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

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Motivation and Overview

View user sessions as use cases
Behaviorally related sequence of events performed by the user through interaction with the system

User session analysis
Test case generation

Clustering via concept analysis
Common subsequences analysis

Monitoring load of traffic
Content personalization
Test suite reduction
Software development/maintenance tools

Step 1
Clustering via Concept Analysis

• Mathematical technique for clustering objects that have common discrete attributes
• Set of objects, \( O \): user sessions, \( u \)
• Set of attributes, \( A \): URLs, \( u \)
• Relation, \( R \): \( u \) 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

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}

<table>
<thead>
<tr>
<th>us3</th>
<th>us6</th>
<th>Common Subsequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD</td>
<td>GD</td>
<td>(GD, GR, GL)</td>
</tr>
<tr>
<td>GR</td>
<td>GR</td>
<td>(PL, GS)</td>
</tr>
<tr>
<td>GL</td>
<td>PL</td>
<td>(GR, GL)</td>
</tr>
<tr>
<td>PL</td>
<td>GB</td>
<td>(PL, GS)</td>
</tr>
<tr>
<td>GS</td>
<td>PL</td>
<td>(GR, GL)</td>
</tr>
<tr>
<td>PL</td>
<td>GS</td>
<td>(GR, GL)</td>
</tr>
</tbody>
</table>

Common subsequences:
- [GD, GR, GL]
- [PL, GS]
- [GR, GL]

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

Common subsequences:
- [GD, GR, GL]
- [PL, GS]
- [GR, GL]

**Metric for Common Subsequences Hypothesis**

- attr-size[n] set: level of node in lattice
- attr-size[5]: level 5

<table>
<thead>
<tr>
<th>Sub seq 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>

**Results for Common Subsequence Hypothesis**

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

- **uPortal application**
  - 38,589 LOC, 4233 methods, 508 classes
  - Java, JSP, XML, J2EE
  - 2083 user sessions

**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.

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
  - Useful for other software engineering tasks