SOFTWARE DESIGN
COSC 4353/6353

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OUTLINE

Test Driven Development

Best practices

Advantages and Disadvantages

Fakes, mocks, and integration tests

Example

INTRODUCTION

- A software development process.
- Repetition of a very short development cycle
- First write an initially failing automated test case that defines a desired improvement or new function
- then produce the minimum amount of code to pass that test
- and finally re-factor the new code to acceptable standards.
- Related to XP

WHAT IS TDD?

TDD is a design (and testing) approach involving short, rapid iterations of

- Unit Test
- Code
- Re-factor

Unit tests are automated

Forces to consider use of a method before implementation of the method

WHY TDD?

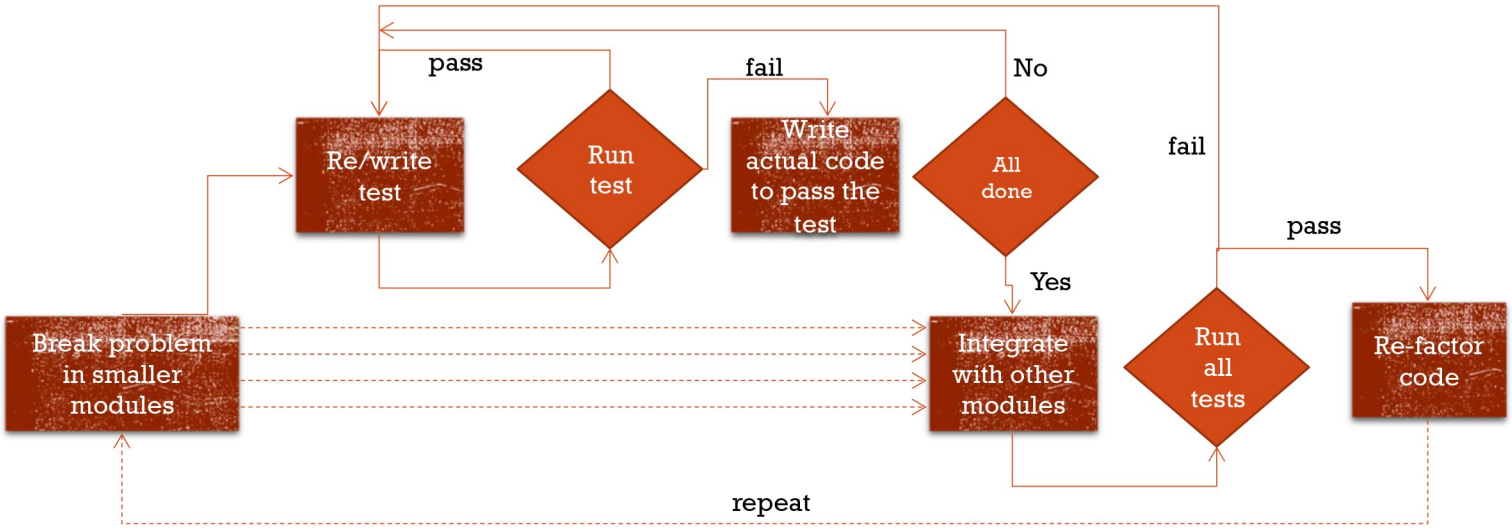
Software development

Should be faster
As economical as it could be
Good quality product

With TDD

Good programmers are more effective
Testing can close the gap
Quality improvement

TEST-DRIVEN DEVELOPMENT CYCLE



DEVELOPMENT STYLE

"keep it simple stupid" (KISS)

“you aren't gonna need it" (YAGNI)

By focusing on writing only the code necessary to pass tests, designs can often be cleaner and clearer.

To achieve some advanced design concept, such as a design pattern, tests are written that generate that design.

The code may remain simpler than the target pattern, but still pass all required tests.

DEVELOPMENT STYLE

For TDD, a unit is most commonly defined as a class or group of related functions often called a module.

Keeping units relatively small is claimed to provide critical benefits.

Reduced Debugging Effort

When test failures are detected, having smaller units aids in tracking down errors.

Self-Documenting Tests

Small test cases have improved readability and facilitate rapid understandability.

DEVELOPMENT STYLE

- Advanced practices of TDD can lead to Acceptance Test-driven development (ATDD) .
- The criteria specified by the customer are automated into acceptance tests.
- Give customer an automated mechanism to decide whether the software meets their requirements.
- Focused development.

BEST PRACTICES

- A commonly applied structure for test cases has: setup, execution, validation, and cleanup
- Treat your test code with the same respect as your production code.
- It must work correctly for both positive and negative cases, last a long time, and be readable and maintainable.
- Review your tests and test practices with team to share effective techniques and catch bad habits.

