Code Coverage is Evil!

Andy Muir

@andrewcmuir

muirandy

String Reverser

IntelliJ IDEA File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help 100% Thu 9 Jul 21:28 Andy Muir

EvilCodeCoverage – StringReverserTest.java

PalindromeTest.java | BowlingGameTest.java | StringReverserTest.java

```java
package com.github.muirandy.evil;

import org.junit.Test;

import static org.junit.jupiter.api.Assertions.assertEquals;

public class StringReverserTest {
    @Test
    public void single() {
        StringReverser stringReverser = new StringReverser();

        String result = stringReverser.reverse("o");

        assertEquals("o", result);
    }
}
```

Palindrome.java | BowlingGame.java | StringReverser.java

```java
package com.github.muirandy.evil;

public class StringReverser {
    public String reverse(String input) {
        return input;
    }
}
```

Run: StringReverserTest

Tests passed: 1 of 1 test – 7 ms

StringReverserTest (com.github.muirand 7 ms
single 7 ms

```
/Users/andy/.sdkman/candidates/java/11.0.6.hs-adpt/bin/java ...
---- IntelliJ IDEA coverage runner ----
tracing and tracking per test coverage ...
include patterns:
com\.github\.muirandy\.evil\..*
exclude patterns:
Class transformation time: 0.015245274s for 501 classes or 3.042968862275449E-5s per class

Process finished with exit code 0
```

Tests passed: 1 (moments ago) 15:6 LF UTF-8 master 4 spaces

IntelliJ IDEA File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help 100% Thu 9 Jul 21:27 Andy Muir

EvilCodeCoverage – StringReverser.java

StringReverserTest Git:

PalindromeTest.java | BowlingGameTest.java | StringReverserTest.java

```java
import static org.junit.jupiter.api.Assertions.assertEquals;

public class StringReverserTest {

    private StringReverser stringReverser = new StringReverser();

    @Test
    public void single() {
        String result = stringReverser.reverse("o");

        assertEquals("o", result);
    }

    @Test
    public void twoChars() {
        String result = stringReverser.reverse("ab");

        assertEquals("ba", result);
    }
}
```

Palindrome.java | BowlingGame.java | StringReverser.java

```java
package com.github.muirandy.evil;

import org.apache.commons.lang3.StringUtils;

public class StringReverser {
    public String reverse(String input) {
        if (input.length() < 2)
            return input;

        String result = StringUtils.reverse(input);

        return result;
    }
}
```

Run: StringReverserTest

Tests passed: 2 of 2 tests – 11 ms

- StringReverserTest (com.github.muiran 11 ms
  - single 7 ms
  - twoChars 4 ms

```
/Users/andy/.sdkman/candidates/java/11.0.6.hs-adpt/bin/java ...
---- IntelliJ IDEA coverage runner ----
tracing and tracking per test coverage ...
include patterns:
com\.github\.muirandy\.evil\..*
exclude patterns:
Class transformation time: 0.017623097s for 503 classes or 3.503597813121272E-5s per class

Process finished with exit code 0
```

Tests passed: 2 (moments ago) 7:32 LF UTF-8 master 4 spaces

Chrome File Edit View History Bookmarks People Tab Window Help 100% Thu 9 Jul 21:33 Andy Muir
STAMP-project/pitest-desc | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | index.html | index.html
File | /Users/Shared/Code/EvilCodeCoverage/target/report/202007092133/index.html
Apps localhost iOS Apple Firebase Google AWS WordPress Flutter QNAP Kafka GitHub Trains BBC Amazon Apple Experis LH BBC Emulator Jobs

Pit Test Coverage Report

Project Summary

Number of Classes	Line Coverage		Mutation Coverage	
3	100%	36/36	84%	492/583

Breakdown by Package

Name	Number of Classes	Line Coverage		Mutation Coverage	
com.github.muirandy.evil	3	100%	36/36	84%	492/583

Report generated by PIT 1.5.1

Chrome File Edit View History Bookmarks People Tab Window Help 100% Thu 9 Jul 21:34 Andy Muir
STAMP-project/pitest-desc | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | index.html | index.html
File | /Users/Shared/Code/EvilCodeCoverage/target/report/202007092133/com.github.muirandy.evil/index.html
Apps localhost iOS Apple Firebase Google AWS WordPress Flutter QNAP Kafka GitHub Trains BBC Amazon Apple Experis LH BBC Emulator Jobs

