Value-Based Software Test Prioritization

Annual Research Review
CSSE-USC
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Outline

- Research Motivation
- Research Method
- Case Studies
- Tool Support
- Conclusion
Research Motivation

• Value-neutral SE methods are increasingly risky [Boehm, 2003]
  – Every requirement, use case, object, test case, and defect is equally important
  – “Earned Value” Systems don’t track business value
  – System value-domain problems are the chief sources of software project failures

• Testing & Inspection resources are expensive and scarce
  – 30%-50%, even higher for high reliability projects [Ramler, 2005]
  – Time-to-market [Boehm, Huang, 2005]

• Empirical Findings [Bullock 2000, Boehm & Basili 2001 ]
  – About 20 percent of the features provide 80 percent of business value
  – About 80 percent of the defects come from 20 percent of the modules
  – ...

• Value-based Software Engineering 4+1 theorem [Boehm, 2005]
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Value-Based Software Test Prioritization

What to be prioritized?

• Testing items: Testing Scenarios, Testing Features, Test Cases

How to prioritize?

• Value-Based (Business Importance, Risk, Cost)
• Dependency Aware

How to Measure?

• Average Percentage of Business Importance Earned (APBIE)
Research Method: Value-Based

• Risk Exposure (RE)

\[ RE = \text{Size (Loss)} \times \text{Pro (Loss)} \]

– Where Size (Loss) is the risk impact size of loss if the outcome is unsatisfactory, Pro (Loss) is the probability of an unsatisfactory outcome

• Risk Reduction Leverage (RRL)

\[ RRL = \frac{RE_{before} - RE_{after}}{\text{Risk Reduction Cost}} \]

– Where \( RE_{before} \) is the \( RE \) before initiating the risk reduction effort and \( RE_{after} \) is the \( RE \) afterwards.

– \( RRL \) is a measure of the cost-benefit ratio of performing a candidate risk reduction or defect removal activity
Research Method: Value-Based

• Value-Based Prioritization Drivers:
  – Business Case Analysis → Business Value
  – Stakeholder Prioritization → Size of Loss
  – Impact of Defect → Defect Criticality
    → Risk Exposure
  – Experience Base → Defect-prone Components, Performers → Probability of Loss

Testing items are to be ranked by how well they can reduce RE
Research Method: Value-Based

• Combining with the testing items’ relative costs

• =>Priority Trigger:

\[ RRL = \frac{RE_{before} - RE_{after}}{Risk \ Reduction \ Cost} \]

• This proposed strategy enables them to be prioritized in terms of Risk Reduction Leverage (RRL) or ROI

• Supposed to improve the lifecycle cost-effectiveness of defect removal techniques
Research Method: Dependency Aware

Cost of software product [Boehm, 1981]
Research Method: Dependency Aware

- **Dependency:**
  - Example: dependencies among test cases to be executed
  - Solution: Prioritization Algorithm (greedy alg)
    - Select the one with the highest RRL
    - Check dependency

```
9 -> 3 -> 9 -> 5 -> 9 -> 4 -> 7
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Research Method: Metrics

• Testing Cost Effectiveness
  – Average Percentage of Business Importance Earned (APBIE)

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APBIE 35%

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APBIE 85%
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Case Studies Results

• Exercise Test Prioritization based on Risk Reduction Level (RRL)
  ✓ software testing scenarios to be walked through in Galorath.Inc
  ✓ software features to be tested in a Chinese company
  ✓ software test cases to be executed in USC SE course projects

All of them show preliminary positive results
Case Studies Results (Galorath Inc.)

Prioritize testing scenarios to be walked through

- Galorath Inc. (2011 Summer)

- Value-based prioritization can improve the cost-effectiveness of testing
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Automated Tool Support (Beta Version)
Tool Demo

Website: http://greenbay.usc.edu/dacs/vbt/testlink/index.php
Future Features

• Establish the traceability matrix between the requirement specifications and test cases to automatically obtain test case business importance ratings

• Establish the traceability matrix between test cases and defects in order to automatically predict the fail probability based on the collected historical defect data via incorporating the-state-of-art defect prediction techniques

• Experiment sensitivity analysis for reasoning and judging the correctness of factors’ ratings

If you would like to be a beta version tester, please contact me at qli1@usc.edu
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Conclusion

• Propose a Real “Earned Value” System to Track Business Value of Testing and Measure Testing Efficiency in terms of APBIE

• Propose a Systematic Strategy for Value-based, Dependency Aware Test Processes

• Apply This Strategy to a Series of Empirical Studies with different granularities of Prioritizations

• Elaborate Decision Criteria of Testing Priorities Per Project Contexts, Which are Helpful for Real Industry Practices

• Implement an automatic tool for its application on large-scale industrial projects
Question and Answer