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

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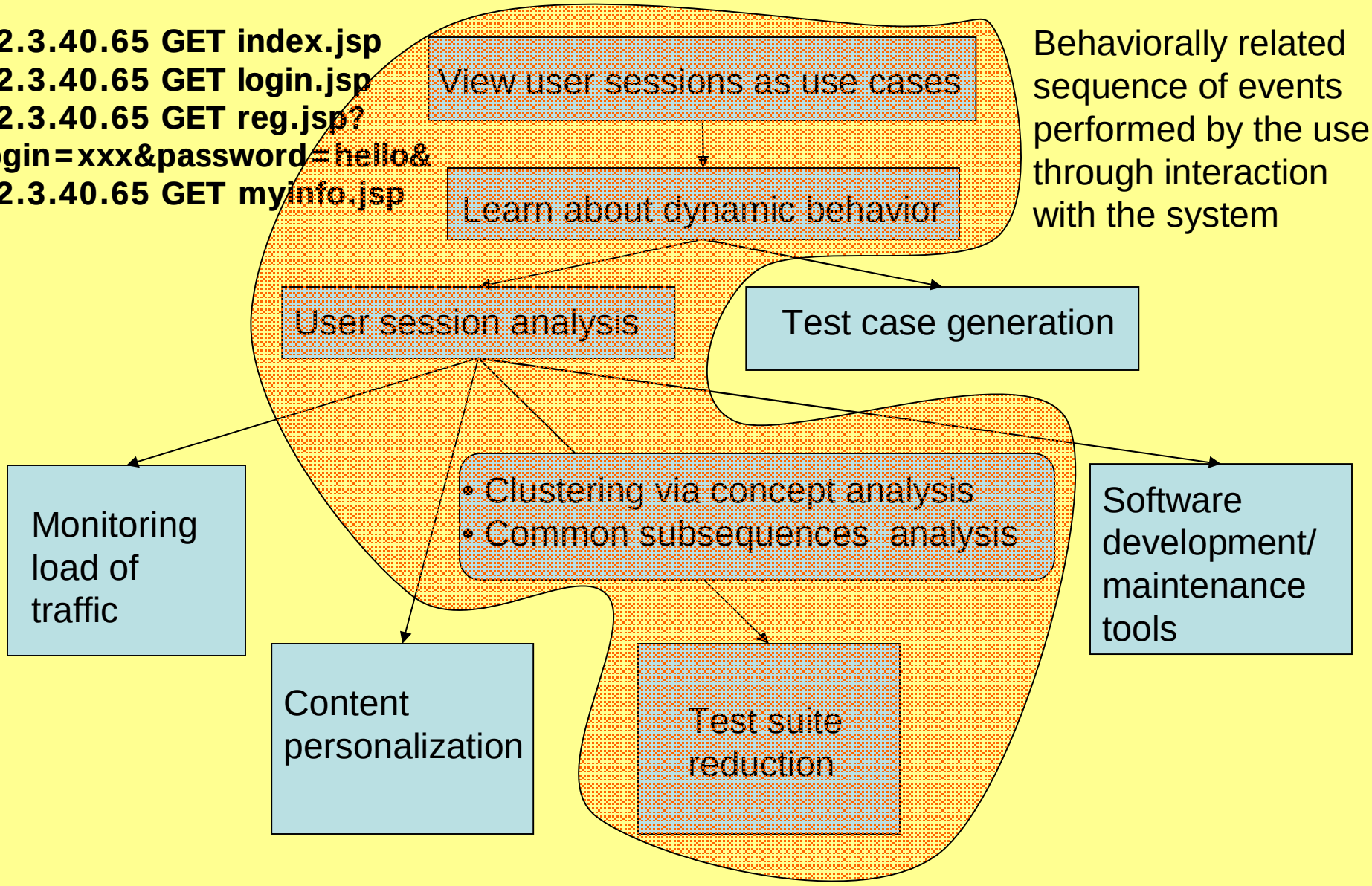
Workshop on Dynamic Analysis (WODA), May 25, 2004
co-located with
International Conference on Software Engineering (ICSE 2004)

