ASSESSING TEST QUALITY USING MUTATION ANALYSIS

Presenter: Ali Parsai
Advisors: Prof. Serge Demeyer
Quinten D. Soetens

Vrije Universiteit Brussel

Universiteit Antwerpen

PROBLEM

PROBLEM

PROBLEM

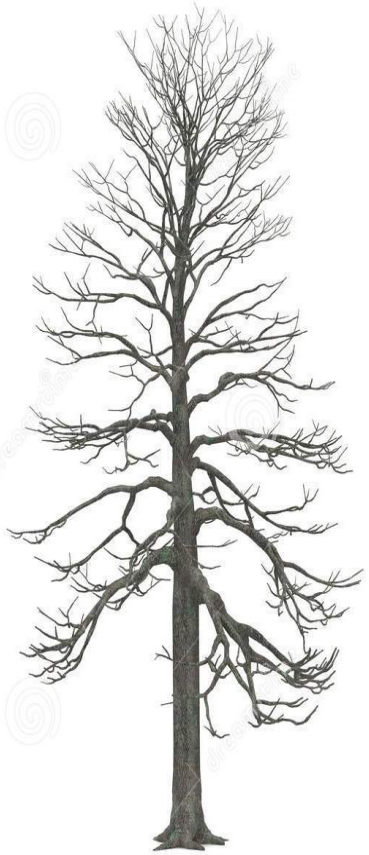
PROBLEM

PROBLEM

