A Framework to Support Research in and Encourage Industrial Adoption of Regression Testing Techniques

Jonathan Miller Kauffman and Gregory M. Kapfhammer

Department of Computer Science
Allegheny College

Testing: Academic & Industrial Conference – Practice and Research Techniques
Montréal, Québec, Canada
April 21, 2012
Regression Testing

\[ T_1 \rightarrow T_2 \rightarrow T_3 \rightarrow T_4 \rightarrow \ldots \rightarrow T_n \]
Regression Testing

Developers may introduce faults when adding new functionality

$T_1 \rightarrow T_2 \rightarrow T_3 \rightarrow T_4 \rightarrow \ldots \rightarrow T_n$
Regression Testing

Run a regression test suite to detect these faults

$T_1 \rightarrow T_2 \rightarrow T_3 \rightarrow T_4 \rightarrow \ldots \rightarrow T_n$
Regression Testing

Need ways to manage regression test suites as they grow in size

$T_1 \rightarrow T_2 \rightarrow T_3 \rightarrow T_4 \rightarrow \ldots \rightarrow T_n$
Regression Testing

\[ T_1 \rightarrow T_2 \rightarrow T_3 \rightarrow T_4 \rightarrow \ldots \rightarrow T_n \]

Regression Testing Technique
Regression Testing

What if Some Test Cases are More Effective?

Regression Testing Technique

$T_1 \rightarrow T_2 \rightarrow T_3 \rightarrow T_4 \rightarrow \ldots \rightarrow T_n$
Regression Testing

What if Some Test Cases are More Effective?

Regression Testing Technique

Prioritization

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Regression Testing

What if Some Test Cases are More Effective?

Regression Testing Technique

Prioritization
Regression Testing

What if Some Test Cases are Redundant?

Regression Testing Technique

Prioritization

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What if Some Test Cases are Redundant?

Regression Testing Technique

Prioritization

Reduction

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Regression Testing Challenges
Regression Testing Challenges

Research
Regression Testing Challenges

Research

Replication difficult due to unavailability of artifacts
Regression Testing Challenges

- Research

- Replication difficult due to unavailability of artifacts
- Insufficient number of trials and inappropriate statistical analyses
Regression Testing Challenges

Research

Replication difficult due to unavailability of artifacts

Insufficient number of trials and inappropriate statistical analyses

Practice
Regression Testing Challenges

**Research**
- Replication difficult due to unavailability of artifacts
- Insufficient number of trials and inappropriate statistical analyses

**Practice**
- Unwilling to adopt techniques due to lack of empirical studies
Regression Testing Challenges

Research

Replication difficult due to unavailability of artifacts

Insufficient number of trials and inappropriate statistical analyses

Practice

Unwilling to adopt techniques due to lack of empirical studies

Techniques must be usable with minimal configuration
Regression Testing Challenges

Research
- Replication difficult due to unavailability of artifacts
- Insufficient number of trials and inappropriate statistical analyses

Practice
- Unwilling to adopt techniques due to lack of empirical studies
- Techniques must be usable with minimal configuration

Address challenges by releasing two open-source tools
Proteja: Test Suite Executor & Coverage Monitor
Proteja: Test Suite Executor & Coverage Monitor

Program written in the Java programming language
Proteja: Test Suite Executor & Coverage Monitor

JUnit test suite that exercises program $P$
Proteja: Test Suite Executor & Coverage Monitor

Test Coverage Monitoring

Controls test case execution and coverage monitoring
Proteja: Test Suite Executor & Coverage Monitor

Identifies the program entities executed by each test case

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Proteja: Test Suite Executor & Coverage Monitor

Coverage criteria: Statement, method, and class
Proteja: Test Suite Executor & Coverage Monitor

Test Coverage Monitoring

Run test suite according to a reduction or prioritization

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Modificare: Test Suite Management & Experimentation
Modificare: Test Suite Management & Experimentation

Algorithms: Greedy, Hill Climbing, Random, Adaptive Random, Simulated Annealing, Genetic
Modificare: Test Suite Management & Experimentation

Coverage Report → Modificare

Per-test coverage information produced by Proteja
Modificare: Test Suite Management & Experimentation

Controls the execution of the reduction and prioritization algorithms
Modificare: Test Suite Management & Experimentation

Visualized and statistically analyzed to identify trends

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Modificare: Test Suite Management & Experimentation