Motivation and Overview

12.3.40.65 GET index.jsp
12.3.40.65 GET login.jsp
12.3.40.65 GET reg.jsp?
login=xxx&password=hello&
12.3.40.65 GET myinfo.jsp



Behaviorally related sequence of events performed by the user through interaction with the system

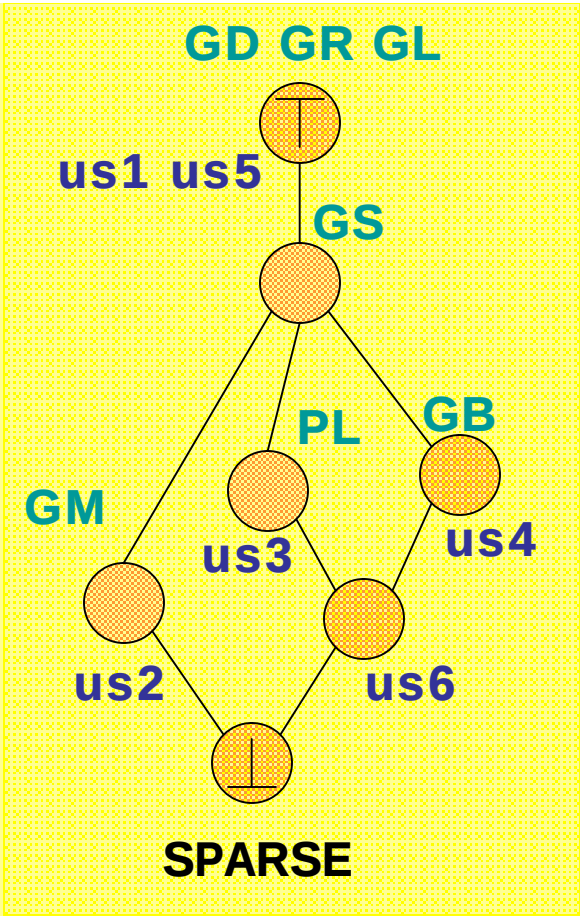
Step 1
Clustering via Concept Analysis

- 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)

RELATION TABLE attributes (URLs)

objects

	GD	GR	GL	PL	GS	GB	GM
us1	x	x	x				
us2	x	x	x		x		x
us3	x	x	x	x	x		
us4	x	x	x		x	x	
us5	x	x	x				
us6	x	x	x	x	x	x	



