A Criterion for Filtering Code Clone Related Bugs

Yasuhiro Hayase†, Yii Yong Lee, Katsuro Inoue†
Osaka University

†{y-hayase,inoue}@ist.osaka-u.ac.jp

Background

- Code Clone
  - a code fragment occurring more than once in identical or similar form into a software system
  - introduced in the source program because of various reasons such as reusing code by `copy-and-paste'
- Clone Pair

  a pair of code fragment that are identical or similar each other

Clone-Related Bugs

- Clone-Related Bug
  - Clones are often modified after copy-and-paste
  - Faults are possibly introduced through the modification.

- CP-Miner (Zhenmen Li *et al.*, 2007)
  - Detecting clone-related bugs
    - Find and present inconsistent renaming of identifier between clones
  - Problem
    - False-positives

      ➔ Propose a new criterion to filter out the false-positives

Brief Summary of CP-Miner

- Map identifier appearances between a clone pair
- Create renaming table between a clone pair
- Compute **UnchangedRatio (UR)**
  - Smaller UR except for 0 means that the renaming is suspicious.

Clone C1	Clone C2

… = b;
b++;
 	
for (p=0; p<10; p++) {
  x += p;
}
 	
a(x);
a(x);
	… = c;
	c++;
	
	for (q=0; q<10; q++) {
	  y += p;
	}
	
	a(x);
	a(z);

Leave unchanged

ID in C1	ID in C2	count	UR
a	a	2	1
b	c	2	0
p	p	1	0.25
	q	3	
x	x	1	0.20
	y	2	
	z	2	

