Lecture 13: Chapter 17

Software Testing Strategies

Slide Set to accompany
Software Engineering: A Practitioner’s Approach, 7/e
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Software Testing

Testing is the process of exercising a program with the specific intent of finding errors prior to delivery to the end user.
What Testing Shows

- errors
- requirements conformance
- performance
- an indication of quality
Strategic Approach

- To perform effective testing, you should conduct effective technical reviews. By doing this, many errors will be eliminated before testing commences.
- Testing begins at the component level and works "outward" toward the integration of the entire computer-based system.
- Different testing techniques are appropriate for different software engineering approaches and at different points in time.
- Testing is conducted by the developer of the software and (for large projects) an independent test group.
- Testing and debugging are different activities, but debugging must be accommodated in any testing strategy.
**V & V**

- **Verification** refers to the set of tasks that ensure that software correctly implements a specific function.

- **Validation** refers to a different set of tasks that ensure that the software that has been built is traceable to customer requirements. Boehm [Boe81] states this another way:
  - **Verification**: "Are we building the product right?"
  - **Validation**: "Are we building the right product?"
Who Tests the Software?

**developer**
Understands the system but, will test "gently" and, is driven by "delivery"

**independent tester**
Must learn about the system, but, will attempt to break it and, is driven by quality
Testing Strategy

System engineering
Analysis modeling
Design modeling
Code generation

Unit test
Integration test
Validation test
System test
Testing Strategy

- We begin by ‘testing-in-the-small’ and move toward ‘testing-in-the-large’

- For conventional software
  - The module (component) is our initial focus
  - Integration of modules follows

- For OO software
  - our focus when “testing in the small” changes from an individual module (the conventional view) to an OO class that encompasses attributes and operations and implies communication and collaboration
Strategic Issues

- Specify product requirements in a quantifiable manner long before testing commences.
- State testing objectives explicitly.
- Understand the users of the software and develop a profile for each user category.
- Develop a testing plan that emphasizes “rapid cycle testing.”
- Build “robust” software that is designed to test itself (re-route or cleanly terminate)
- Use effective technical reviews as a filter prior to testing
- Conduct technical reviews to assess the test strategy and test cases themselves.
- Develop a continuous improvement approach for the testing process.
Unit Testing

software engineer

module to be tested

test cases

results
Unit Testing

- Module to be tested
- Interface
- Local data structures
- Boundary conditions
- Independent paths
- Error handling paths
- Test cases
Unit Test Environment

Module

stub
stub

driver

interface
local data structures
boundary conditions
independent paths
error handling paths
test cases

RESULTS
Integration Testing Strategies

Options:
- the “big bang” approach (all at once)
- an incremental construction strategy
Top Down Integration

The top module is tested with stubs. Stub modules are replaced one at a time, "depth first", as new modules are integrated. Some subset of tests is re-run.
Bottom-Up Integration

Drivers are replaced one at a time, "depth first"

Worker modules are grouped into builds and integrated

Cluster
Sandwich Testing

- Top modules are tested with stubs
- Worker modules are grouped into builds and integrated

Cluster
Regression Testing

- *Regression testing* is the re-execution of some subset of tests that have already been conducted to ensure that changes have not propagated unintended side effects.
- Whenever software is corrected, some aspect of the software configuration (the program, its documentation, or the data that support it) is changed.
- Regression testing helps to ensure that changes (due to testing or for other reasons) do not introduce unintended behavior or additional errors.
- Regression testing may be conducted manually, by re-executing a subset of all test cases or using automated capture/playback tools.
Smoke Testing

- A common approach for creating “daily builds” for product software
- Smoke testing steps:
  - Software components that have been translated into code are integrated into a “build.”
    - A build includes all data files, libraries, reusable modules, and engineered components that are required to implement one or more product functions.
  - A series of tests is designed to expose errors that will keep the build from properly performing its function.
    - The intent should be to uncover “show stopper” errors that have the highest likelihood of throwing the software project behind schedule.
  - The build is integrated with other builds and the entire product (in its current form) is smoke tested daily.
    - The integration approach may be top down or bottom up.
Object-Oriented Testing

- begins by evaluating the correctness and consistency of the analysis and design models
- testing strategy changes
  - the concept of the ‘unit’ broadens due to encapsulation
  - integration focuses on classes and their execution across a ‘thread’ or in the context of a usage scenario
  - validation uses conventional black box methods
- test case design draws on conventional methods, but also encompasses special features
OO Testing Strategy

- class testing is the equivalent of unit testing
  - operations within the class are tested
  - the state behavior of the class is examined

- integration applied three different strategies
  - thread-based testing—integrates the set of classes required to respond to one input or event
  - use-based testing—integrates the set of classes required to respond to one use case
  - cluster testing—integrates the set of classes required to demonstrate one collaboration
WebApp Testing - I

- The content model for the WebApp is reviewed to uncover errors.
- The interface model is reviewed to ensure that all use cases can be accommodated.
- The design model for the WebApp is reviewed to uncover navigation errors.
- The user interface is tested to uncover errors in presentation and/or navigation mechanics.
- Each functional component is unit tested.
WebApp Testing - II

- Navigation throughout the architecture is tested.
- The WebApp is implemented in a variety of different environmental configurations and is tested for compatibility with each configuration.
- Security tests are conducted in an attempt to exploit vulnerabilities in the WebApp or within its environment.
- Performance tests are conducted.
- The WebApp is tested by a controlled and monitored population of end-users. The results of their interaction with the system are evaluated for content and navigation errors, usability concerns, compatibility concerns, and WebApp reliability and performance.
High Order Testing: Complete System

- Validation testing
  - Focus is on software requirements
- System testing
  - Focus is on system integration
- Alpha/Beta testing
  - Focus is on customer usage
- Recovery testing
  - forces the software to fail in a variety of ways and verifies that recovery is properly performed
- Security testing
  - verifies that protection mechanisms built into a system will, in fact, protect it from improper penetration
- Stress testing
  - executes a system in a manner that demands resources in abnormal quantity, frequency, or volume
- Performance Testing
  - test the run-time performance of software within the context of an integrated system
Debugging: A Diagnostic Process
The Debugging Process
Debugging Effort

- Time required to diagnose the symptom and determine the cause.
- Time required to correct the error and conduct regression tests.
Symptoms & Causes

- symptom and cause may be geographically separated
- symptom may disappear when another problem is fixed
- cause may be due to a combination of non-errors
- cause may be due to a system or compiler error
- cause may be due to assumptions that everyone believes
- symptom may be intermittent
Consequences of Bugs

Bug Categories:
function-related bugs, system-related bugs, data bugs, coding bugs, design bugs, documentation bugs, standards
Debugging Techniques

- brute force / testing
- backtracking
- induction
- deduction
Correcting the Error

- **Is the cause of the bug reproduced in another part of the program?** In many situations, a program defect is caused by an erroneous pattern of logic that may be reproduced elsewhere.

- **What ”next bug” might be introduced by the fix I’m about to make?** Before the correction is made, the source code (or, better, the design) should be evaluated to assess coupling of logic and data structures.

- **What could we have done to prevent this bug in the first place?** This question is the first step toward establishing a statistical software quality assurance approach. If you correct the process as well as the product, the bug will be removed from the current program and may be eliminated from all future programs.
Final Thoughts

- *Think* -- before you act to correct
- Use tools to gain additional insight
- If you’re at an impasse, get help from someone else
- Once you correct the bug, use regression testing to uncover any side effects