

Using Oracles in Test Automation

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Running A Software Test

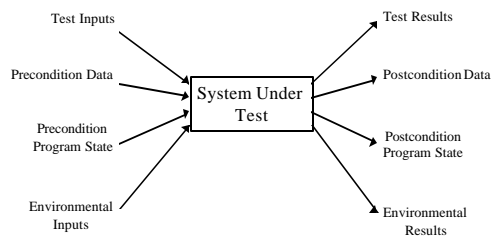
- Test setup
 - SUT program state
 - Data values
 - System environment
- Run test exercise
- Capture/compare actual with expected results

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Expanded Testing Model



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Fully Automated Software Tests

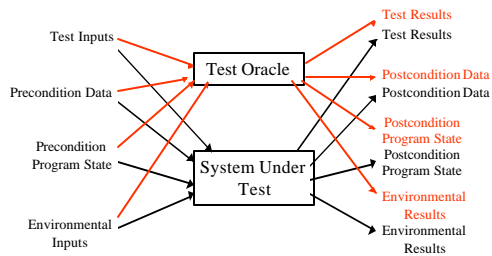
- Able to run two or more specified test cases
- Able to run a subset of the automated test cases
- No intervention needed after launching tests
- Automatically set-up and/or record relevant test environment
- Run test cases
- Capture relevant results
- Compare actual with expected results
- Report analysis of pass/fail

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Testing With An Oracle



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Deterministic Strategies

- Parallel function
 - previous version
 - competitor
 - standard function
 - custom model
- Inverse function
 - mathematical inverse
 - operational inverse (e.g. split a merged table)
- Useful mathematical rules (e.g. $\sin^2(x) + \cos^2(x) = 1$)
- Saved result from a previous test. (Consistency test)
- Expected result encoded into data (SVD)

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Oracle Characteristics

- Completeness of information
- Accuracy of information
- Usability of the oracle or of its results
- Maintainability of the oracle
- Complexity
- Temporal relationships
- Costs

Oracle Strategies for Verification

| | No Oracle | The Oracle | Consistency | Self Referential (SVD) | Heuristic |
|---------------|---|--|--|--|--|
| Definition | - Doesn't check correctness of results | - Independent generation of all expected results | - Verifies current run results with a previous run (Regression Test) | - Embeds answer within data in the message | - Verifies some characteristics of values |
| Advantages | - Can run any amount of data (limited only by the time the SUT takes) | - All encountered errors are detected | - Fastest method using an oracle - Verification is straightforward | - Allows extensive post-test analysis - Verification is based on message contents | - Fast and easier than The Oracle - Often much less expensive to create and use |
| Disadvantages | - Only spectacular failures are noticed | - Expensive to implement - Complex and often time consuming when used | - Only generate and verify large amounts of data - Original may include undetected errors | - Must define answers and generate messages to contain them | - Can miss errors - Can miss systematic errors |

'No Oracle' Strategy

- Easy to implement
- Tests run fast
- Only spectacular errors are noticed
- False sense of accomplishment

True Oracle

- Independent implementation
- Coverage over domains
 - Input ranges
 - Result ranges
- “Correct” results
- Usually expensive
- Never “Complete”

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Consistency Strategy

- A / B compare
- Check for changes
- Regression checks
 - Validated
 - Unvalidated
- Alternate versions or platforms
- Foreign implementations

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Self-Referential Strategy

- Embed results in the data
- Cyclic algorithms
- Shared keys with algorithms

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Choosing / Using a Heuristic

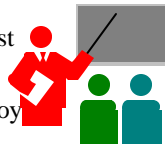
- Rules of thumb
 - similar results that don't always work
 - low expected number of false errors, misses
- Levels of abstraction
 - General characteristics
 - Statistical properties
- Simplify
 - use subsets
 - break down into ranges
 - step back (20,000 or 100,000 feet)
- Other relationships not explicit in SUT
 - date/transaction number
 - one home address
 - employee start date

Choosing Which Strategy

- Decide how the oracle fits in
- Identify the oracle strategy or combinations
- Prioritize testing risks

Summary

- Automated tests can be powerful
- Test oracles are critical factors in making good automated tests
- There are different types of test oracles available
- There are many ways to employ test oracles



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