Pit Test Coverage Report

Package Summary

com.github.muirandy.evil

Number of Classes	Line Coverage		Mutation Coverage	
3	100%	36/36	84%	492/583

Breakdown by Class

Name	Line Coverage		Mutation Coverage	
BowlingGame.java	100%	24/24	89%	410/460
Palindrome.java	100%	7/7	67%	67/100
StringReverser.java	100%	5/5	65%	15/23

Report generated by PIT 1.5.1

Chrome File Edit View History Bookmarks People Tab Window Help 100% Thu 9 Jul 21:34 Andy Muir
STAMP-project/pitest-desc | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | index.html | StringReverser.java.html
File | /Users/Shared/Code/EvilCodeCoverage/target/report/202007092133/com.github.muirandy.evil/StringReverser.java.html
Apps localhost iOS Apple Firebase Google AWS WordPress Flutter QNAP Kafka GitHub Trains BBC Amazon Apple Experis LH BBC Emulator Jobs

StringReverser.java

```
1      package com.github.muirandy.evil;
2
3      import org.apache.commons.lang3.StringUtils;
4
5      public class StringReverser {
6          public String reverse(String input) {
7  17          if (input.length() < 2)
8  2               return input;
9
10 2           String result = StringUtils.reverse(input);
11
12 2           return result;
13         }
14     }
```

Mutations

```
       1. changed conditional boundary → KILLED
       2. Substituted 2 with 3 → KILLED
       3. negated conditional → KILLED
       4. removed call to java/lang/String::length → KILLED
       5. removed conditional - replaced comparison check with false → SURVIVED
       6. removed conditional - replaced comparison check with true → KILLED
       7. Substituted 2 with 1 → SURVIVED
       8. Substituted 2 with 0 → SURVIVED
7      9. Substituted 2 with -1 → SURVIVED
       10. Substituted 2 with -2 → SURVIVED
       11. Substituted 2 with 3 → KILLED
       12. Substituted 2 with 1 → SURVIVED
       13. greater or equal to less than → KILLED
       14. greater or equal to less or equal → SURVIVED
       15. greater or equal to greater than → KILLED
       16. greater or equal to equal → SURVIVED
       17. greater or equal to not equal → KILLED
8      1. replaced return value with "" for com/github/muirandy/evil/StringReverser::reverse → KILLED
       2. mutated return of Object value for com/github/muirandy/evil/StringReverser::reverse to ( if (x != null) null else throw new RuntimeException ) → KILLED
10     1. replaced call to org/apache/commons/lang3/StringUtils::reverse with argument → KILLED
       2. removed call to org/apache/commons/lang3/StringUtils::reverse → KILLED
12     1. replaced return value with "" for com/github/muirandy/evil/StringReverser::reverse → KILLED
       2. mutated return of Object value for com/github/muirandy/evil/StringReverser::reverse to ( if (x != null) null else throw new RuntimeException ) → KILLED
```

Active mutators

- ABS_MUTATOR
- AOD_1_MUTATOR

Chrome File Edit View History Bookmarks People Tab Window Help 100% Thu 9 Jul 21:35 Andy Muir
STAMP-project/pitest-desc | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | localhost:63342/EvilCodeC | index.html | StringReverser.java.html
File | /Users/Shared/Code/EvilCodeCoverage/target/report/202007092133/com.github.muirandy.evil/StringReverser.java.html
Apps localhost iOS Apple Firebase Google AWS WordPress Flutter QNAP Kafka GitHub Trains BBC Amazon Apple Experis LH BBC Emulator Jobs

