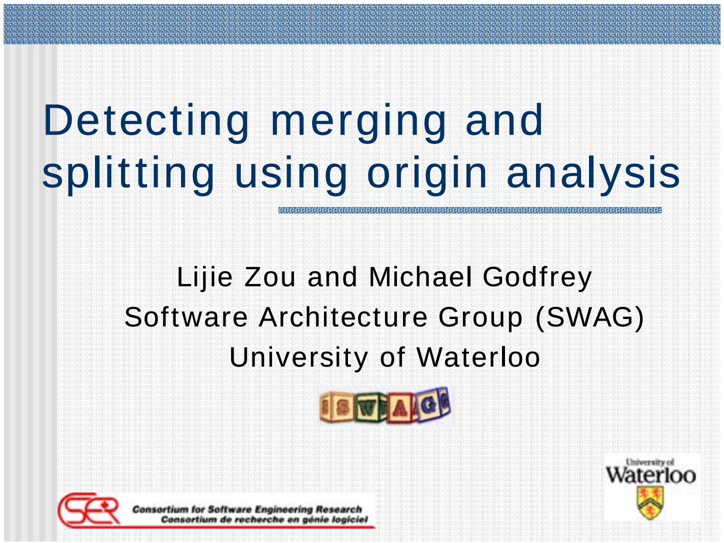

Detecting merging and splitting using origin analysis

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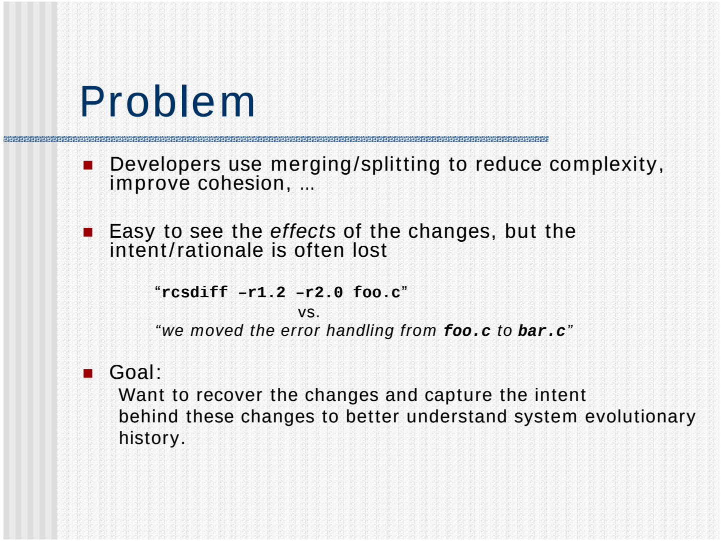
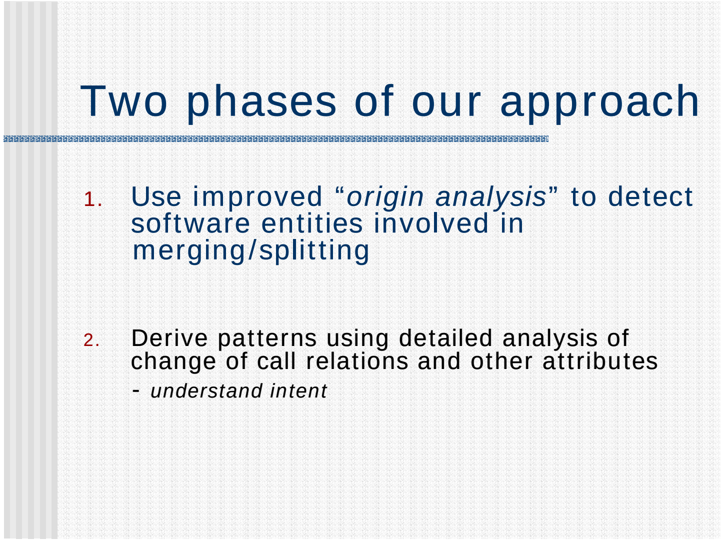


