>
</tr>
</tbody>
</table>

Use metrics “holistically”

- Better for *identifying where improvement is needed* than for *signing off*
- Look for “hotspots”, i.e. code flagged by multiple metrics (what services like CodeClimate do...
Refactoring

• Start with code with smells
• Through a series of *small steps*, transform code eliminate those smells
• Protect each step with tests
• *Minimize time during which tests are “red”*
Refactoring has common patterns too

Fowler et al. created a catalog of common refactoring patterns

**Decompose Conditional**

You have a complicated conditional (if-then-else) statement.

*Extract methods from the condition, then part, and else parts.*

```java
if (date.before(SUMMER_START) || date.after(SUMMER_END))
    charge = quantity * _winterRate + _winterServiceCharge;
else charge = quantity * _summerRate;
```

```
if (notSummer(date))
    charge = winterCharge(quantity);
else charge = summerCharge (quantity);
```
Which of the following is not a goal of method level refactoring?

A. Reduce code complexity
B. Eliminate code-smells
C. Eliminate bugs
D. Improve testability
A blast from the past!
Quantitative metrics
What did we do?

Made date calculator easier to read and understand using simple refactorings

*Extract method* is one of most common, and allows testing “helper” methods separately

Found a bug!

If we had developed using TDD, might have been prevented...

Improved code metrics

https://github.com/csci312a-s18/zune-refactor
Which SOFA guidelines is most important for unit testing?

A. Short
B. Do One thing
C. Have Few arguments
D. Stick to one level of Abstraction
Summary

**Goal:** Improve code *structure* (as measured by quantitative & qualitative measures) without changing *functionality* (as measured by tests)

1. Use metrics as a guide to where you can improve your code
2. Apply *refactorings* (found in following slide, in Refactoring books, on line, etc.)
3. At each step, test newly-exposed *seams*, then stub/mocking them out in higher-level tests
Other smells and their remedies

<table>
<thead>
<tr>
<th>Smell</th>
<th>Refactoring that may resolve it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large class</td>
<td>Extract class, subclass or module</td>
</tr>
<tr>
<td>Long method</td>
<td>Decompose conditional</td>
</tr>
<tr>
<td></td>
<td>Replace loop with collection method</td>
</tr>
<tr>
<td></td>
<td>Extract method</td>
</tr>
<tr>
<td></td>
<td>Replace temp variable with query</td>
</tr>
<tr>
<td></td>
<td>Replace method with object</td>
</tr>
<tr>
<td>Long parameter list/data clump</td>
<td>Replace parameter with method call</td>
</tr>
<tr>
<td></td>
<td>Extract class</td>
</tr>
<tr>
<td>Shotgun surgery; Inappropriate</td>
<td>Move method/move field to collect related items into one DRY place</td>
</tr>
<tr>
<td>intimacy</td>
<td></td>
</tr>
<tr>
<td>Too many comments</td>
<td>Extract method</td>
</tr>
<tr>
<td></td>
<td>Introduce assertion</td>
</tr>
<tr>
<td></td>
<td>Replace with internal documentation</td>
</tr>
<tr>
<td>Inconsistent level of abstraction</td>
<td>Extract methods &amp; classes</td>
</tr>
</tbody>
</table>
What makes code “legacy”?  

Still meets customer need, and

- You didn’t write it, and it’s poorly documented
- You did write it, but a long time ago (and it’s poorly documented)

“Legacy code is simply code without tests” [regardless of who wrote it or how pretty it is]

-Michael Feathers
Feathers’ two ways to approach modifying legacy code

**Edit and Pray**
1. Familiarize yourself with the relevant code
2. Plan the changes you will make
3. Make the planned changes
4. Poke around to make sure you didn’t break anything

**Cover and Modify**
1. Write tests that cover the code you will modify (creating a “safety blanket”)
2. Make the changes
3. Use tests to detect unintended effects
An Agile approach to legacy code

1. Identify places you need to change (termed “change points”)
2. Add “characterization tests” to capture how the code works now (in TDD+BDD cycles)
3. Refactor the code to make it more testable or to accommodate the changes
4. When code is well factored and well tested, make your changes!
5. Repeat...
If you’ve been assigned to modify legacy code, which of the following statements about that code base do you most hope will be true?

A. It was originally developed using Agile techniques
B. It is well covered by tests
C. It’s nicely structured and easy to read
D. Many of the original design documents are available
Exploring a legacy codebase: Step 1

Get the code to run!

• In a either production-like or development-like setting
• Ideally with something resembling a copy of production database
• A catch: Some systems may be too large to copy

Learn the user stories: Have customers show you how they use the application
Exploring a legacy codebase: Step 2+

2. Inspect the database schema

3. Try to build a model interaction diagram
   Can be automated for some frameworks, e.g. Rails

4. Identify the key (highly connected) classes
   Recall Class-Responsibility-Collaborators (CRC) cards

5. (Extend) design docs as you go:
   Diagrams
   README, GitHub wiki, etc.
   Add JSDoc comments to create documentation automatically
Adding tests: Getting started

• You don’t want to write code without tests
• You don’t have tests
• You can’t create tests without understanding the code

*How do you get started?*
Characterization Tests

Establish the \textit{ground truth about how the SW works today}

- Repeatable tests ensure current behaviors aren’t changed (even if buggy)
- Integration tests are a natural starting point (b/c they are typically “black box”)

\textbf{Pitfall: Don’t try to make improvements at this stage!}
Unit- and Functional-level characterization tests

Use the tests to help you learn as you go:

test('it should calculate sales tax', () => {
  const order = Order.fromJson({});
  expect(order.computeTax()).toBe(-99.99);
});

ValidationError: total: is a required property

test('it should calculate sales tax', () => {
  const order = Order.fromJson({ total: 100.00 });
  expect(order.computeTax()).toBe(-99.99);
});

Expected value to be: -99.99 Received: 8

test('it should calculate sales tax', () => {
  const order = Order.fromJson({ total: 100.00 });
  expect(order.computeTax()).toBe(8.00);
});

✓ it should calculate sales tax
Which of the following is a difference between integration-level and unit-level characterization tests?

A. Unit tests can be created by automating user actions, integration tests cannot

B. Integration tests require more information about how the code works

C. Integration tests are more likely to depend on the production database
What is the best tool for detecting (and fixing) code smells/problems?

There is no best tool!
The primary enforcement mechanism is your self-discipline!
First and foremost beautiful code is the result of your professionalism to do the “Right Thing” not the easy thing. The tools just help along the way.