Active mutators

- ABS_MUTATOR
- AOD_1_MUTATOR
- AOD_2_MUTATOR
- AOR_1_MUTATOR
- AOR_2_MUTATOR
- AOR_3_MUTATOR
- AOR_4_MUTATOR
- ARGUMENT_PROPAGATION_MUTATOR
- BOOLEAN_FALSE_RETURN
- BOOLEAN_TRUE_RETURN
- CONDITIONALS_BOUNDARY_MUTATOR
- CONSTRUCTOR_CALL_MUTATOR
- CRCR_1_MUTATOR
- CRCR_2_MUTATOR
- CRCR_3_MUTATOR
- CRCR_4_MUTATOR
- CRCR_5_MUTATOR
- CRCR_6_MUTATOR
- EMPTY_RETURN_VALUES
- EXPERIMENTAL_BIGINTEGER_MUTATOR
- EXPERIMENTAL_MEMBER_VARIABLE_MUTATOR
- EXPERIMENTAL_REMOVE_SWITCH_MUTATOR_[0-99]
- EXPERIMENTAL_SWITCH_MUTATOR
- INCREMENTS_MUTATOR
- INLINE_CONSTANT_MUTATOR
- INVERT_NEGS_MUTATOR
- MATH_MUTATOR
- NAKED_RECEIVER
- NEGATE_CONDITIONALS_MUTATOR
- NON_VOID_METHOD_CALL_MUTATOR
- NULL_RETURN_VALUES
- OBBN_1_MUTATOR
- OBBN_2_MUTATOR
- OBBN_3_MUTATOR
- PRIMITIVE_RETURN_VALS_MUTATOR
- REMOVE_CONDITIONALS_EQUAL_ELSE_MUTATOR
- REMOVE_CONDITIONALS_EQUAL_IF_MUTATOR
- REMOVE_CONDITIONALS_ORDER_ELSE_MUTATOR
- REMOVE_CONDITIONALS_ORDER_IF_MUTATOR
- REMOVE_INCREMENTS_MUTATOR
- RETURN_VALS_MUTATOR
- ROR_1_MUTATOR
- ROR_2_MUTATOR
- ROR_3_MUTATOR
- ROR_4_MUTATOR
- ROR_5_MUTATOR
- UOI_1_MUTATOR
- UOI_2_MUTATOR
- UOI_3_MUTATOR
- UOI_4_MUTATOR
- VOID_METHOD_CALL_MUTATOR

Tests examined

Palindromes

IntelliJ IDEA File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help

EvilCodeCoverage – Palindrome.java

PalindromeTest.java | BowlingGameTest.java | StringReverserTest.java

```java
package com.github.muirandy.evil;

import org.junit.Test;

import static org.junit.Assert.assertTrue;

public class PalindromeTest {

    private Palindrome palindrome = new Palindrome();

    @Test
    public void zeroLength() {
        assertTrue(palindrome.isPalindrome(""));
    }

}
```

Palindrome.java | BowlingGame.java | StringReverser.java

```java
package com.github.muirandy.evil;

public class Palindrome {
    public boolean isPalindrome(String inputString) {
        return true;
    }
}
```

Run: PalindromeTest

Tests passed: 1 of 1 test – 1 ms

PalindromeTest (com.github.muirandy.ev 1 ms
zeroLength 1 ms

```
/Users/andy/.sdkman/candidates/java/11.0.6.hs-adpt/bin/java ...
---- IntelliJ IDEA coverage runner ----
sampling ...
include patterns:
com\.github\.muirandy\.evil\..*
exclude patterns:
Class transformation time: 0.013188383s for 487 classes or 2.7080868583162217E-5s per class

Process finished with exit code 0
```

Tests passed: 1 (moments ago) 5:21 LF UTF-8 master 4 spaces

IntelliJ IDEA File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help 100% Thu 9 Jul 21:44 Andy Muir

EvilCodeCoverage – PalindromeTest.java

PalindromeTest.java | BowlingGameTest.java | StringReverserTest.java

```java
import static org.junit.Assert.assertFalse;
import static org.junit.Assert.assertTrue;

public class PalindromeTest {

    private Palindrome palindrome = new Palindrome();

    @Test
    public void palindromes() {
        assertTrue(palindrome.isPalindrome(""));
        assertTrue(palindrome.isPalindrome("f"));
    }

    @Test
    public void nonPalindromes() {
        assertFalse(palindrome.isPalindrome("fd"));
    }
}
```

Palindrome.java | BowlingGame.java | StringReverser.java

```java
package com.github.muirandy.evil;

public class Palindrome {
    public boolean isPalindrome(String inputString) {
        if (inputString.length() < 2)
            return true;
        return false;
    }
}
```

Run: PalindromeTest

Tests passed: 2 of 2 tests – 2 ms

- PalindromeTest (com.github.muirandy.ev 2 ms
  - palindromes 2 ms
  - nonPalindromes 0 ms

```
/Users/andy/.sdkman/candidates/java/11.0.6.hs-adpt/bin/java ...
---- IntelliJ IDEA coverage runner ----
sampling ...
include patterns:
com\.github\.muirandy\.evil\..*
exclude patterns:
Class transformation time: 0.013244447s for 483 classes or 2.7421215320910974E-5s per class

Process finished with exit code 0
```

