

# Software Testing

## CS6367

Mid-Term Presentation

Group 4

Yatin M Prakash

Tejal Bagade



**Basic Idea**

# Augment PIT Testing Tool

To increase the rate of non-equivalent bugs to be killed, adding additional mutators to existing PIT tool.

- ❖ **ROR**
  - Replaces the relational operators with another one. It applies every replacement, e.g.,  $<$  becomes  $\geq$ , or  $>$  becomes  $\leq$ .
- ❖ **AOR**
  - Replaces an arithmetic expression by another one.  $a + b$  becomes  $a * b$ .
- ❖ **AOD**
  - Replaces an arithmetic expression by one of the operand, e.g.,  $a + b$  becomes  $a$ .



Design

# AOR

OPERATOR	MUTANTS				
+	-	x	/	%	
-	x	/	%	+	
x	/	%	+	-	
/	%	+	-	x	
%	+	-	x	/	

# ROR

OPERATOR	MUTANTS					
<	<=	>	>=	==	!=	
<=	>	>=	==	!=	<	
>	>=	==	!=	<	<=	
>=	==	!=	<	<=	>	
==	!=	<	<=	>	>=	
!=	<	<=	>	>=	==	

# AOD

$a + b$	$a$
$a + b$	$b$

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**Implementation**



# Sample Execution

```
788 2. negated conditional → KILLED
      3. negated conditional → KILLED
787 1. changed conditional boundary → SURVIVED
      2. negated conditional → KILLED
793 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::parseStringToSet to ( if (x != null) null else throw new
      RuntimeException ) → KILLED
809 1. negated conditional → KILLED
818 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
814 1. negated conditional → KILLED
815 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
821 1. negated conditional → KILLED
822 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
829 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
832 1. negated conditional → KILLED
      2. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
843 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
852 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
      1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getExposedHeaders to ( if (x != null) null else throw new
861 RuntimeException ) → KILLED
878 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
879 1. replaced return of long value with value + 1 for org/ebaysf/web/cors/CORSFilter::getPreflightMaxAge → KILLED
889 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getAllowedOrigins to ( if (x != null) null else throw new
      RuntimeException ) → KILLED
898 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getAllowedHttpMethods to ( if (x != null) null else throw new
      RuntimeException ) → KILLED
907 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getAllowedHttpHeaders to ( if (x != null) null else throw new
      RuntimeException ) → KILLED
```

## Active mutators

- INCREMENTS\_MUTATOR
- VOID\_METHOD\_CALL\_MUTATOR
- RETURN\_VALS\_MUTATOR
- MATH\_MUTATOR
- NEGATE\_CONDITIONALS\_MUTATOR
- INVERT\_NEGS\_MUTATOR
- CONDITIONALS\_BOUNDARY\_MUTATOR

```
5. CHANGED_EQ_TO_LT → KILLED
6. negated conditional → KILLED
822 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
829 1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
832 1. negated conditional → KILLED
      2. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
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889 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getAllowedOrigins to ( if (x != null) null else throw new
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898 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getAllowedHttpMethods to ( if (x != null) null else throw new
      RuntimeException ) → KILLED
907 1. mutated return of Object value for org/ebaysf/web/cors/CORSFilter::getAllowedHttpHeaders to ( if (x != null) null else throw new
      RuntimeException ) → KILLED
```

## Active mutators

- CONDITIONALS\_BOUNDARY\_MUTATOR4
- CONDITIONALS\_BOUNDARY\_MUTATOR3
- CONDITIONALS\_BOUNDARY\_MUTATOR2
- CONDITIONALS\_BOUNDARY\_MUTATOR1
- RETURN\_VALS\_MUTATOR
- OPERATOR\_REPLACEMENT\_MUTATOR
- INVERT\_NEGS\_MUTATOR
- CONDITIONALS\_BOUNDARY\_MUTATOR
- MATH\_MUTATOR3
- MATH\_MUTATOR4
- INCREMENTS\_MUTATOR
- VOID\_METHOD\_CALL\_MUTATOR
- MATH\_MUTATOR
- NEGATE\_CONDITIONALS\_MUTATOR
- MATH\_MUTATOR1
- MATH\_MUTATOR2

# Pitest by Hcoles

## Pit Test Coverage Report

### Project Summary

Number of Classes	Line Coverage	Mutation Coverage
1	100% <div><div>306/307</div></div>	84% <div><div>118/141</div></div>

### Breakdown by Package

Name	Number of Classes	Line Coverage	Mutation Coverage
<a href="#">org.cbaysf.web.cors</a>	1	100% <div><div>306/307</div></div>	84% <div><div>118/141</div></div>

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Report generated by [PIT](#) 1.3.2

## Augmented Pitest

## Pit Test Coverage Report

### Project Summary

Number of Classes	Line Coverage	Mutation Coverage
1	100% <div><div>306/307</div></div>	77% <div><div>258/337</div></div>

### Breakdown by Package

Name	Number of Classes	Line Coverage	Mutation Coverage
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# Challenges & Problems faced

## Issue:

- ❖ Converting the augmented Pitest to a jar file throws stderr.

## Solutions:

- ❖ Skip test suites during jar file creation.
- ❖ Add additional test suites for the new mutators.

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Progress  
&  
Plan

# Future Enhancements

## ❖ ***Operator ADD OR swap***

- Replaces the operators '&&' by '||' and '||' by '&&', for example, a&&b becomes a||b

## ❖ ***Unary operator position replacement***

- Replaces a variable with a pre- unary operator with post- unary operator, for example ++a becomes a++.

## ❖ ***Variable replacement with negative***

- Replaces a constant variables with its negation, for example, a becomes -a.

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# Contributions

## **Main Contribution made by members**

Yatin:

- 1] Understanding the working of pitest on github projects
- 2] ROR Mutators
- 3] Selecting 3 github projects for testing purpose
- 4] AOD Mutators

Tejal:

- 1] Understanding the purpose and how to use maven
- 2] AOR Mutators
- 3] Selecting 2 github projects for testing purpose



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# References

# References

1. H. Coles. 2017. "PIT." Retrieved from <http://pitest.org/>
2. Coles, Henry, Thomas Laurent, Christopher Henard, Mike Papadakis, and Anthony Ventresque. "PIT: a practical mutation testing tool for Java." In Proceedings of the 25th International Symposium on Software Testing and Analysis, pp. 449-452. ACM, 2016.

**Thank you**

**To Dr. Lingming Zhang  
and Ali Ghanbari**