Software Testing, Quality Assurance & Maintenance—Lecture 26

Patrick Lam

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Last Time

Practical techniques for writing tests.

Result verification:

- state verification;
- behaviour verification.

Also, techniques for improving your tests.

- reducing duplication
- simplifying tests

Today: More Test Design

- Mock objects;
- Flaky tests;
- Continuous integration;

Mock Objects

John Tenniel's original (1865) illustration for Lewis Carroll's "Alice in Wonderland". Alice sitting between Gryphon and Mock turtle.

Test Doubles

Meszaros proposes four kinds of test doubles:

- dummy objects (don't do anything);
- fake objects (do something, but no good in prod, e.g. in-memory database);
- stubs (canned answers)
- spies (stubs/proxies that record interactions);
- mocks (objects with expectations)

Reference:
`martinfowler.com/articles/mocksArentStubs.html`

Mail Service Stub

```
public class MailServiceStub implements MailService {
  private List<Message> messages =
     new ArrayList<Message>();
  public void send (Message msg) {
    messages.add(msg);
  }
  public int numberSent() {
    return messages.size();
  }
}
```

good for state verification:

```
assertEquals(1, mailer.numberSent());
```

Using Mocks

```
class OrderInteractionTester...

  public void testOrderSendsMailIfUnfilled() {
    Order order = new Order(TALISKER, 51);
    Mock warehouse = mock(Warehouse.class);
    Mock mailer = mock(MailService.class);
    order.setMailer((MailService) mailer.proxy());

    mailer.expects(once()).method("send");
    warehouse.expects(once()).method("hasInventory")
      .withAnyArguments()
      .will(returnValue(false));

    order.fill((Warehouse) warehouse.proxy());
  }
}
```

Creating Mock Objects with EasyMock[1]

```
@RunWith(EasyMockRunner.class)
public class ExampleTest {

  @TestSubject
  private ClassUnderTest classUnderTest = new
      ClassUnderTest();

  @Mock // creates a mock object
  private Collaborator mock;

  @Test
  public void testRemoveNonExistingDocument() {
    replay(mock);
    classUnderTest.removeDocument("Does not exist");
  }
}
```

[1] http://easymock.org/user-guide.html

Expecting behaviour: method calls

```
@Test
public void testAddDocument() {
   // recording phase:
   mock.documentAdded("New Document");
   replay(mock);
   // replaying phase; we expect the recorded actions
       to happen
   classUnderTest.addDocument("New Document",
                                    new byte[0]);
   // check that the behaviour actually happened:
   verify(mock);
}
```

Expecting behaviour: return values

```
@Test
public void testVoteForRemoval() {
  // expect document addition
  mock.documentAdded("Document");
  // expect to be asked to vote for document removal,
      and vote for it
  expect(mock.voteForRemoval("Document"))
              .andReturn((byte) 42);
  // expect document removal
  mock.documentRemoved("Document");
  replay(mock);
  classUnderTest.addDocument("Document", new byte[0]);
  assertTrue
    (classUnderTest.removeDocument("Document"));
  verify(mock);
}
```

Flakiness: Good for croissants[2], bad for tests

[2]thanks Pixabay

Reference

Qingzhou Luo, Farah Hariri, Lamyaa Eloussi, Darko Marinov. “An Empirical Analysis of Flaky Tests”. In FSE ’14.

What Are Flaky Tests?

Flaky test = sometimes fails (nondeterministically).

Dealing with Flaky Tests

- Label as flaky.
- Re-run tests, see if it ever passes.
- Ignore/remove flaky tests.

What causes flakiness?

Result of studying 201 fixes:

- improper wait for async responses;
- concurrency;
- test order dependency;
- etc.

Async Wait

Problem:

do something, then sleep for not-long enough.

Solution:

use a `wait` call to wait until the thing happens.

Concurrency

Usual concurrency problems:

- data races;
- atomicity violations;
- deadlocks.

May be in test or the system under test.

Test Order Dependency

Problem: test X expects test Y to have completed.
Solution: remove dependency.

Continuous Integration

Literally:

use a single shared master branch

Why This Is Continuous Integration

Integration = merge one's changes
back into master.

Continuous = do it all the time.

Why CI Is Awesome

Software stays in working state.

Developers don't integrate for months-on-end.

Things that go with CI

Continuous Builds

Test Automation

Continuous Deployment (optional)

What Happens In CI

1. You clone the repo (which works).
2. You make your changes.
3. You commit and push your changes (often!)
4. A machine pulls the changes, compiles them, and runs automated tests.
5. Everyone knows whether your changes passed tests or not.

Continuous Deployment

Minor variation to CI:

production machine also pulls changes as soon as tests pass.

Key Details

- Fix broken builds immediately!
- Keep the build fast (minutes):
  parallelize it & tier your tests.
- Test in a prod-like environment.

Continuous Integration References

Bullet points from Gitlab:
`about.gitlab.com/2015/02/03/7-reasons-why-you-should-be-using-ci/`

Mid-length article from Atlassian:
`www.atlassian.com/agile/continuous-integration`

Longer article by Martin Fowler:
`martinfowler.com/articles/continuousIntegration.html`

Serverless CI:
`medium.com/@hichaelmart/lambci-4c3e29d6599b`

Summary

More practical techniques for writing tests:

How to actually do behaviour verification (mock objects).
Pitfalls of bad test writing (flaky tests).
Making sure your code's always good (CI).