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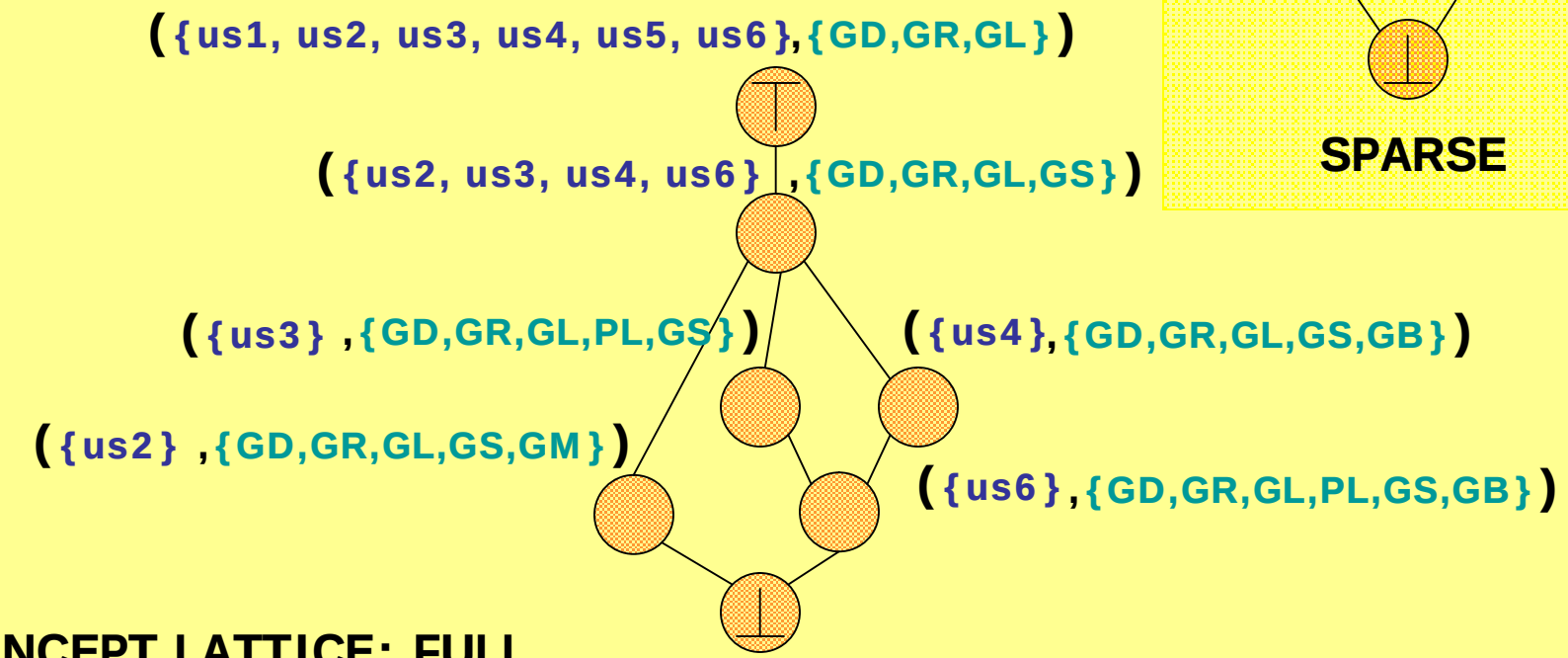
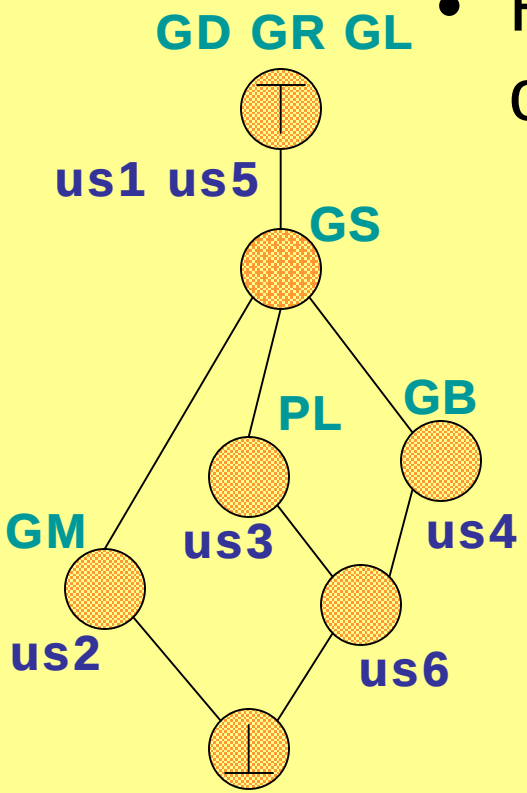


CONCEPT LATTICE: FULL

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

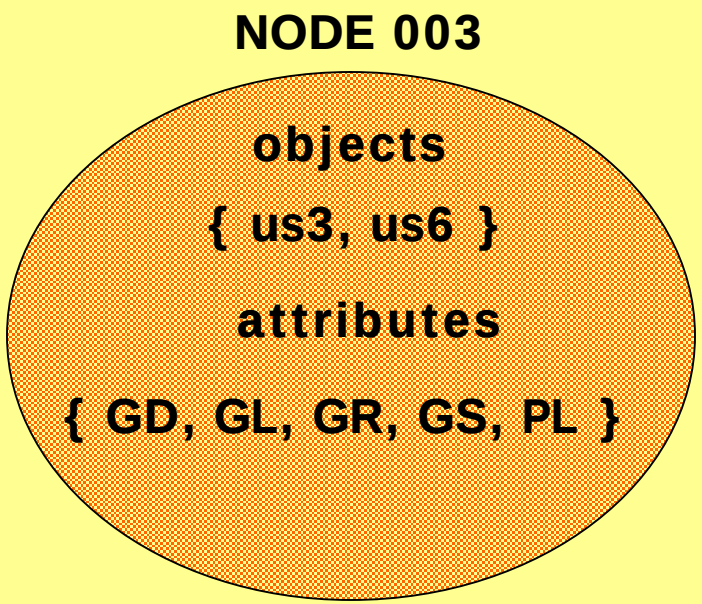
Resulting reduced test suite: {us2, us6}

