Dimensions of Test Coverage
Quantifying What Has and Hasn’t Been Tested
Introduction

- What do we mean by “test coverage”?
- What do outside stakeholders hear when we talk about “test coverage”?
- What’s the difference between “test coverage” and “test execution status”?
- Confusion abounds, and leads to misunderstanding of status
- Can we build a better understanding of how to measure coverage, along with the strengths and weakness of these measures and how to use tools to gather them?
- Yes!

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Test Coverage, Generally

- Test coverage is generally about building confidence
  - In sufficiency and proper execution of testing (proof we tested what we said we would)
  - In proper operation of system (assuming test results are good)
- Building confidence is one of four typical test objectives, which also include
  - Detect defects, especially important defects
  - Reduce risk to an acceptable level
  - Provide information to guide decision-making about project and product
- Metrics can be used to measure the extent to which these objectives are being achieved
- These test coverage metrics should be reported as part of test execution status
Common (and Uncommon) Dimensions

- Specification (esp. requirements) coverage
- Risk coverage
- White-box (esp. code) coverage
- Supported configurations (and combinations thereof)
- Data set
- Personas
- Defect taxonomy
Specification Coverage

What it is: The degree to which defined behaviors and/or structures have been tested

How’s it measured: Percentage of defined requirements, use cases, design elements, screens and fields, or user stories tested, along with test status (pass/fail)

Strengths: Flags situations where testing is clearly incomplete or where system elements are weak

Weaknesses: Gaps in the specification can create false confidence

Tools: Test management and Agile sprint management
Example of Specification Coverage

Coverage Breakdown

- Closed Defects
- Active Defects
- Failed Tests
- Passed Tests
Risk Coverage

What it is: The extent to which identified quality risks have been mitigated

How's it measured: Risk-weighted percentage of identified risks tested, along with test status (pass/fail)

Strengths: Clear measurement of the residual level of quality risk

Weaknesses: Requires good quality risk analysis process

Tools: Test management tools, but customization is usually required
Example of Risk Coverage

Region in green represents risks for which all tests were run and passed and no must-fix bugs were found. Region in red represents risks for which at least one test has failed and at least one must-fix bug is known. Region in black represents other risks, which have no known must-fix bugs but still have tests pending to run.
White-box Coverage

- What it is: The degree to which the code (and sometimes data) has been tested
- How’s it measured: Varies, depending on the specific metrics (next slide)
- Strengths: Can reveal under-tested areas of code and help programmers do thorough unit tests
- Weaknesses: Even very thorough unit testing can only find about 50% of defects, and you can’t reveal missing code with white-box coverage
- Tools: Code instrumentation tools and unit test tools
Examples of White-box Coverage Metrics

- Statement: % of statements
- Decision: % of possible outcomes (T/F)
- Condition: % of atomic conditions (T/F)
- Modified condition/decision: % of atomic condition that have alone determined outcome twice (T/F)
- Multiple condition: % of all possible combinations of condition in a decision
- Basis path: % of McCabe basis paths
Configuration Coverage

- What it is: The extent to which supported configurations have been tested
- How’s it measured: Percentage of supported configurations (or configuration pairs) tested, along with test results
- Strengths: Especially for highly portable applications (e.g., mobile apps, browser-based apps), can flag untested hardware and software
- Weaknesses: These metrics sometimes motivate unnecessary pairwise testing, hard to devise a metric that deals with combinations properly
- Tools: Can use test management tools
Data Set Coverage

What it is: Extent to which specific types of data have been tested

How’s it measured: Specify the different types of data, then include as part of specification coverage measures

Strengths: Makes visible gaps in testing certain types of data

Weaknesses: Requires a good understanding of the data, which isn’t always available in the test team

Tools: As with specification coverage
Persona Coverage

What it is: Extent to which identified types of users have been included

How's it measured: Specify the different types of users, then include as part of specification coverage measures

Strengths: Especially for mass-market software, gets people to pay attention to user diversity

Weaknesses: Requires a good understanding of the users and their styles of interacting with the application, which isn't always available in the test team

Tools: As with specification coverage
Defect Taxonomy Coverage

- **What it is:** Extent to which we’ve tested for common defects
- **How’s it measured:** Percentage of defects tested, often severity- or frequency-weighted
- **Strengths:** Helps avoid the “oh no, not again” syndrome after release
- **Weaknesses:** When production defect information is not available for the current application, can result in over-testing
- **Tools:** Test management tools, but customization may be required
Conclusions

- Test coverage metrics can give us and other project stakeholders essential insights into our testing
- Unidimensional coverage metrics can be misleading
- Use a balanced combination of coverage dimensions to provide a complete picture
- Educate people on the coverage metrics, their strengths and weaknesses, before use
- Use tools where possible to automate the process
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