Problem

- Developers use merging/splitting to reduce complexity, improve cohesion, …
- Easy to see the *effects* of the changes, but the intent/rationale is often lost

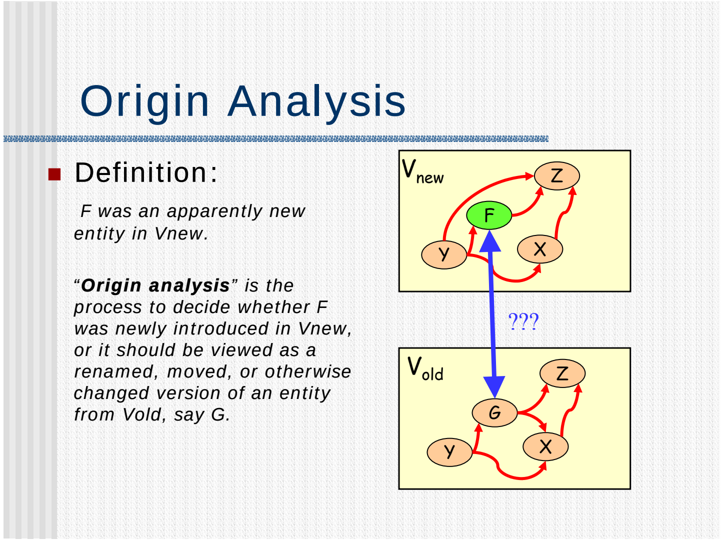
  “**rcsdiff –r1.2 –r2.0 foo.c**”
  vs.
  *“we moved the error handling from **foo.c** to **bar.c**”*

- Goal:
  Want to recover the changes and capture the intent behind these changes to better understand system evolutionary history.



Two phases of our approach

1. Use improved “*origin analysis*” to detect software entities involved in merging/splitting
2. Derive patterns using detailed analysis of change of call relations and other attributes
   - *understand intent*



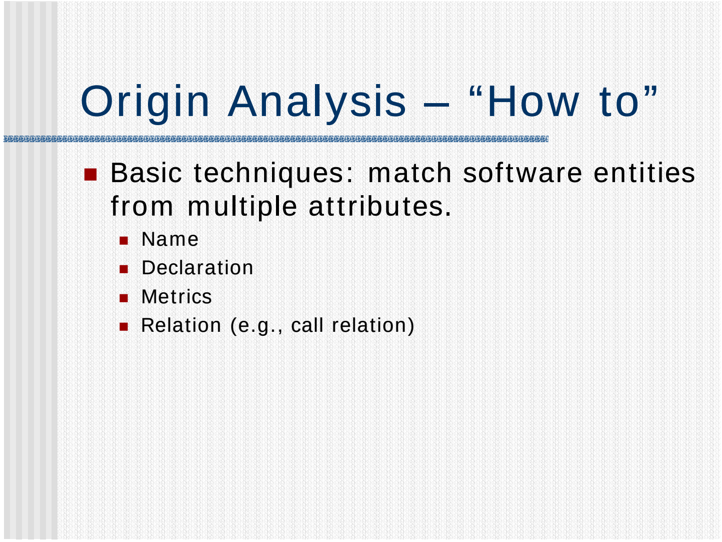
Origin Analysis

- Definition:

  F was an apparently new entity in Vnew.