PRACTICES TO AVOID, OR "ANTI-PATTERNS"

- ✕ Do not have test cases depend on system state manipulated from previously executed test cases.
- ✕ Execution order has to be specifiable and/or constant.
- ✕ Do not test precise execution behavior timing or performance.
- ✕ Do not try to build “all-knowing oracles.”

ADVANTAGES

A study shows that programmer using TDD are:

- more productive
- Rarely debug
- Effective and efficient system design

Few failed systems

No unnecessary code

Focus on task

Reduced bugs in the code

DISADVANTAGES

- More time needed initially
- Requirements change
- May not be flexible if only pass and fail is required
- Code maintenance
- Complex systems may require extended development

FAKES, MOCKS AND INTEGRATION TESTS

Unit tests focus on a unit

A complex module may have a thousand unit tests

Tests used for TDD should never cross process boundaries in a program.

Doing so introduces delays that make tests run slowly and discourage developers from running the whole suite.

Introducing dependencies on external modules or data also turns unit tests into integration tests.

FAKES, MOCKS AND INTEGRATION TESTS

When code under development relies on a database, a web service, or any other external process

an interface should be defined that describes the access available

The interface should be implemented in two ways, one of which really accesses the external process, and the other of which is a fake or mock.

Fake and mock objects:

methods return data to help the test process by always returning the same, realistic data that tests can rely upon

Integration tests:

any database should always be designed carefully with consideration of the initial and final state of the database, even if any test fails.

EXAMPLE – TEST-DRIVEN FIBONACCI

- The Fibonacci numbers or series or sequence are the numbers in the following integer sequence:

  0, 1, 1, ,2 ,3, 5, 8, 13, 21, 34, …

- The sequence Fn of Fibonacci numbers is defined by the recurrence relation

  $$Fn = Fn\text{-}1 + Fn\text{-}2$$

  with seed values

  $$F0 = 0, F1 = 1$$

EXAMPLE – TEST-DRIVEN FIBONACCI

- The second test shows that fib(1) = 1.

```
public void testFibonacci() {
        assertEquals(0, fib(0));
        assertEquals(1, fib(1));
}
```

```
int fib(int n) {
        return 0;
}
```

EXAMPLE – TEST-DRIVEN FIBONACCI

- The first test shows that fib(0) = 0. The implementation returns a constant.

```
public void testFibonacci() {
        assertEquals(0, fib(0));
}
```

```
int fib(int n) {
        if (n == 0) return 0;
        return 1;
}
```

EXAMPLE – TEST-DRIVEN FIBONACCI

- We can factor out the common structure of the assertions by driving the test from a table of input and expected values.

```
public void testFibonacci() {
        int cases[][]= {{0,0},{1,1}};
        for (int i= 0; i < cases.length; i++)
        assertEquals(cases[i][1], fib(cases[i][0]));
        }
```

EXAMPLE – TEST-DRIVEN FIBONACCI

- Now adding the next case requires 6 keystrokes and no additional lines:

```
public void testFibonacci() {
        int cases[][]= {{0,0},{1,1},{2,1}};
        for (int i= 0; i < cases.length; i++)
        assertEquals(cases[i][1], fib(cases[i][0]));
}
```

- The test works. It just so happens that our constant "1" is right for this case as well.

EXAMPLE – TEST-DRIVEN FIBONACCI

- On to the next test:

```
public void testFibonacci() {
        int cases[][]= {{0,0},{1,1},{2,1},{3,2}};
        for (int i= 0; i < cases.length; i++)
        assertEquals(cases[i][1], fib(cases[i][0]));
}
```

- Hooray, it fails. Applying the same strategy as before (treating smaller inputs as special cases), we write:

EXAMPLE – TEST-DRIVEN FIBONACCI

```
int fib(int n) {
        if (n == 0) return 0;
        if (n <= 2) return 1;
        return 2;
}
```

- Now we are ready to generalize. We wrote "2", but we don't really mean "2", we mean "1 + 1".

```
int fib(int n) {
        if (n == 0) return 0;
        if (n <= 2) return 1;
        return 1 + 1;
}
```

EXAMPLE – TEST-DRIVEN FIBONACCI

- That first "1" is an example of fib(n-1):

```
int fib(int n) {
        if (n == 0) return 0;
        if (n <= 2) return 1;
        return fib(n-1) + 1;
}
```

- The second "1" is an example of fib(n-2):

```
int fib(int n) {
        if (n == 0) return 0;
        if (n <= 2) return 1;
        return fib(n-1) + fib(n-2);
}
```

EXAMPLE – TEST-DRIVEN FIBONACCI

- Cleaning up now, the same structure should work for fib(2), so we can tighten up the second condition:

```
int fib(int n) {
        if (n == 0) return 0;
        if (n == 1) return 1;
        return fib(n-1) + fib(n-2);
}
```

- And there we have Fibonacci, derived totally from the tests.

HOMEWORK

Review class notes.

Additional reading:

Examples of UML diagrams

Start a discussion on Google Groups to clarify your doubts.