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



us3	us6
GD	GD
GR	GR
GL	GL
PL	GB
GS	PL
PL	GS
GR	GR
GL	GL
PL	GB
GS	PL
	GS

Common Subsequences

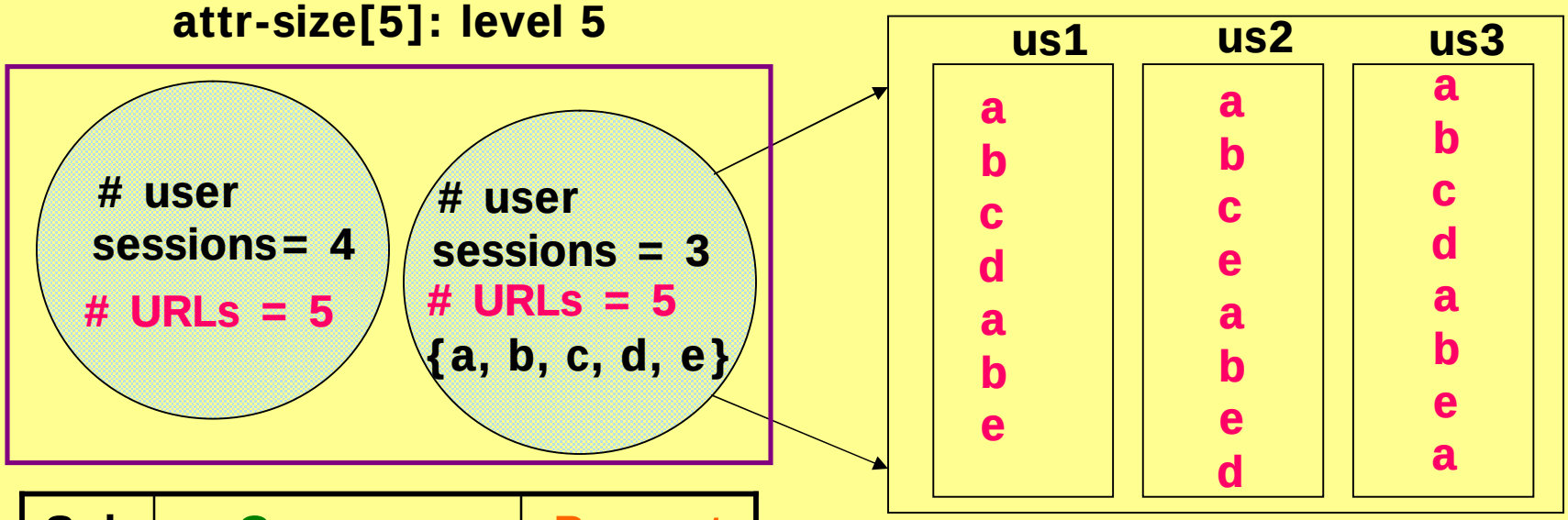
[GD, GR, GL]

[PL, GS]

[GR, GL]

