Chap 2. Introduction to Software Testing

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1. Introduction

-Testing is the process of uncovering evidence of flaws and fixing these flaws in software systems.

÷Flaws may result from various reasons such as mistakes, misunderstandings, and omissions occurring during any phase of software development.

-Testing allows mitigating software risks.

÷Testing is conducted according to a test plan, which is more effectively driven by the specific risks faced by the system.

÷The risks determine what type of tests need to be conducted;

÷The test plan determines how much testing is needed or is acceptable from a business perspective.

-Testing remains one of the most costly and challenging aspects of the software development process.

÷From a business perspective, there is an optimum level of testing, which is acceptable.

÷Beyond the optimum level, testing becomes less cost-effective, because the cost of testing simply exceeds the gains obtained from the defects detected.

Purpose of Testing

-According to the test objectives, different approaches may be used:

÷*Defect testing*: guided by the objective of uncovering latent defects in the program, before delivering it; involves exercising the program in order to trigger some incorrect behavior, exposing some defect.

÷*Validation testing*: establish that the system behaves according to its specification; requires testing the system or correct behavior by exercising some acceptance testing criteria.

- Hence, missions of test groups can vary:

•Find defects; Maximize bug count

•Block premature product releases; Help managers make ship / no-ship decisions

•Assess/Assure quality; Conform to regulations

•Minimize technical support costs; Minimize safety-related lawsuit risk

•Assess conformance to specification/ Verify correctness of the product

•Find safe scenarios for use of the product (find ways to get it to work, in spite of the bugs)

2. Test Dimensions

-Since program errors are diverse and complex, no single test technique can cover all kinds of errors. In practice, a combination of several techniques is used to achieve adequate testing.

÷There are many levels of testing as well as many dimensions to testing, which should be considered in order to test appropriately a software system.

Test Scopes

-There are three levels of testing:

÷*Unit Testing*: targets small piece of software entity such as a method, a class, a cluster of interdependent classes, or a software component.

÷*Integration Testing*: tests the interactions between a collection of related functions or components.

÷*System Testing*: test the whole system after all the components or subsystems are combined into the final product.

Testing Dimensions

-Testing dimensions can be defined based on two criteria: task and data.

÷Testing activities can be categorized in either validation or verification tasks.

÷Based on the test data available, testing can be categorized in either functional testing or structural testing.

Validation & Verification

-***Verification*** consists of checking that the system works according to the organization's standards and processes.

÷Verification techniques include requirements review, design review, code walkthrough, and code inspection.

-***Validation*** consists of ensuring that the system functions according to the specification.

÷Involves executing the system in real-life scenarios and checking whether it behaves as expected.

÷Validation techniques include unit testing, integration testing, system testing, and user acceptance testing.

Functional vs. Structural Testing

-***Functional testing***, also called black box testing, consists of checking the system without having or using any knowledge of the internal logic in developing the test cases.

÷Mostly accomplished using validation techniques.

÷Checks that the software system is built according to the requirements.

-***Structural testing***, also called white-box testing, use knowledge of the internal logic to develop test cases.

÷Checks the structure of the software artifacts (e.g., code, design etc.).

÷Mostly accomplished using verification techniques.

