Software Testing

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Software Testing I

Executing a program with the intent of finding errors

Two Key Goals

Validation: *Are we building the right product?*

Verification: *Are we building the product right?*

Boehm, 1979

Software Testing II

Validation testing

Does the software meet the technical requirements? (typical usage)

Defect testing

Is the system behaving incorrectly? (atypical situations)

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5. How should code be tested?

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Testing can only show the presence of error, not their absence – Dijkstra, 1972

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- Scope: examine the code as well as the execution of the code in various environments and conditions
- Functional testing: tests that verify a specific function of the code
  Does this particular feature work?
- Non-functional testing: tests that verify aspects not directly related to function
  Is the system scalable? Is it secure?

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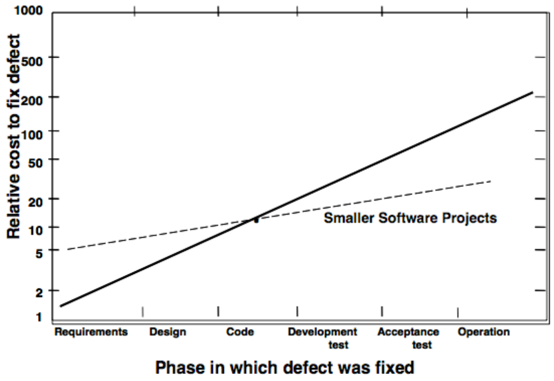
  Other culprits:
  - Missing requirements $\rightarrow$ errors of omission in design
    Common case: Non-functional req. (scalability, maintainability, security, etc.) were not specified
  - Ambiguity of requirements
  - Incorrect design

4. How does it matter whether a defect is found during the planning, development or post-release?



Barry Boehm - A View of 20th and 21st Century Software Engineering

- *The earlier a defect is found the cheaper it is to fix it*
- E.g. if problem in requirements is found only in post-release, then the cost to fix it is 10-100 times more

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- Static approaches: when the software isn't actually used
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  - Walkthroughs
  - Inspections
- Dynamic approaches: when the software is actually executed
  - Break test domain into regions and test the boundaries
    Test domain for a code?
  - Can take place *before, during, and after* program is complete
    Stubs (piece of code standing-in for some functionality) often used while program is being completed.

Testing Methods

Black box testing

- Software product is a **black box**
- No knowledge of the implementation is assumed
- Many methods proposed, e.g. equivalence partitioning, boundary value analysis, etc
- Specification-based testing: Verify output for well-defined test cases

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White box testing

- Have access to internal data structures and algorithms
- testing API
- testing code coverage, etc.
- Includes all static testing

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- System Testing
  - Testing of the completely integrated system

Unit Testing with JUnit

- A tool for testing OO Java code
- A JAR linked at compiled time
  - `junit.framework` for v. 3.8 and earlier
  - `org.junit` for v. 4.0 and later
- Has been ported to many other languages

Framework for JUnit v. 4.0

- Classes: `Assert`, `Assume`, `Test.None`
- Annotations: `@After`, `@AfterClass`, `@Before`, `@BeforeClass`, `@ClassRule`, `@Ignore`, `@Rule`, `@Test`

Simple example:

```
public class Example {
   File output;
   @Before
   public void createOutputFile() {
         output= new File(...);
   }
   @Test
   public void something() {
         ...
   }
   @After
   public void deleteOutputFile() {
         output.delete();
   }
}
```

Sample Code[a]

[a] Hong Qing Yu

```
class Money {
   private int fAmount;
   private String fCurrency;

   public Money(int amount, String currency) {
        fAmount= amount;
        fCurrency= currency;
   }
   public int amount() { return fAmount; }

   public String currency() { return fCurrency; }
   public Money add(Money m) {
        return new Money(amount()+m.amount(), currency());
   }
}
```

A JUnit v.4 Test Class

```
import static org.junit.Assert.assertTrue;
import org.junit.Test;

public class MoneyTest {

   @Test
   public void testSimpleAdd() {
      Money m12USD= new Money(12, "USD");
      Money m14USD= new Money(14, "USD");
      Money expected= new Money(26, "USD");
      Money result=  m12USD.add(m14USD);

      assertTrue(expected.equals(result));
   }
}
```

Will this test pass or fail?

Another JUnit v.4 Test Class

```
public class MoneyTest {
   private Money f12USD;
   private Money f14USD;

   @Before public void setUp() {
      f12USD= new Money(12, "USD");
      f14USD= new Money(14, "USD"); }

   @Test public void testSimpleAdd() {
      Money expected= new Money(26, "USD");
      Money result= f12USD.add(f14USD);
      assertTrue(expected.equals(result)); }

   @Test public void zeroTest() {
      Money zero= new Money(0, "USD");
      Money result= zero.add(zero);
      assertTrue(result.equals(zero)); }

   @Test(expected=ArithmeticException.class)
   public void negativeTest() {
      Money odd= new Money(-16, "USD");
      Money result= f12USD.add(odd);
      Money expected = new Money(-4, "USD");
      assertTrue(result.equals(expected)); }
}
```

Useful Resources

`junit.sourceforge.net/javadoc`

`open.ncsu.edu/se/tutorials/junit/`

`developer.android.com/training/activity-testing/activity-unit-testing.html`

`mobile.tutsplus.com/tutorials/android/android-sdk-junit-testing/`