Metric for Common Subsequences Hypothesis

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



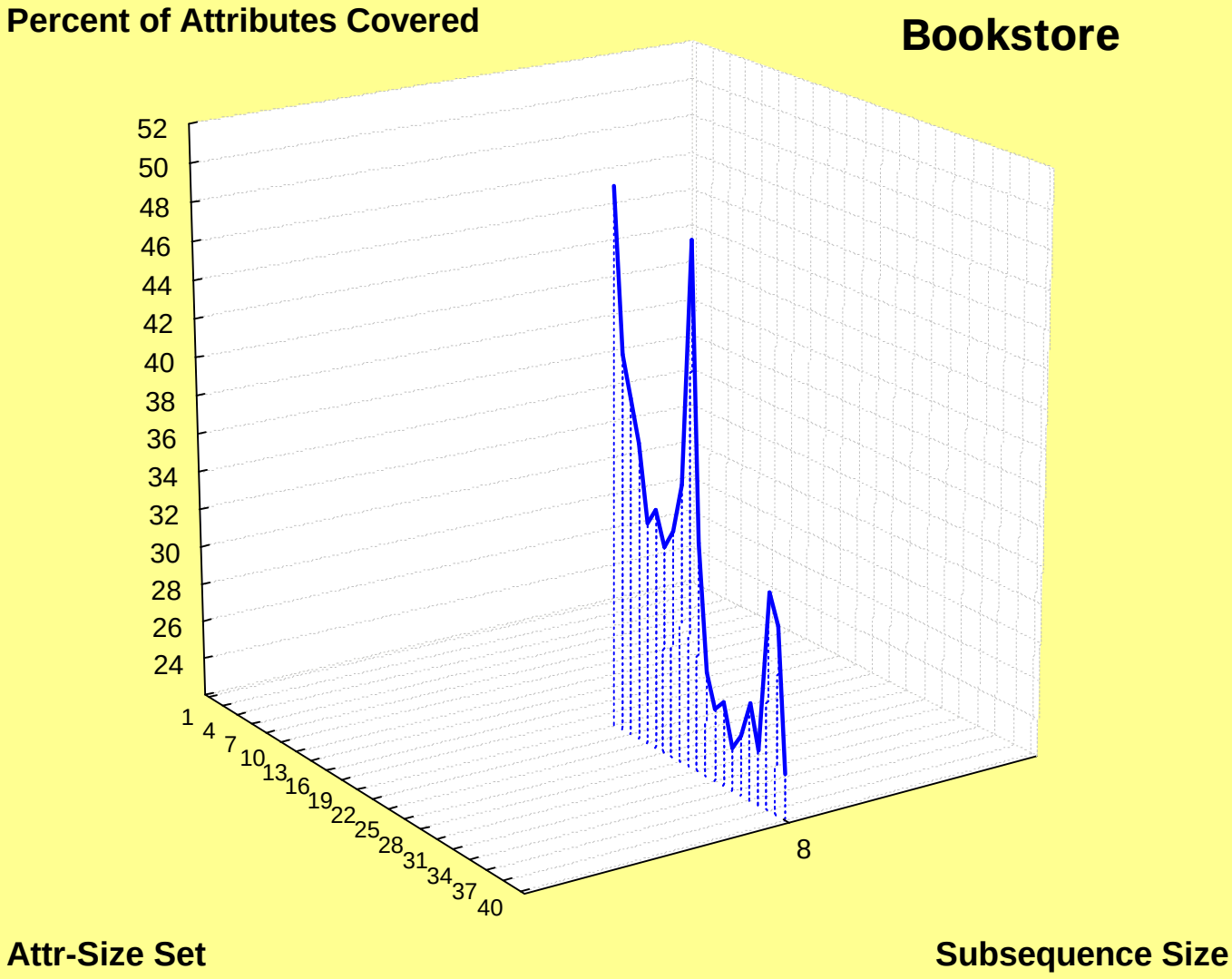
Sub seq size	Common subsequence	Percent attrs covered
1	a, b, c, d, e	100 %
2	ab, bc, be	80%
3	abc, abe	80%

Metric
Percent of attributes covered
by common subsequences
of URLs of various sizes

