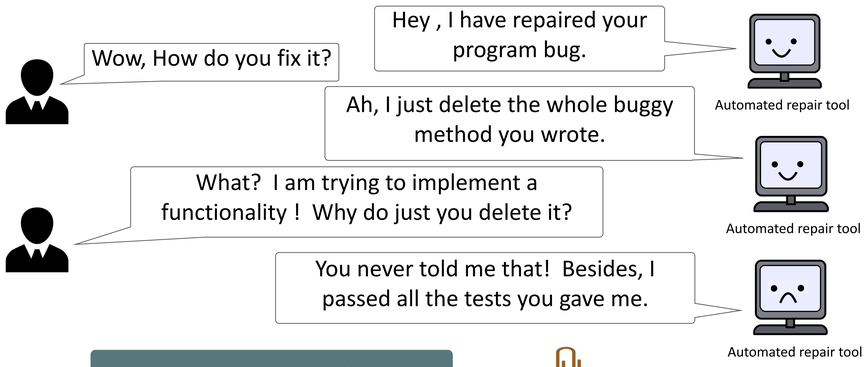
Anti-patterns for Java Automated Repair Tools

Yi Wu
11712738@mail.sustech.edu.cn
Southern University of Science and Technology
Automated Program RepaIr and MaintEnance Lab (A-PRIME)

SUSTech
Southern University of Science and Technology

PRIME A
Automated Program RepaIr and MaintEnance Lab (A-PRIME)

Motivation



Prior study has identified anti-patterns in C program repair. ***Do anti-patterns also exist in Java repair tools***?

Plausible patches are sufficient to pass the given tests but are incorrect beyond the test suite.

- Use test suites to specify the intended behavior of programs.
- Insufficient test cases cause Incomplete specification.
- Automated repair tools generate plausible patches.

solution : specify what not to do.

`Anti-pattern` — a set of forbidden transformations on programs

Anti-pattern Category

Anti-append Trivial Condition

SimFix for Defects4J Math80

```
- for (int k = 0; k < 4; k += step ) {
+ for (int k = 0; k < 0; k += step ) {
        final double tmp=work[i+k];
        …
```

If condition is always false

Anti-delete Control Statement

LSRepair for Defects4J Lang51

```
- if (str == "true") {return true; }
- if (str == null) {return false;}
- switch (str.length()) { … }
+ return !(arg0.startsWith("(") && arg0.endsWith(")"));
```

Delete if and switch statements

Anti-append Early Exit

Observed running behavior of jGenProg2 for Defects4J Math73

```
   double yInitial = f.value(initial);
+  return result;
   if (…){ … }
```

Insert early return

Prevalence of Anti-patterns

- Manually analyzed plausible patches generated by SimFix, CapGen, and LSRepair, shown in Table1 below.
- Difference of anti-pattern distribution is due to the distinct repair strategies of the Java repair tools

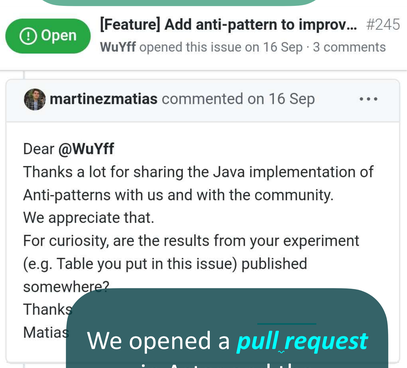
Table 1: Proportion of Anti-patterns

	Total number of plausible patches inspected	Anti-append trivial condition		Anti-delete Control Statement		Anti-append early exit
		Insert contradiction	Insert tautology	Delete if-statement	Delete loop	Insert early return/exit
SimFix	22	8.33%	0	0	0	0
CapGen	219	10.0%	1.83%	0	0	0
LSRepair	484	0	0	64.87%	19.63%	2.48%

*SimFix has only 22 plausible patches available on GitHub)

Anti-pattern exists despite advancement of technique in Java repair tools.

Integrated in ***jGenProg2(Astor)*** to check if anti-patterns generalize across Java repair tools.

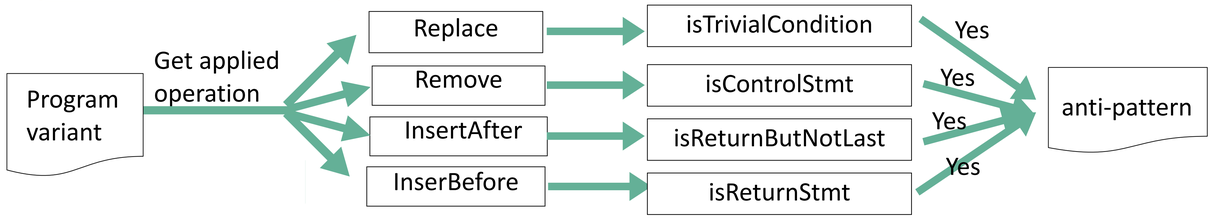


We opened a ***pull request*** in Astor and the implementation has been ***merged*** by the developers. Click to see!

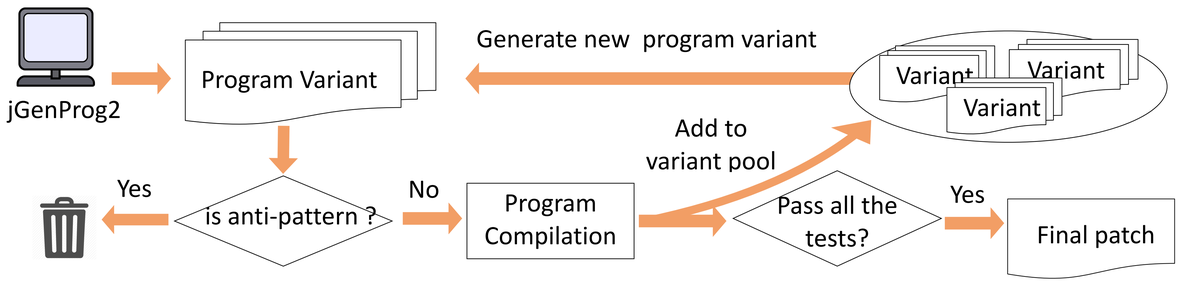
GitHub

Integrating Anti-patterns

Checking for anti-pattern



Anti-pattern in evolution



Experiment

- Focus on the 29 Defect4J bugs where original jGenProg2 generates patches.
- Run jGenProg2 on each bug up to 20 times with different seeds.
- Recorded the first run jGenProg2 produced any patches.

Results

- Successfully generated patches for 14 bugs with original jGenProg2
- For the 14 bugs:
  - The average repair time is reduced by 22.6 %.
  - The number of generated plausible patches is reduced from 67 to 29 in total.

Potential New Anti-patterns

Control loop condition by irrelevant variable

```
  for (int i = 0; i < j; i += 4) {
-     for (int k = 0; k < 4; k +=
+     for (int k = 0; n < 4; k +=
```

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