Tests passed: 2 (moments ago) 18:10 LF UTF-8 master 4 spaces

IntelliJ IDEA File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help

Thu 9 Jul 21:45 Andy Muir

EvilCodeCoverage – Palindrome.java

PalindromeTest.java | BowlingGameTest.java | StringReverserTest.java

```java
import static org.junit.Assert.assertFalse;
import static org.junit.Assert.assertTrue;

public class PalindromeTest {

    private Palindrome palindrome = new Palindrome();

    @Test
    public void palindromes() {
        assertTrue(palindrome.isPalindrome(""));
        assertTrue(palindrome.isPalindrome("f"));
        assertTrue(palindrome.isPalindrome("ff"));
    }

    @Test
    public void nonPalindromes() {
        assertFalse(palindrome.isPalindrome("fd"));
    }
}
```

Palindrome.java | BowlingGame.java | StringReverser.java

```java
package com.github.muirandy.evil;

public class Palindrome {
    public boolean isPalindrome(String inputString) {
        if (inputString.length() < 2)
            return true;
        else {
            char firstChar = inputString.charAt(0);
            char lastChar = inputString.charAt(inputString.length() - 1);
            String mid = inputString.substring(1, inputString.length() - 1);
            return (firstChar == lastChar) && isPalindrome(mid);
        }
    }
}
```

Run: PalindromeTest

Tests passed: 2 of 2 tests – 1 ms

- PalindromeTest (com.github.muirandy.ev 1 ms
  - palindromes 1 ms
  - nonPalindromes 0 ms

```
/Users/andy/.sdkman/candidates/java/11.0.6.hs-adpt/bin/java ...
---- IntelliJ IDEA coverage runner ----
sampling ...
include patterns:
com\.github\.muirandy\.evil\..*
exclude patterns:
Class transformation time: 0.015124069s for 487 classes or 3.105558316221766E-5s per class

Process finished with exit code 0
```

Tests passed: 2 (moments ago)

15:1 LF UTF-8 master 4 spaces

Chrome File Edit View History Bookmarks People Tab Window Help 100% Thu 9 Jul 21:47 Andy Muir

File | /Users/Shared/Code/EvilCodeCoverage/target/report/202007092146/com.github.muirandy.evil/Palindrome.java.html

Apps localhost iOS Apple Firebase Google AWS WordPress Flutter QNAP Kafka GitHub Trains BBC Amazon Apple Experis LH Emulator Jobs

```
1   package com.github.muirandy.evil;
2
3   public class Palindrome {
4       public boolean isPalindrome(String inputString) {
5 17        if (inputString.length() < 2)
6 8             return true;
7           else {
8 6             char firstChar = inputString.charAt(0);
9 15            char lastChar = inputString.charAt(inputString.length() - 1);
10 22           String mid = inputString.substring(1, inputString.length() - 1);
11 40           return (firstChar == lastChar) && isPalindrome(mid);
12          }
13      }
14  }
```

Mutations

```
    1. changed conditional boundary → KILLED
    2. Substituted 2 with 3 → KILLED
    3. negated conditional → KILLED
    4. removed call to java/lang/String::length → KILLED
    5. removed conditional - replaced comparison check with false → KILLED
    6. removed conditional - replaced comparison check with true → KILLED
    7. Substituted 2 with 1 → KILLED
    8. Substituted 2 with 0 → KILLED
5   9. Substituted 2 with -1 → KILLED
    10. Substituted 2 with -2 → KILLED
    11. Substituted 2 with 3 → KILLED
    12. Substituted 2 with 1 → KILLED
    13. greater or equal to less than → KILLED
    14. greater or equal to less or equal → KILLED
    15. greater or equal to greater than → KILLED
    16. greater or equal to equal → SURVIVED
    17. greater or equal to not equal → KILLED
    1. replaced boolean return with false for com/github/muirandy/evil/Palindrome::isPalindrome → KILLED
    2. Substituted 1 with 0 → KILLED
    3. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
    4. Substituted 1 with 0 → KILLED
6   5. Substituted 1 with -1 → SURVIVED
    6. Substituted 1 with -1 → SURVIVED
    2. removed call to org/apache/commons/lang3/StringUtils::reverse → KILLED
    1. replaced return value with "" for com/github/muirandy/evil/StringReverser::reverse → KILLED
12  2. mutated return of Object value for com/github/muirandy/evil/StringReverser::reverse to ( if (x != null) null else throw new RuntimeException ) → KILLED
```

Active mutators

- ABS_MUTATOR
- AOD_1_MUTATOR