Description of the reduced or prioritized test suite

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Integrating Proteja and Modificare
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Integrating Proteja and Modificare

Visualization and analysis used to identify trends
Integrating Proteja and Modificare

\(P, T\) → Test Suite Executor → Coverage Report → Reduction Prioritization → Data Set

\(T'\) executed using Proteja
Integrating Proteja and Modificare

Use any tool that produces data in the correct format
Integrating Proteja and Modificare

Test Suite Executor
- JUnit
- Cobertura

Coverage Report

Reduction Prioritization

Data Set

Experimentation
- Visualization
- Analysis

However, greatest benefits realized when tools used together
Empirical Results

Original NAPSC Score: 0.2784
Empirical Results

Negligible NAPSC increase as population size increases
Empirical Results

Increases in runtime are more marked

<table>
<thead>
<tr>
<th>Runtime (seconds)</th>
<th>Population Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Statement</td>
</tr>
<tr>
<td>20</td>
<td>JodaTime (JT)</td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>
Empirical Results

<table>
<thead>
<tr>
<th>Similarity Metric</th>
<th>NAPSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euclidean</td>
<td>0.3194</td>
</tr>
<tr>
<td>Jaccard</td>
<td>0.3195</td>
</tr>
<tr>
<td>Manhattan</td>
<td>0.3196</td>
</tr>
<tr>
<td>JodaTime (JT)</td>
<td>0.3197</td>
</tr>
</tbody>
</table>

Original NAPSC Score: 0.2784
Empirical Results

NAPSC changes little as similarity metric is varied.

<table>
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</tr>
<tr>
<td>Jaccard</td>
<td>0.3195</td>
</tr>
<tr>
<td>Manhattan</td>
<td>0.3197</td>
</tr>
</tbody>
</table>

Statement

JodaTime (JT)
Scores are comparable to those produced by random (0.3240 - 0.3265)
Empirical Results

<table>
<thead>
<tr>
<th>Similarity Metric</th>
<th>Runtime (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euclidean</td>
<td>80</td>
</tr>
<tr>
<td>Jaccard</td>
<td>90</td>
</tr>
<tr>
<td>Manhattan</td>
<td>100</td>
</tr>
<tr>
<td>JodaTime (JT)</td>
<td>110</td>
</tr>
</tbody>
</table>

Adaptive random executes more slowly than random.
Empirical Results

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<th>JodaTime (JT)</th>
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<td>Manhattan</td>
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</tr>
</tbody>
</table>

Choose random because it produces comparable NAPSC scores in less time
Getting Involved
Getting Involved

How can you “battle” research and practice challenges?
Getting Involved

How can you “battle” research and practice challenges?

Download Proteja and Modificare
Getting Involved

How can you “battle” research and practice challenges?

Download Proteja and Modificare

Proteja: http://proteja.googlecode.com
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Getting Involved

How can you “battle” research and practice challenges?

- Download Proteja and Modificare
- Contribute new features and bug fixes
Getting Involved

How can you “battle” research and practice challenges?

- Download Proteja and Modificare
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All contributions will be recognized
Getting Involved

How can you “battle” research and practice challenges?

- Download Proteja and Modificare
- Contribute new features and bug fixes
- Perform empirical studies

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Getting Involved

How can you “battle” research and practice challenges?

- Download Proteja and Modificare
- Contribute new features and bug fixes
- Perform empirical studies
- Study more algorithms or configurations of individual algorithms
Getting Involved

How can you “battle” research and practice challenges?

- Download Proteja and Modificare
- Contribute new features and bug fixes
- Perform empirical studies
- Share industry experience reports

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How well do these tools work in practice?

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Conclusions and Future Work
Conclusions and Future Work
Conclusions and Future Work
Conclusions and Future Work

Test Suite Executor & Coverage Monitor

http://proteja.googlecode.com
Conclusions and Future Work

Test Suite Executor & Coverage Monitor

http://proteja.googlecode.com
Conclusions and Future Work

**Protaja**

Test Suite Executor & Coverage Monitor

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**Modificare**

Test Suite Management & Experimentation
Conclusions and Future Work

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Conclusions and Future Work

Choose algorithm based on efficiency instead of effectiveness

Proteja
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Conclusions and Future Work

Choose algorithm based on efficiency instead of effectiveness

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Extend and enhance tools and perform additional empirical studies
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Thank you for your attention! Questions?