Effective Unit Testing

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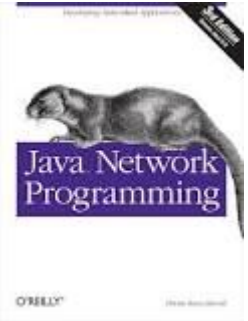
TL - Google Cloud Tools for Eclipse

Where do I come from?

- Currently TL of Google Cloud Tools for Eclipse (70% test coverage)
- Developer of XOM (~99% test coverage, almost all test first)
- Jaxen maintainer, Apache Maven committer
- Author of a few books and co-author of https://jlbp.dev



Why do we write unit tests?

- Because we want our code to work
- Because we want it to **keep** working
- Because we want to develop faster with more confidence and fewer regressions
- Because we make mistakes

The Fundamental Principle of Unit Testing

Verify that a known, fixed input produces a known, fixed output.

Start in the Middle of the Road

What if you don’t know the correct output?

- If it’s a deterministic answer, write a characterization test.
- If the problem is fuzzy or not perfectly defined, test a similar problem with less fuzzy answers.

Eliminate everything that makes input or output unclear or contingent.

- No random input. Always fixed values.
- Don’t use named constants from the model code. They may be wrong or change. Prefer literal strings and numbers.
- Don’t access the network and preferably not the file system.
- Control time, the speed of light, or the gravitational constant of the universe.

#2 Write Your Tests First!

- It’s not just about testing; it’s about software development.
- Test first development creates better API because you start with the user, not the used.
- Test first hides implementation and avoids exposing internal implementation details. It avoids brittle, tightly coupled tests.

Test First also makes better tests

```
public class ListTest {
  private List<String> list = new ArrayList<>();

  public void testAdd() {
    list.add("Foo");
    Assert.assertEquals(1, list.size());
  }

}
```

#3 *Unit* Tests

- Unit means ***One***. Each test tests exactly one thing.
- Each test method is one test
- Best practice: one assert per test method
- Share setup in a fixture, not the same method
- You can have multiple test classes per model class. Do not feel compelled to stuff all your tests for `Foo` into `FooTest`.

Unit also means ***Independent***

- Tests can (and do) run in any order.
- Tests can (and do) run in parallel in multiple threads.
- Tests should not interfere with each other.

Avoid Conditional Logic in Tests

```
if (x > 5) {
  assertTrue(y);
}
else {
 assertEquals(1, z);
}
```

Tests and Thread Safety

- **Don’t** use synchronization, semaphores, or special data structures.
- Do not share data between tests:
  - Do not use non-constant static fields in your tests.
  - Be wary of global state in the model code under test.
- Best practice: one assert per test method.
- Share setup in a fixture, not the same method

The Two Least Known Facts of Unit Testing

1. Tests do not share instance data.

```
public class ListTest {
  private List<String> list = new ArrayList<>();

  @Test
  public void testAdd() {
    list.add("Foo");
    Assert.assertEquals(1, list.size());
  }

  @Test
  public void testAdd2Elements() {
    list.add("Baz");
    list.add("Bar");
    Assert.assertEquals(2, list.size());
  }
}
```

2. You can have many test classes per model class.

- Do not feel compelled to stuff all your tests for `Foo` into `FooTest`.
- Every test that needs a slightly different setup can go into a separate test class.

Speed

- A single test should run in a second or less.
- A complete suite should run in a minute or less. (cloud-opensource-java)
- Separate larger tests into additional suites; separate unit and integration tests; e.g. Apache Maven
- This is for ease of development.
- Fail fast. Run slowest tests last.
  - Example

Not All Tests Need to be Unit Tests

The Power of Integration Tests

- Integration tests cover many LOC with very little effort
- The tradeoff is they are harder to debug when something goes wrong
- Integration tests can catch errors in the interfaces between classes that unit tests miss.
- They can even catch changes in the external environment.
- You need both

Passing tests should produce no output

- There should never be any question as to whether a test passed. **Green** or **Red**, **Pass** or **Fail**.
- If necessary, silence loggers in tests.
- Maven gets this badly wrong.
  - Example

Failing tests should produce clear output

- Failing tests should give clear, unambiguous error messages.
- Rotate your test data.
  - Don’t use the same data in every test.
  - E.g. don’t set all ints you test to 3. Use 3, 33, 1117, -98, etc.
  - This makes it much easier to see immediately which test is failing and why.
- Truth helps with collections

Flakiness

- Work really, really hard to avoid
- Sources of flakiness:
  - Time dependence
  - Network availability
  - Explicit Randomness
  - Multithreading
  - Unexpectedly flaky model code
  - Test interdependence and order
  - Bad test infrastructure; e.g. CI servers

System Skew

- Sources of flakiness:
  - Multithreading
  - Assumptions about the underlying operating system
  - Undefined behavior
    - Floating point roundoff
    - Integer width
    - Default character set
    - etc.

Debugging

- Write a failing test before you fix the bug.
- If the test passes, the bug isn’t what you think it is.

Refactoring

- Break the code before you refactor it.
  - Do the tests fail?
  - Example
- Check your code coverage
- If necessary, write additional tests before doing unsafe refactorings.

Development Practices

- Use continuous integration (e.g. Travis, CircleCI, etc.).
- Use a submit queue
- Never, ever check in with a failing test.
- If it does happen, rollback first; ask questions later.
- A **red test** blocks all merges. No further check ins until the build is **green**.

Final Thoughts

- Write your tests first.
- Make all tests unambiguous and reproducible.

Questions?
Comments?
Thoughts?
War Stories?

Thank You

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