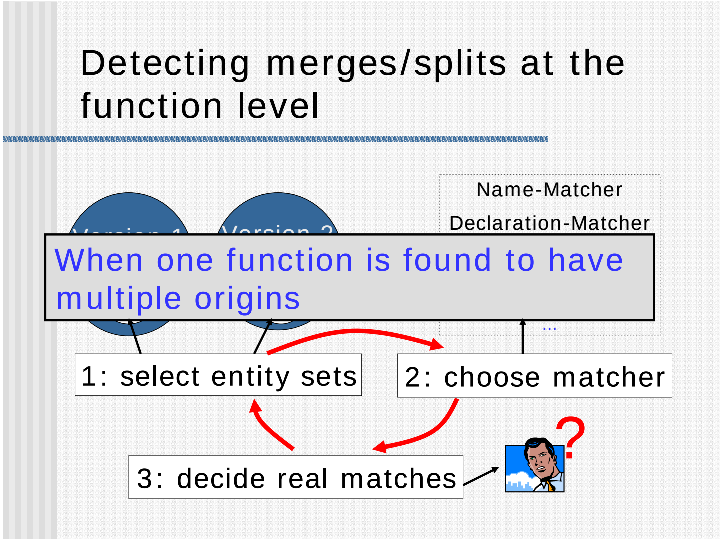
  *“**Origin analysis**” is the process to decide whether F was newly introduced in Vnew, or it should be viewed as a renamed, moved, or otherwise changed version of an entity from Vold, say G.*

V_{new}
Z
F
Y
X
???
V_{old}
Z
G
Y
X



Origin Analysis – “How to”

- Basic techniques: match software entities from multiple attributes.
  - Name
  - Declaration
  - Metrics
  - Relation (e.g., call relation)



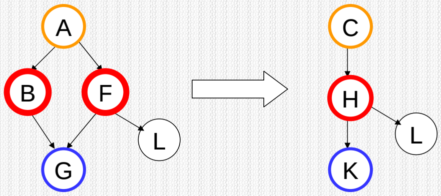
Detecting merges/splits at the function level

When one function is found to have multiple origins

Version 1
Version 2
Name-Matcher
Declaration-Matcher
…
1: select entity sets
2: choose matcher
3: decide real matches
?

Detecting **chained** merges/splits at the function level

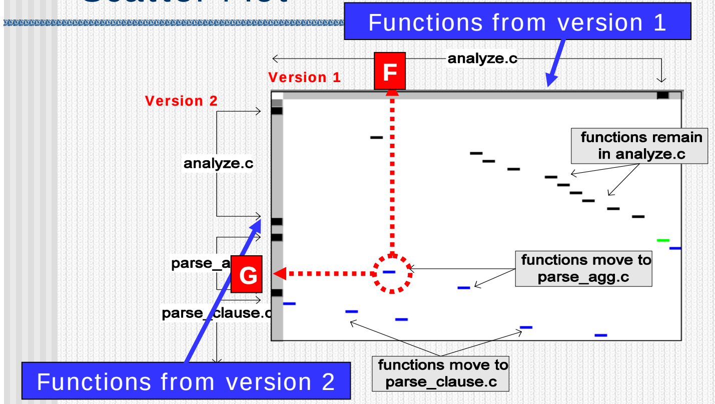
- Functions involved are interdependent
- Multiple iterations



Detecting merges/splits at the file level

- Manually
- File merge:
  - A new file G is found to be composed of most functions from two old files F1 and F2
- File split

Scatter Plot



Two phases of our approach

1. Use improved “*origin analysis*” to detect software entities involved in merging/splitting
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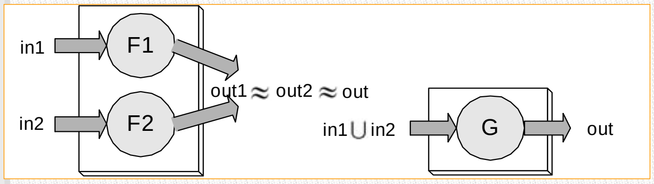
   - *understand intent*

Patterns

- Clone elimination
- Pipeline extraction
- Service consolidation
- Parameterization
- Partial clone elimination

