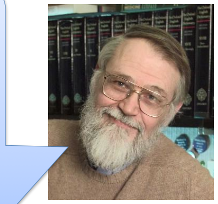
CS 312 Software Development

Testing

Debugging is twice as hard as writing the code in the first place. Therefore, if you write the code as cleverly as possible, you are, by definition, not smart enough to debug it.



Testing can never demonstrate the absence of errors in software, only their presence

Testing in an “agile” workflow

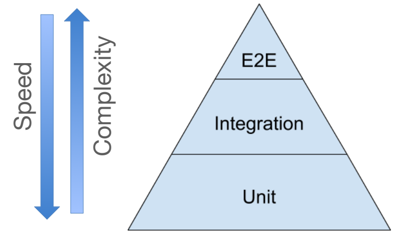
Previously (Waterfall, et al.)
Developers finish code, some ad-hoc testing
Toss over the wall to Quality Assurance (QA)”
QA staff manually poke at software

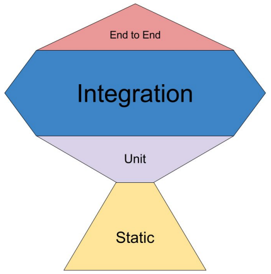
Agile
Testing is part of *every* Agile iteration
Developers test their own code
Testing tools & processes highly automated
QA/testing group improves testability & tools

Hierarchy of testing

- **System (or end-to-end) testing**: Testing the entire application (typically to ensure compliance with the specifications, i.e. "acceptance" testing)
- **Integration testing**: Tests of combinations of units (i.e. integration of multiple units)
- **Unit testing**: Tests for isolated "units", e.g. a single function or object
- **Static testing**: Compile or build time testing

Where do I spend my effort?





Google testing blog

Kent C Dodds "Write tests. Not too many. Mostly integration."

Test-driven development (TDD)

- Think about one thing the code *should* do
- Capture that thought in a test, which fails
- Write the simplest possible code that lets the test pass
- Refactor: DRY out commonality w/other tests
- Continue with next thing code should do

Red – Green – Refactor

Aim for "always have working code"

Anatomy of a test (with Jest)

```
// Import fib function from module
const fib = require('./fibonacci');
```

Set of tests with common purpose, shared setup/teardown

```
describe('Computes Fibonacci numbers', () => {
  test('Computes first two numbers correctly', () => {
    expect(fib(0)).toBe(0);
    expect(fib(1)).toBe(1);
  });
});
```

Individual test

One or more:
expect(*expression*).*matcher*(*assertion*)

Tests should be F.I.R.S.T.

- **F**ast: Tests need to be fast since you will run them frequently
- **I**ndependent: No test should depend on another so any subset can run in any order
- **R**epeatable: Test should produce the same results every time, i.e. be deterministic
- **S**elf-checking: Test can automatically detect if passed, i.e. no manual inspection
- **T**imely: Test and code developed concurrently (or in TDD, test developed first)

How would you test this function?

```
const moment = require('moment');
const isBirthDay = function (birthday) {
  // moment() initializes with current date
  return moment().isSame(birthday, 'day');
};

describe('Checks if today is birthdate', () => {
  let _Date;
  beforeAll(() => { _Date = Date; });

  afterAll(() => { Date = _Date; // Reset Date });

  beforeEach(() => {
    Date.now = // Set a fixed date
      jest.fn(() => new Date('01 Jan 2018').valueOf());
  });
  …
});
```

`moment()` calls `Date.now()`. Replace with “mock” function to control current date

An example of *seams*

- **Seam**: A place where you can change app's *behavior* without changing its *source code*. -Michael Feathers, *Working Effectively With Legacy Code*

- Useful for testing: *isolate* behavior of code from that of other code it depends on
- Here we use JS’s flexible objects to create a seam for `Date.now()`
- Make sure to reset all mocks, etc. to ensure tests are Independent

Seams, not just for Independence

Development is an iterative process

- Work from the “outside in” to identify code “collaborators”
- Implement “the code you wish you had” at seam
- Efficiently test out the desired interface

How much testing is enough?

- Bad: “Until time to ship”
- A bit better: *X%* of coverage, i.e. 95% of code is exercised by tests
- Even better?

“You rarely get bugs that escape into production, [and] you are rarely hesitant to change some code for fear it will cause production bugs.” –Martin Fowler

Moderation in all things

× “I kicked the tires, it works”

× “Don’t ship until 100% covered & green”

☑ Use coverage to identify untested or undertested parts of code

× “Focus on unit tests, they’re more thorough”

× “Focus on integration tests, they’re more realistic”

☑ Each finds bugs the other misses

In spite of good testing, debugging happens

To minimize the time to solution take a “scientific” approach to debugging:

1. What did you expect to happen (be as specific as possible)?
2. What actually happened (again as specific as possible)?
3. Develop a hypothesis that could explain the discrepancy
4. Test your specific hypothesis (with console.log, the debugger, etc.)

1 & 2 aren’t that different than writing tests!