Towards Defining and Exploiting Similarities in Web Application Use Cases through User Session Analysis

Sreedevi Sampath, University of Delaware
Amie Souter, Drexel University
Lori Pollock, University of Delaware

Workshop on Dynamic Analysis (WODA), May 25, 2004
co-located with
International Conference on Software Engineering (ICSE 2004)
Motivation and Overview

- View user sessions as use cases
- Learn about dynamic behavior
- User session analysis
- Test case generation
  - Clustering via concept analysis
  - Common subsequences analysis
- Test suite reduction
- Monitoring
  - Load of traffic
- Test suite
- Software development/maintenance tools
- Content personalization

Behaviorally related sequence of events performed by the user through interaction with the system.
Step 1
Clustering via Concept Analysis

- Mathematical technique for clustering objects that have common discrete attributes
- Set of objects, $O$: user sessions, $us$
- Set of attributes, $A$: URLs, $u$
- Relation, $R$: $us$ requests $u$
- Concept analysis identifies all concepts $(O_i, A_j)$ for a given tuple $(O, A, R)$
Step 2
Heuristic for Test Suite Reduction

- Smallest set of user sessions
- Covers all the URLs
- Represents common URL subsequences of different use cases

Identify *next-to-bottom* nodes
Pick one user session from each of these *next-to-bottom* nodes

Resulting reduced test suite: \{us2, us6\}
Hypothesis Motivating the Approach

- **Common Subsequences Hypothesis:** The set of user sessions clustered together into the same concept node will have a high commonality in the subsequences of URLs in their sessions.
Finding Common Subsequences of URLs

Subsequences of URLs are representative of partial use cases of the user sessions.

NODE 003

**objects**
{ us3, us6 }

**attributes**
{ GD, GL, GR, GS, PL }

Common Subsequences

[GD, GR, GL]
[PL, GS]
[GR, GL]
Metric for Common Subsequences Hypothesis

- attr-size[n] set: level of node in lattice

<table>
<thead>
<tr>
<th>Subseq size</th>
<th>Common subsequence</th>
<th>Percent attrs covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a, b, c, d, e</td>
<td>100%</td>
</tr>
<tr>
<td>2</td>
<td>ab, bc, be</td>
<td>80%</td>
</tr>
<tr>
<td>3</td>
<td>abc, abe</td>
<td>80%</td>
</tr>
</tbody>
</table>
Experiment: Applications Used

• Bookstore web application
  β 9,748 LOC, 385 methods, 11 classes
  β Front end: JSP, Backend: MySql
  β 123 user sessions

• uPortal application
  β 38,589 LOC, 4233 methods, 508 classes
  β Java, JSP, XML, J2EE
  β 2083 user sessions
Results for Common Subsequences Hypothesis

Percent of Attributes Covered

Attr-Size Set

Subsequence Size

Bookstore
Results for Common Subsequence Hypothesis

Result: subsequences of various sizes cover reasonable percent of attributes
Conclusions for Common Subsequences Hypothesis

• Between user sessions of a node there exists commonality in subsequences of URLs

• These common subsequences cover a reasonable percent of URLs (attributes) of the node

• Clustering based on single URLs
  ∝ clusters similar use cases
  ∝ can choose one object from each node
Next-to-bottom Coverage of Use Cases Hypothesis

In addition to covering all the URLs of the original test suite, the user sessions in *next-to-bottom* nodes execute a high percentage of the subsequences of URLs of the rest of the original test suite.

- **Reduced Set:** \{us2, us6\}
- **Remaining Set:** \{us1, us3, us4, us5\}

User sessions belonging to *next-to-bottom* nodes

All other user sessions except sessions belonging to *next-to-bottom* nodes
Results for Next-to-bottom Coverage of Use Cases Hypothesis

**Metric:** loss of coverage of use cases in remaining set by the reduced set

**Result:** short sequences present but long sequences are missing
Conclusion for Next-to-bottom Coverage of Use Cases Hypothesis

• Long sequences absent but smaller sequences are present in reduced set

• reduced set contains more URLs hence may contain other URL sequences absent in remaining set

• Moderately supports picking next-to-bottom nodes for reduced test suite
Pros and Cons of Our Approach

+ Results from common subsequences hypothesis support using concept analysis for clustering user sessions

+ Experiments show little coverage loss (tech report) by reduced test suite

- Results from next-to-bottom coverage of use cases hypothesis indicate further work needed on heuristic
Future Work

• Explore additional heuristics

• Additional user session analysis
  ß Useful for other software engineering tasks