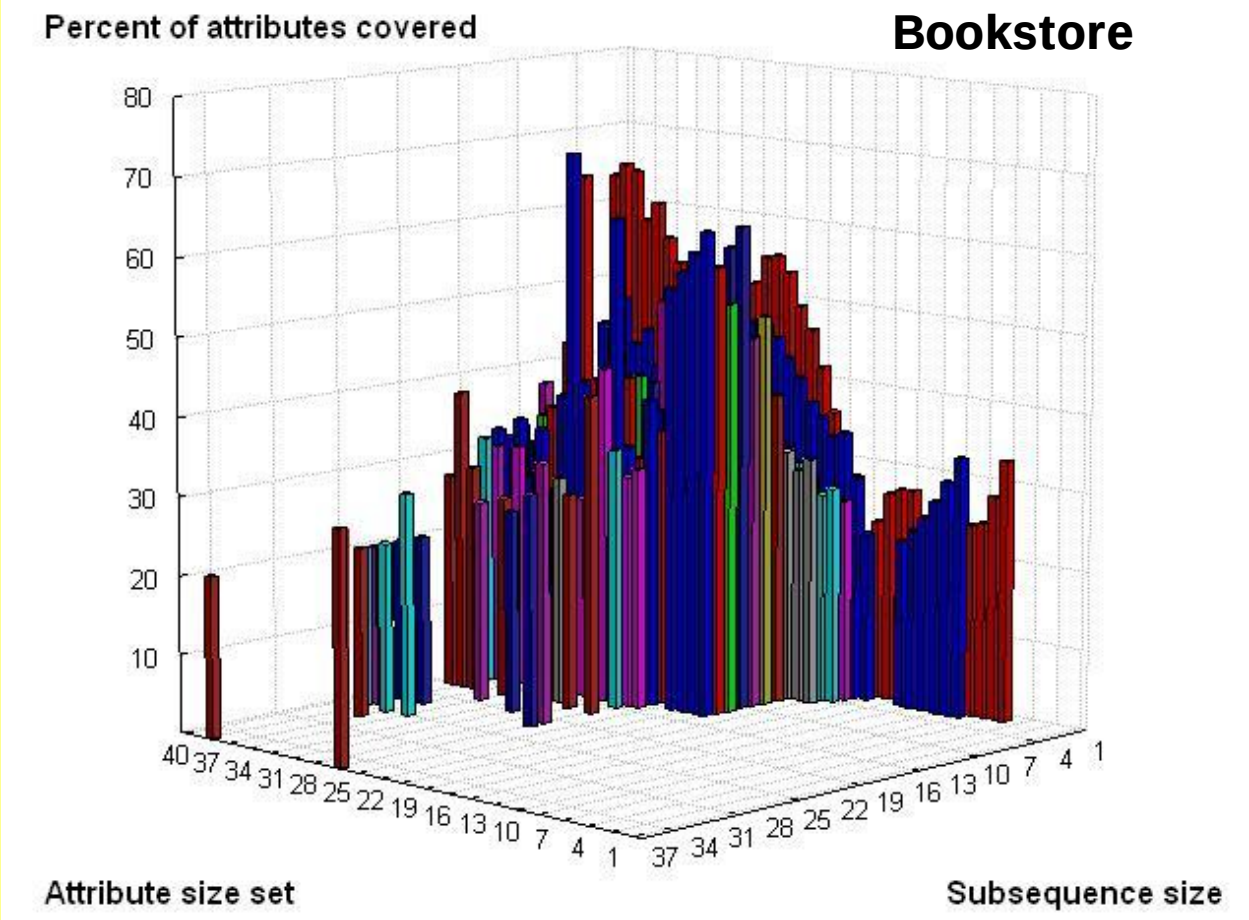
Experiment: Applications Used

- 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

Results for Common Subsequences Hypothesis



Results for Common Subsequence Hypothesis



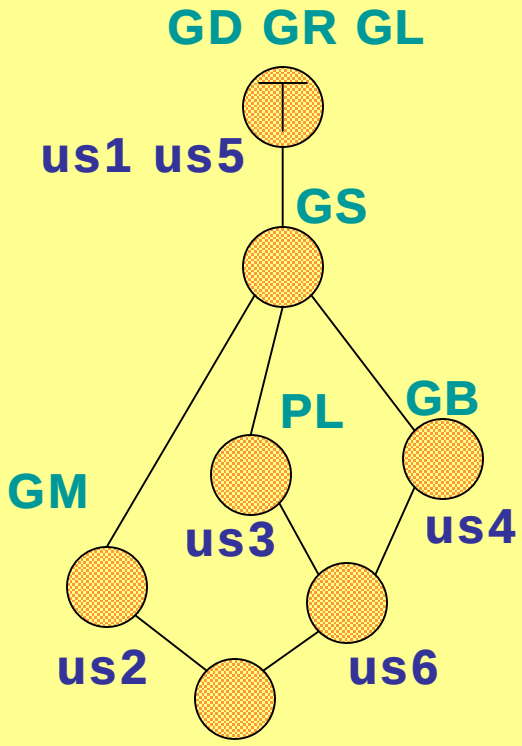
Result: subsequences of various sizes cover reasonable percent of attributes

