Partnership for International Research and Education
A Global Living Laboratory for Cyberinfrastructure Application Enablement

Leveraging Traceability Recovery in Test Planning and Optimization

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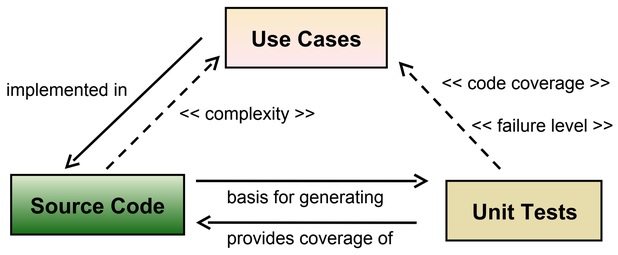
I. Research Overview and Outcome

1.1 Motivation

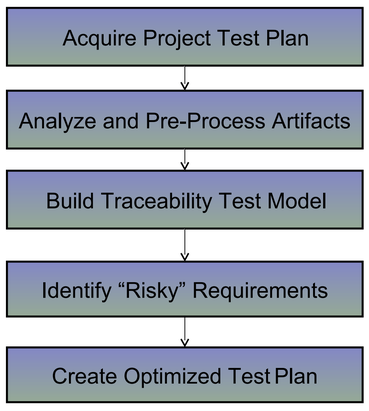
- **A common approach to system test planning utilizes decision support** information such as the frequency, criticality, and risk associated with implementing business requirements, typically expressed as a set of use cases.
- **Estimating the risks associated with use cases is non-trivial** and hence initial estimates may be inaccurate due to over-emphasized or missing risk factors.
- **Implementation and unit testing activities provide valuable test information** such as source code complexity metrics, number of test passes/failures, and code coverage results.
- **Mapping unit test information back to the business requirements** through software traceability links can provide concrete evidence to support or refute decision support risk estimates, and hence optimize the initial system test plan.

1.2 Leveraging Traceability Information



- Traceability analysis can be used to determine how use cases are realized in terms of the **complexity**, **test coverage** and **failure levels** of the set of classes that implement them.

1.3 Overview of Approach



1.4 Hypotheses

- **Highly complex source code** units will contain more defects, or more critical defects, than less complex units.
- **A large number of defects** discovered in a specific unit suggests that more defects will be found in that unit.
- **Sparsely tested source code** units pose additional risk to further testing efforts with respect to undiscovered defects.

1.5 Risk Calculation

- Calculate weight for each source code unit **u**, denoted $\mathbf{w_u}$ according to the following:

$$\mathbf{w_u} = \text{Complexity}(u) + \text{Failure Level}(u) + \text{Coverage}(u)$$

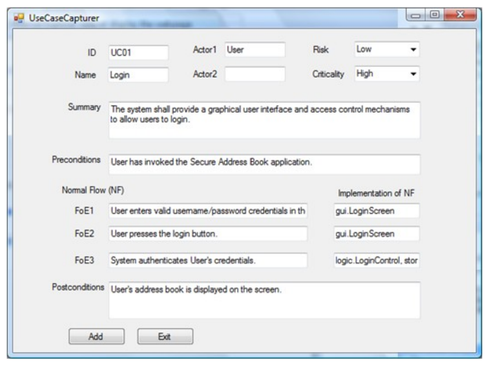
  - Complexity := High (3) | Medium (2) | Low (1)
  - Failure Level := High (3) | Medium (2) | Low (1)
  - Coverage := Poor (3) | Average (2) | Good (1)

The weight of a flow event **e**, denoted $\mathbf{w_e}$, is given by:

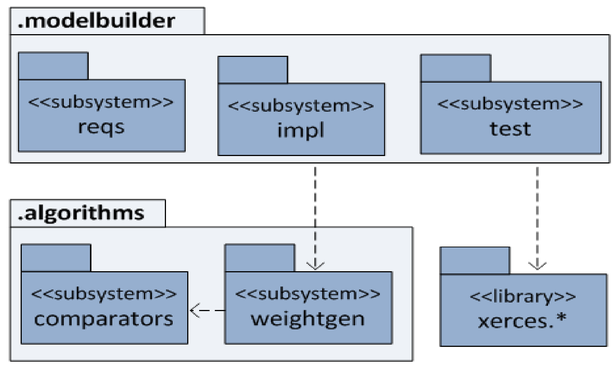
$$w_e = \sum w_{u\_e} \cdot |e|$$ (Note: |e| factors for interaction failures)

- Finally, the weight of a use case flow **f**, denoted $\mathbf{w_f}$, is given by the sum of the weights of all its events: $w_f = \sum w_e$

1.6 Implementation



Use Case Capturer Application (.NET)



Model Builder and Weight Generator (Eclipse, Java)

1.7 Experiments & Preliminary Results

Goal: Determine whether or not the proposed approach provides optimizations over traditional decision support based approach

	Decision Support	Unit Test/Trace
Mutation Score (%)	100 (8/8)	92 (7/8)
Test Set Size	17	15
Total Number of Failures	3	3

Criteria: (1) Mutation Score provides a measure of the adequacy of the test set in exercising requirements, (2) Test Set Size is used as a rough estimate of the cost of testing, and (3) Total Number of Failures metric represents the fault revealing capability of the test set.