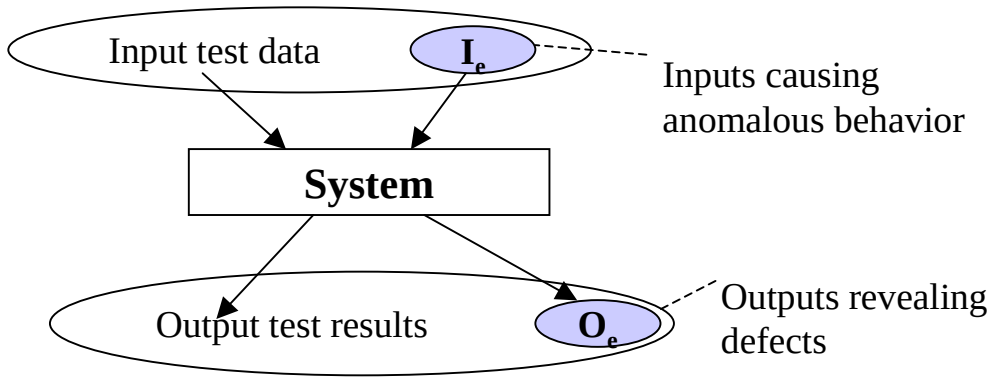
3. Test Concepts and Tasks

Test Concepts

-*Test case*: specification of inputs and outputs required to reveal defects

÷Consists of the pretest state and environment, the test inputs and expected outputs and state.

÷Expected outputs may include data, messages or exceptions generated by the application under testing.



-*Test oracle*: a technique or mechanism used to produce expected results under specific conditions.

-*Test strategy*: an algorithm and/or a collection of heuristics used to identify interesting test cases for an application under testing.

-*Test suite*: a collection of test cases, typically related by a testing goal or implementation dependency.

Example: an IUT and some corresponding test cases and test suite

```
int prog(int X, int Y) {
        x = X; y = Y;
        if (x > 100) {
                x = x – 100;
        } else {
                x = x + 100;
        }

        if (x <= y) {
                y = 2*y;
        }
        else {
                if (x > 200) {
                        x = x - 100;
                } else {
                        x = x*x;
                }
        }
        printf("x=%d. y=%d",x, y);
}
```

Sample test cases:

Test case Id	Input		Expected Output	
	X	Y	x	y
Tc1	10	100	110	200
Tc2	101	100	1	100
Tc3	201	110	1	110

Sample test suite: {Tc1, Tc2, Tc3}

Test concepts (ctd.)

-*Test run:* the execution with actual results of a test suite(s). Actual results are compared against expected one, in order to decide the outcome: ***pass*** or ***no pass***.

÷***pass:*** actual results are the same as expected one.

÷***no pass:*** actual results are different from expected ones; this reveals a bug, and is therefore considered a ***successful*** test.

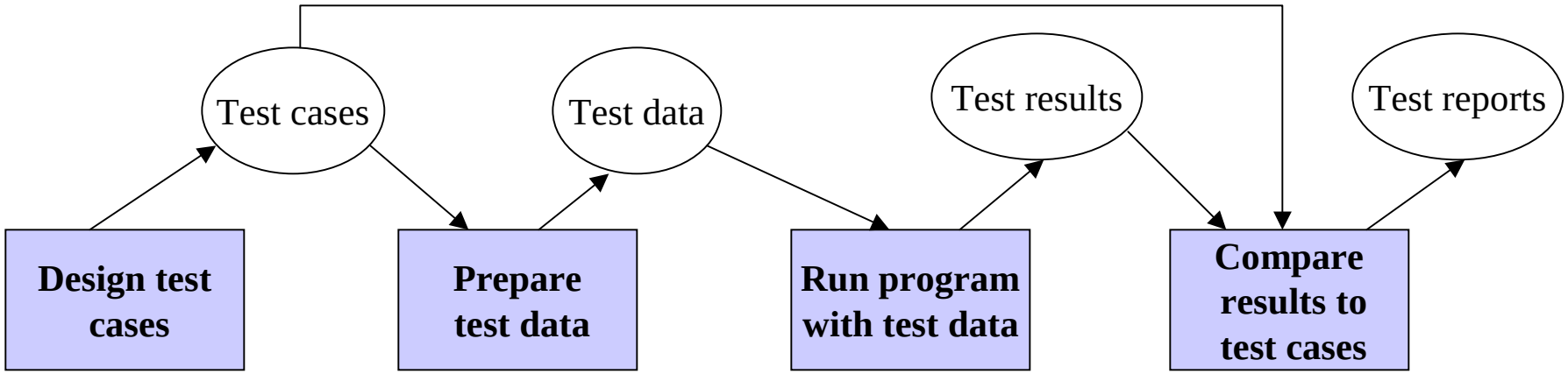
-*Test driver*: a class or utility program that applies test cases to an implementation under testing (IUT)

-*Stub:* a partial, temporary implementation of a component, that may serve as a placeholder for an incomplete component or implement testing support code.