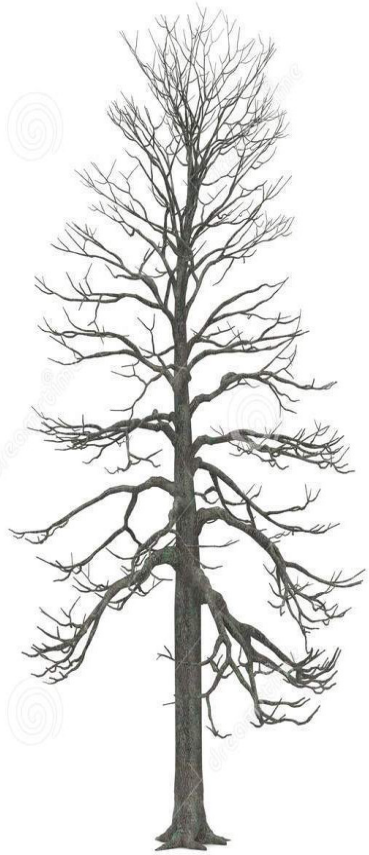
SOLUTION

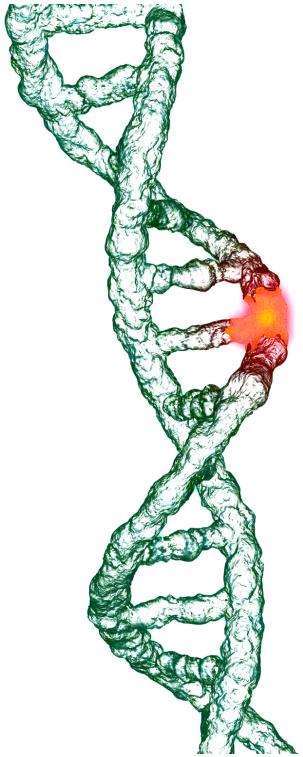
Branch Coverage

SOLUTION



Branch Coverage

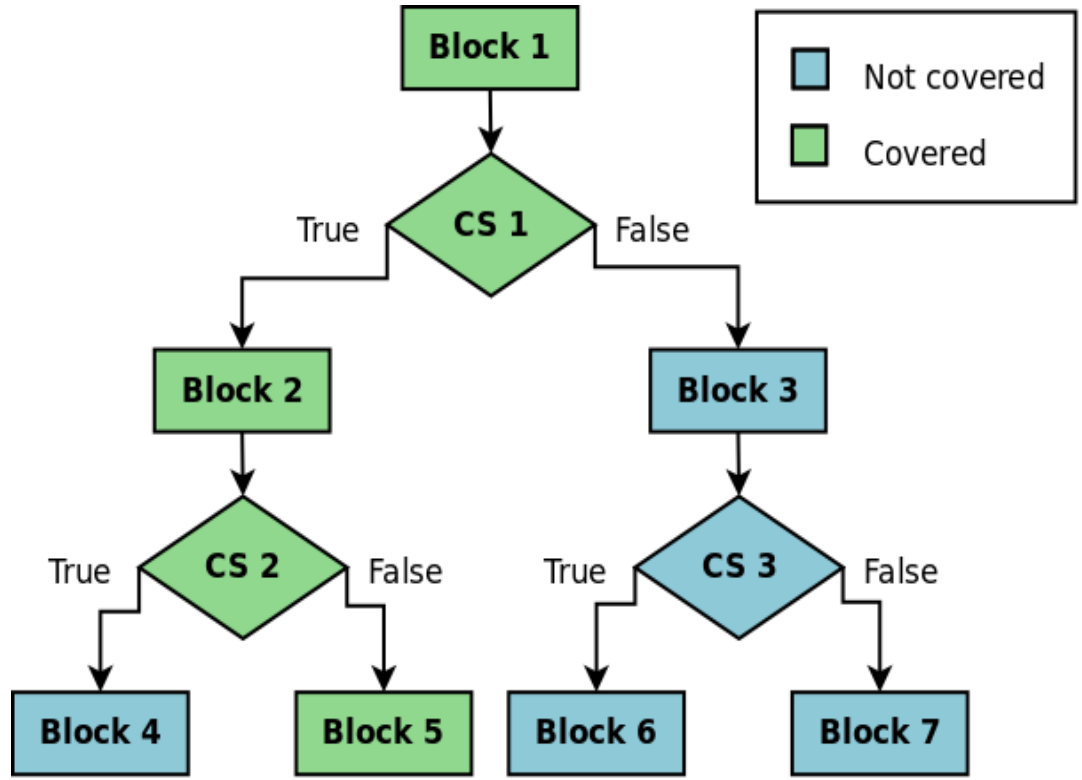


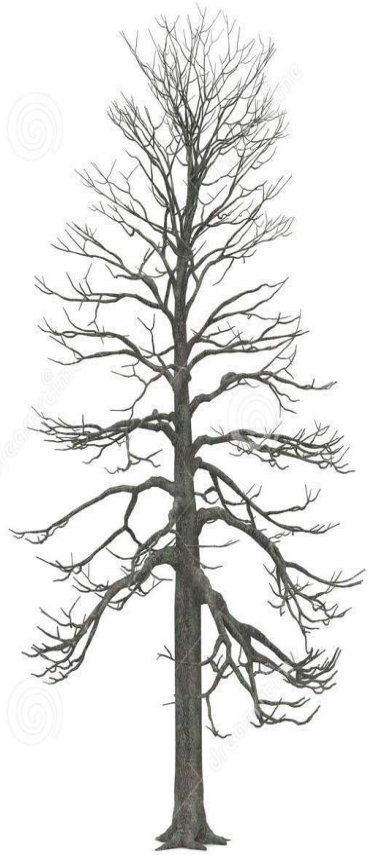


SOLUTION

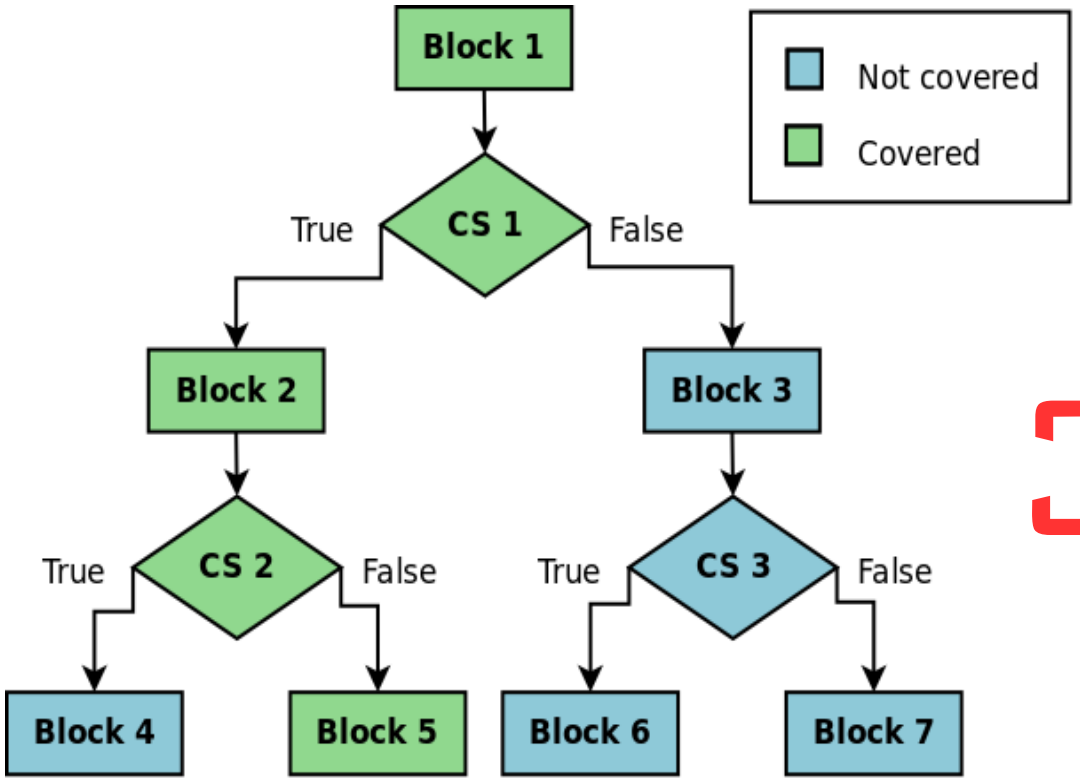