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

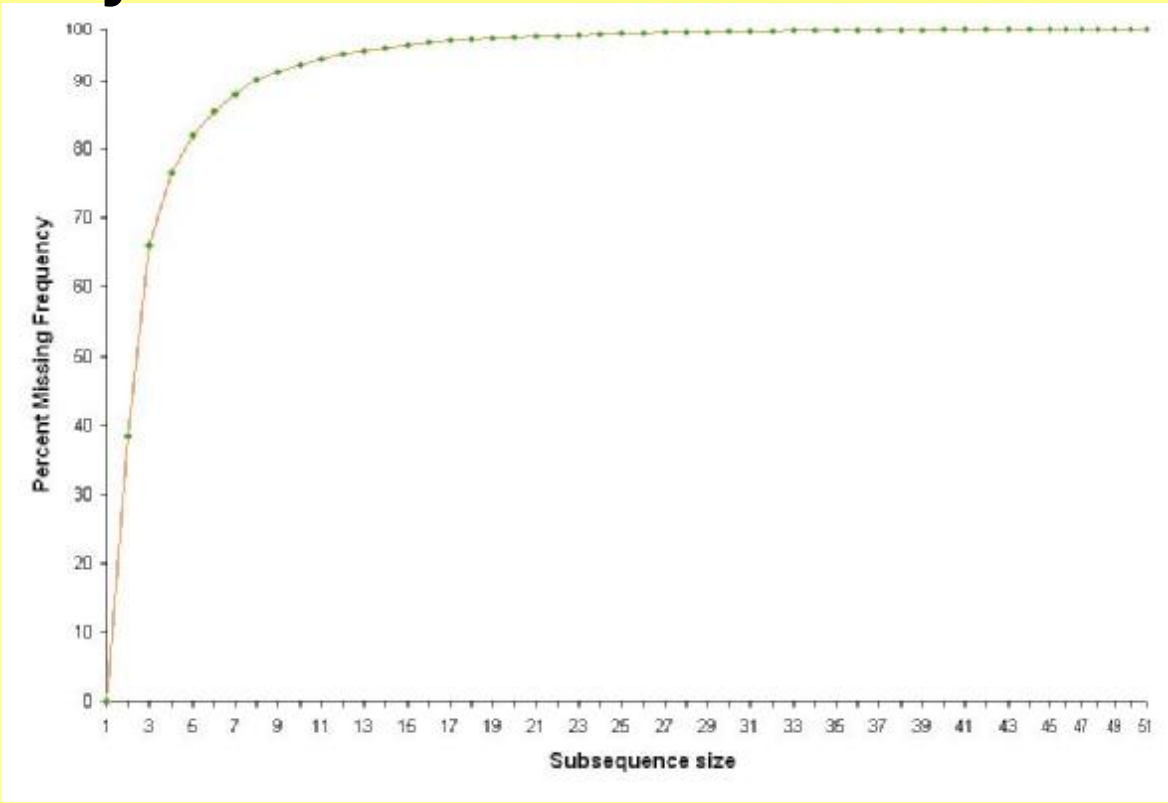


user sessions belonging to *next-to-bottom* nodes

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



Bookstore

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
  - Useful for other software engineering tasks