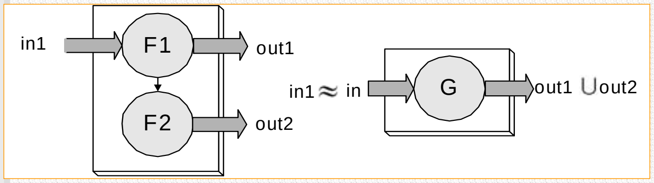
Pattern 1: clone elimination



F1, F2, G	: functions
in1,in2, in	: callers of F1, F2 or G
out1, out2, out	: callees of F1, F2 or G

1. out1 ≈ out2 ≈ out
2. in1∩in2 ≈ Ø , in1 U in2 ≈ in

Pattern 2: pipeline contraction



F1, F2, G	: functions
in1,in2, in	: callers of F1, F2 or G
out1, out2, out	: callees of F1, F2 or G

1. out1 U out2 ≈ out
2. in1 ≈ in

Pattern 3~5

- Service consolidation

  Two functions that perform different services, but are called at the same time by the same clients, are merged into a new, larger function
- Parameterization

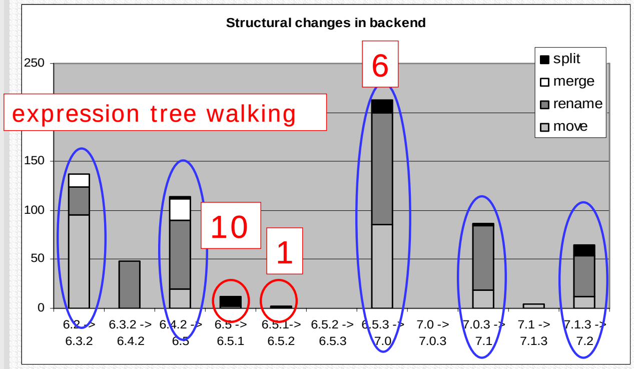
  Two similar functions F1 and F2 are combined into a new function G by adding a parameter to distinguish different functionalities
- Partial clone elimination

  A chunk of code found in F1 and F2 are clones. These clones are extracted out to form a new function G.

Case study - PostgreSQL

- OSS, ORDBMS, widespread used
  - 12 releases from v6.2 (Oct. 1997) to v7.2 (Feb. 2002)
- We looked at the backend subsystem
  - 70% of the codebase
  - KLOC: 186 -> 279, 10% / year
  - Functions: 3262 -> 4531

Overview of Structural changes in PostgreSQL



expression tree walking

6

10

1

Patterns

Pattern	# of instances	Examples
Clone elimination	7	getAttrName, get_attname -> get_attname
Service consolidation	1	Gettypelem, typtoout -> getTypeOutAndElem
Pipeline extraction	29	...
Parameterization	3	...
Partial clone elimination	27	...

Group of merges/splits

- Function level
  - 17 splits in 10 files (expression walker)
  - 6 splits in 4 files from 2 subsystems (to modify expression tree)
  - 4 splits in 4 files in subsystem access (callback mechanism)

  Scattered in different files and subsystems
- File Level
  - parser restructuring (6.2 -> 6.3.2)
  - cleaning up of optimizer subsystem (6.4.2 -> 6.5)

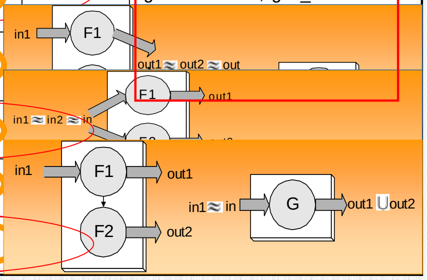
Summary & Future work

- Summary
  - Techniques and tool for detecting instances of merging and splitting
  - Merge/split patterns
- Future work
  - CVS log
  - Catalog of patterns

Questions?

Patterns

Pattern	# of instances	Examples
Clone elimination	7	getAttrName, get_attname
Service consolidation		
Pipeline extraction		
Parameterization		
Partial clone elimination		


in1
F1
out1 ≈ out2 ≈ out
in1 ≈ in2 ≈ in
F1
out1
in1
F1
out1
F2
out2
in1 ≈ in
G
out1 ∪ out2