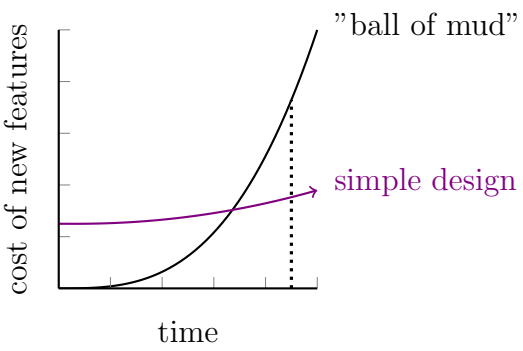
CO220 - Software Engineering Design

8th October 2019

Cost of Change



The "project heat death", denoted by the dotted line, is where the cost of adding new features outweighs the value gained by adding those features. Note that the initial cost of doing a simple design can be more expensive (since it requires more planning).

Elements of Simple Design

This is arranged in a pyramid on the slides (since they "build up on each other") but I will write it as a list, starting from the bottom;

1. **behaves correctly**

   It doesn't matter if the codebase is well structured, or the code is elegant if it doesn't do the right thing (is buggy, or isn't what the customer wanted).

   - automated testing
   - test-driven development
   - mock objects

2. **minimises duplication**

   If something needs to be changed in the future, and it's in multiple places, it will have to be changed in all of those places which will take longer. Additionally, it's also easy to miss, causing bugs.

3. **maximises clarity**

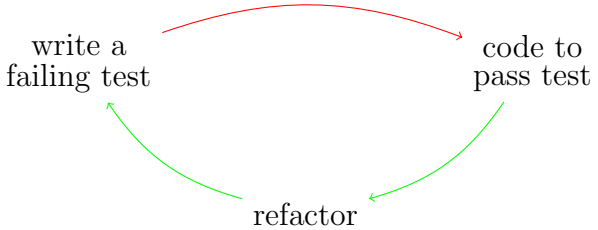
   Code should be easy to modify, such that the parts that need to be changed can be easily located. Important especially if working with others.

4. **has fewer elements**

   Less important - we want to focus on the previous levels first, and don't want to lose the benefits by combining elements.

Test-Driven Development / Behaviour Driven Development

Having a test suite provides confidence that the codebase still works, even after major changes.



We start by writing failing tests, which seems counterintuitive, as there is no code to test. However, these tests are written as if the code was working - which gives us a specification on how the code **should** behave. We want to write code as quickly as possible that gets us from the red state (failing tests), to a green state (passing tests). This code is likely untidy - we can then tidy it up (which shouldn't break the tests).

Additionally, it's not only about testing; we can replace the stages as follows;

- API design (write a failing test)

  "I wish there was a method that would take these parameters and do this"

- internals design (code to pass test)

  "Just making it work"

- structural design (refactor)

  "How can we improve the design?" (pyramid layers)

We focus more on what it should do (how it should behave), and not how it does it. For example, `CustomerLookup` should do the following;

- finds customer by ID
- fails for duplicate customers

The test is named as the expected result, and if it is true, then it behaves correctly.

```
public class CustomerLookupTest {
  @Test
  findsCustomerById() {
    ...
  }
  @Test
  failsForDuplicateCustomers() {
    ...
  }
}
```

Example of TDD

The object `FibonacciSequence` should do the following;

- defines the first two terms to be one
- has each term equal to the sum of the previous two
- is not defined for negative terms

```
... // (FibonacciSequenceTest.java)

import static org.hamcrst.CoreMatchers.is;
import static org,junit.Assert.assertThat;

import org.junit.Test;

public class FibonacciSequenceTest {

  @Test
  public void definesFirstTwoTermsToBeOne() {
```

```
12      assertThat(new FibonacciSeqeunce().term(0), is(1));
13      assertThat(new FibonacciSeqeunce().term(1), is(1));
14    }
15  }
```

Obviously, none of this will work yet, as the code doesn't exist. However, we can use this to create the code as follows (this is incorrect, but our tests now pass);

```
1  ... // (FibonacciSequence.java)
2
3  public class FibonacciSequence {
4
5    public int term(int i) {
6      return 1;
7    }
8  }
```

We can then add more tests, which should now fail;

```
1  ... // (FibonacciSequenceTest.java)
2
3  public class FibonacciSequenceTest {
4    ...
5
6    @Test
7    public void hasEachTermTheSumOfPreviousTwo() {
8      assert(new FibonacciSeqeunce().term(2), is(2));
9      assert(new FibonacciSeqeunce().term(3), is(3));
10     assert(new FibonacciSeqeunce().term(4), is(5));
11   }
12 }
```

Similarly, we can modify the code again to add a naive implementation which performs it recursively;

```
1  ... // (FibonacciSequence.java)
2
3  public class FibonacciSequence {
4
5    public int term(int i) {
6      if (i < 2) {
7        return 1;
8      }
9      return term(i - 1) + term(i - 2);
10   }
11 }
```

Adding the last bullet point as a test;

```
1  ... // (FibonacciSequenceTest.java)
2
3  public class FibonacciSequenceTest {
4    ...
5
6    @Test
7    public void isNotDefinedForNegativeIndices() {
8      try {
9        new FibonacciSeqeunce().term(-1);
10       fail("should have thrown exception")
```

```
    } catch (IllegalArgumentException iae) {
      assertThat(iae.getMessage(), containsString("negative index"))
    }
  }
}
```

Fixing this, we add the following;

```
... // (FibonacciSequence.java)

public class FibonacciSequence {

  public int term(int i) {
    if (i < 0) {
      throw new IllegalArgumentException("negative index not supported");
    }

    ...
  }
}
```

This is the only time I will actually write out every step, since that's the focus of TDD.

11th October 2019

Feedback

Note that the names of the test files should be `SomeObjectTest`, for `SomeObject`. This convention allows the IDE to link the files, as well as having them in alphabetical order. Also always use a *jUnit* library function;

`assertThat(rul.size(), is(0))` or `assertEquals(0, rul.size())`
instead of
`assert rul.size() == 0`

Generally make the LHS of fields the interface `List` instead of `ArrayList`, and attempt to make it `private` and `final` (if possible). Additionally, any fields are reinitialised automatically by *jUnit*, hence it doesn't need to be reset at the end of each test.

Refactoring

This starts with multiple examples on handouts. As we're writing new code, we should look out for small changes that can improve the structure of our code.

We can accumulate "technical debt" by writing code quickly to get a feature working, but we must fix it soon, otherwise it builds up leading to unhygienic code.

Note that refactoring should be done with tools when possible (such as renaming identifiers), since the tool will be able to analyse the entire codebase to detect where changes need to be made. Behaviour should not be changed.

The example after this is mostly using *IntelliJ* tools wherever possible. One note to make is that sometimes it is helpful to get code into a state where it becomes similar enough to other parts of the code, to allow for the tool to do the work.