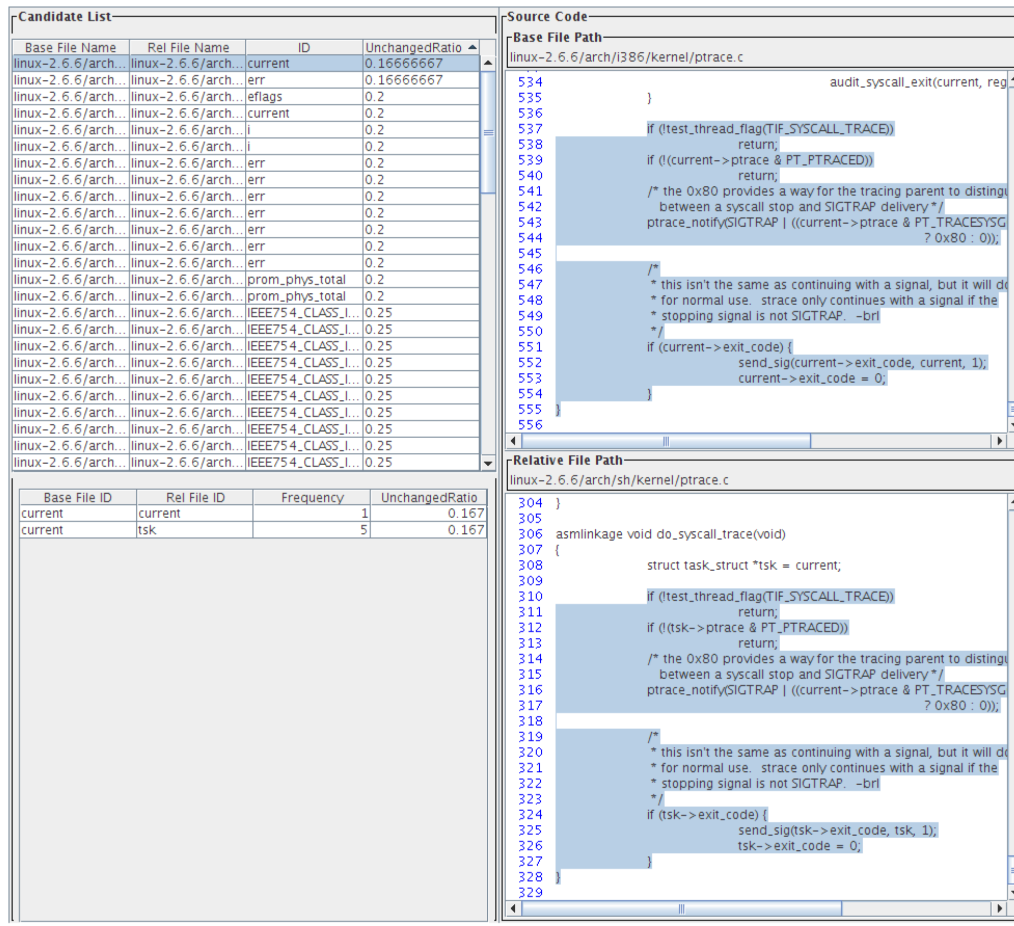
Our Approach: New Filtering Criterion

- **x** seems intentionally renamed to different symbols
- Criterion **Conflict** (**CF**)
  - true if the identifier mapped into two or more other identifiers
  - false otherwise

ID in C1	ID in C2	count	UR	CF
a	a	2	1	false
b	c	2	0	false
p	p	1	0.25	false
	q	3		
x	x	1	0.20	true
	y	2		
	z	2		

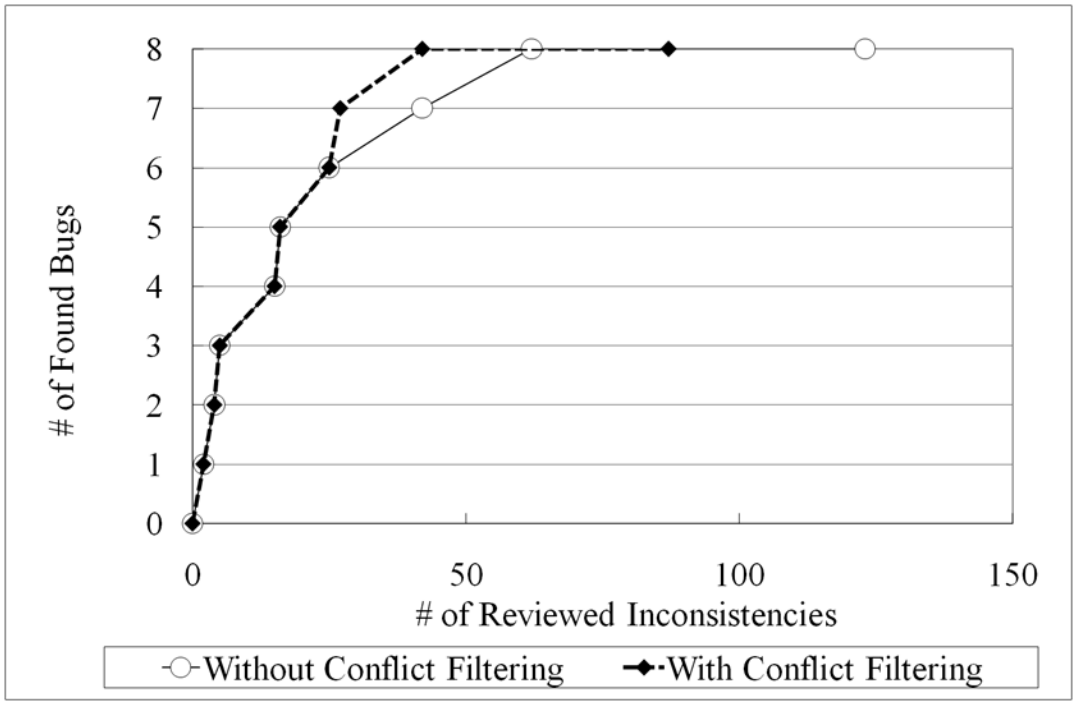
Implementation

- The filter using **Conflict** is implemented into clone-related bug detection system.
  - ▶ The system uses CCFinder



Evaluation

- An experiment was performed for evaluation
  - Target: arch module of Linux 2.6.6
  - Inconsistencies whose UnchangedRatio≦0.4 are reviewed in ascent order of UnchangedRatio
- Result
  - Reduce 27% of inconsistencies
  - Filter removes NO true-faults



Conclusion

- We proposed a criterion for filtering false-candidates detected by CP-Miner
  - The criterion recognizes the identifiers renamed to two or more names different from the original name
- The filter using the criterion is implemented into a clone-related bug detection system
- The filter reduces 27% of inconsistencies