-*Test script:* a program written in a procedural script language (usually interpreted) that executes a test suite(s).

-*Test harness:* a system of test drivers and other tools supporting test execution.

Testing Tasks

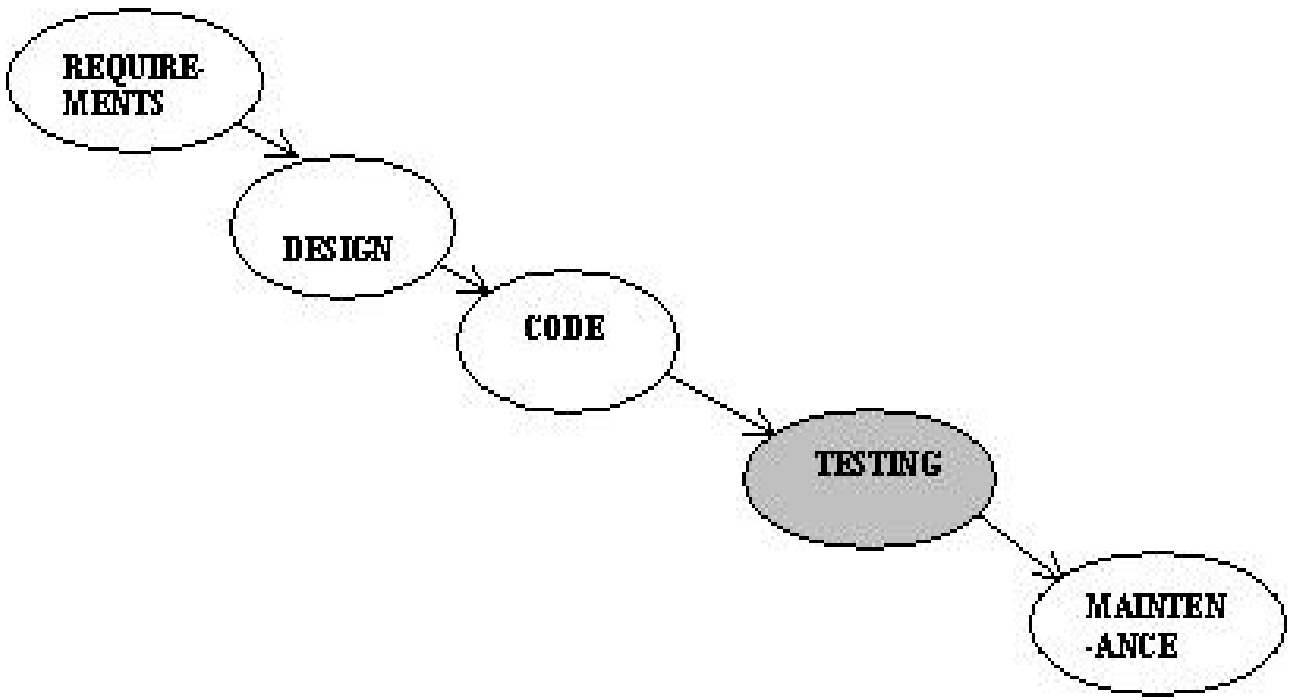


1. *Design test cases:* define and generate test cases using selected test strategies.
2. *Prepare test data:* instantiate the test cases by generating test points.
3. *Execute test cases/suites:* applies the test points to the IUT.
4. *Compare results:* compare the actual outputs with expected ones, and report corresponding test results.

4. Lifecycle Testing

Traditional Testing Approaches

-Traditionally testing occurs at the latter phases of the software development cycle



-However, restricting testing to a single phase creates the potential that errors with significant and costly consequences may occur.

-Studies conducted by IBM over several major projects have shown that:

÷ an average of 60 defects could be detected during application development:

÷50% of the defects could be detected when testing is conducted before the implementation phase,

÷80% could be detected when testing is conducted after implementation.