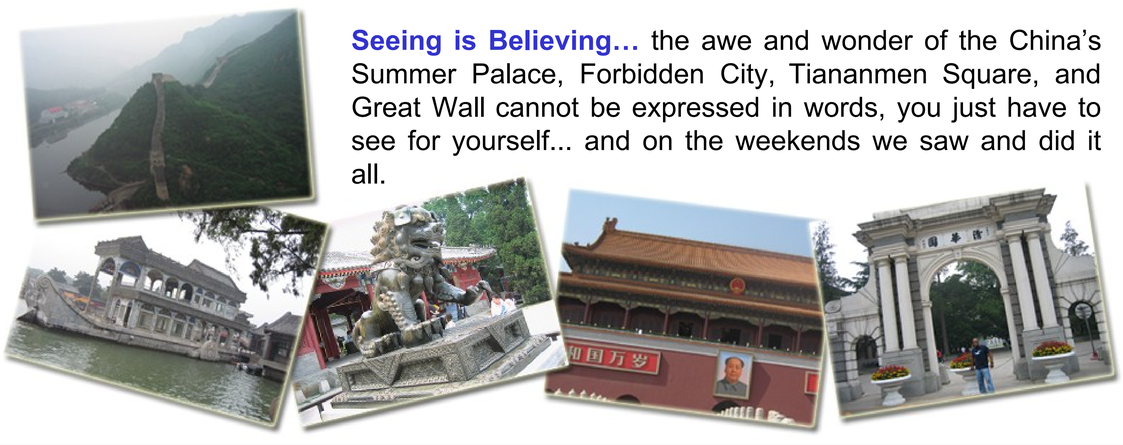
II. International Experience

2.1 Inherently Multi-Cultural

A Mixed Salad! Barbados, India, Colombia, America, Europe… these were the countries represented by our diverse group of six PIRE participants that went to Beijing this summer.

2-Way Culture Shock best describes the first weeks spent at Tsinghua University. We had to quickly adjust to different customs, food, language… while many of the Chinese would soon experience the ten week shock of us!!!

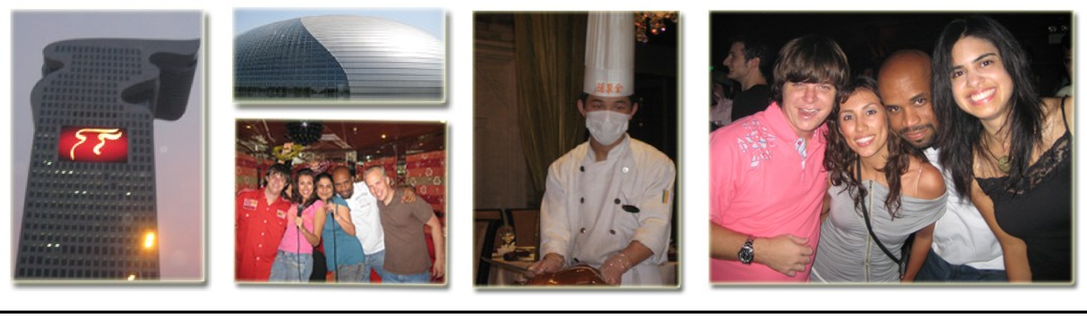
2.2 Extraordinary Sights



Seeing is Believing… the awe and wonder of the China's Summer Palace, Forbidden City, Tiananmen Square, and Great Wall cannot be expressed in words, you just have to see for yourself... and on the weekends we saw and did it all.

2.3 Entertainment, Cuisine, and Night Life

The Beijing Buzz… being in the home city of the 2008 Summer Olympic games was certainly one of the biggest attractions for us. We visited the Olympic Green, took in Chinese Opera, partied, sang Karaoke, and dined in some of the finest restaurants.



2.4 Gracious Hosts and Sponsors

Tsinghua University
Wang Xiaoge

IBM China Research Laboratory
Jun Zhu, Jeffrey Li, He Hui, Shao Chun Li

NSF Beijing
Bill Chang

Our international hosts really went the extra mile to ensure that our stay in China was exciting, pleasant, memorable, and productive… Thanks so much for everything!

III. Acknowledgement

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