÷It is at least 10 times more expensive to fix a defect after implementation than before, and 100 times more expensive during maintenance.

-Lessons learned:

÷Importance of starting testing as early as possible.

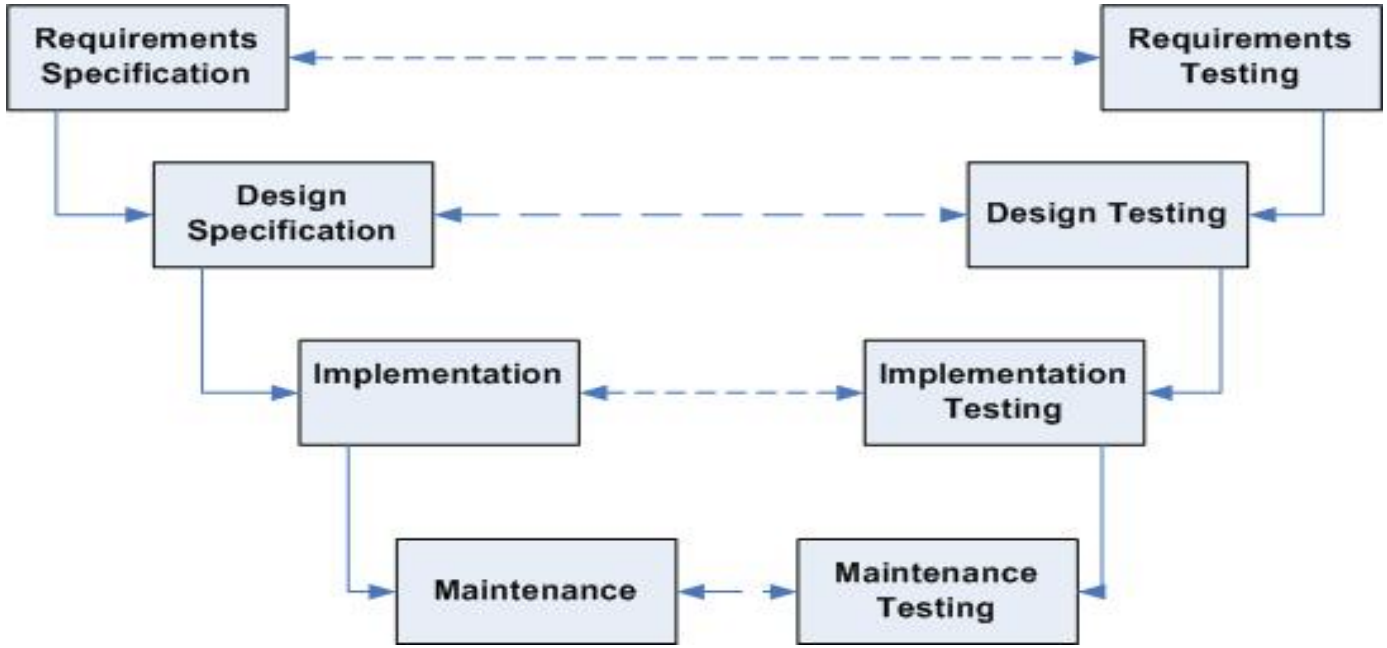
÷Necessity to integrate testing in the entire development life cycle, and not only after coding or during production.

-*Lifecycle testing* is recommended as alternative to traditional testing:

÷Incorporates testing in all the phases of the development process, and as such it spans the entire software lifecycle.

÷Starts at the same time as the product development process; both processes run concurrently and should be conducted using well structured but different methodologies.

Lifecycle Testing



÷*Requirements Testing:* ensure that the requirements are recorded or documented properly, and address user and business concerns.

÷*Design Testing:* ensure that the design is complete, accurate and matches with the requirements.

÷*Implementation Testing:* ensure that the design specification has been correctly implemented.

÷*Maintenance Testing:* involve deployment testing at the installation, and regression testing during operation.