Mutation Coverage

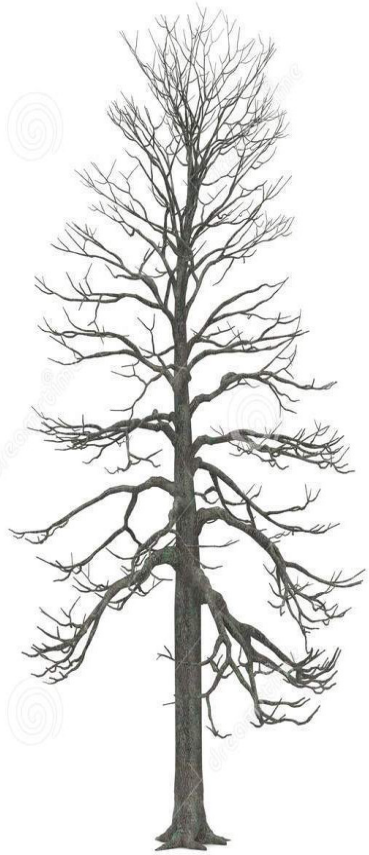
Branch Coverage





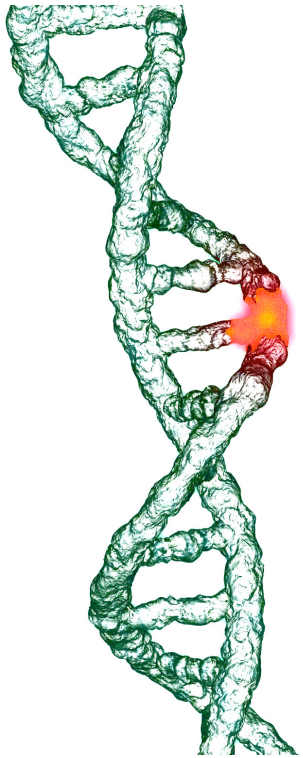
Branch Coverage





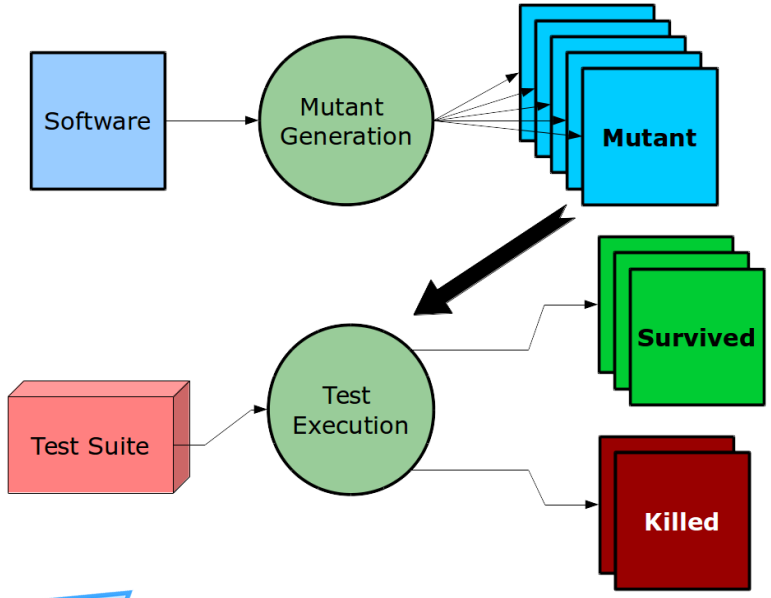
33%

EXAMPLE

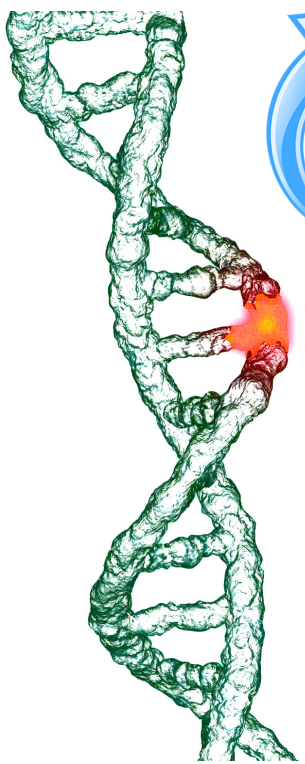


PROCESS

Mutation Coverage

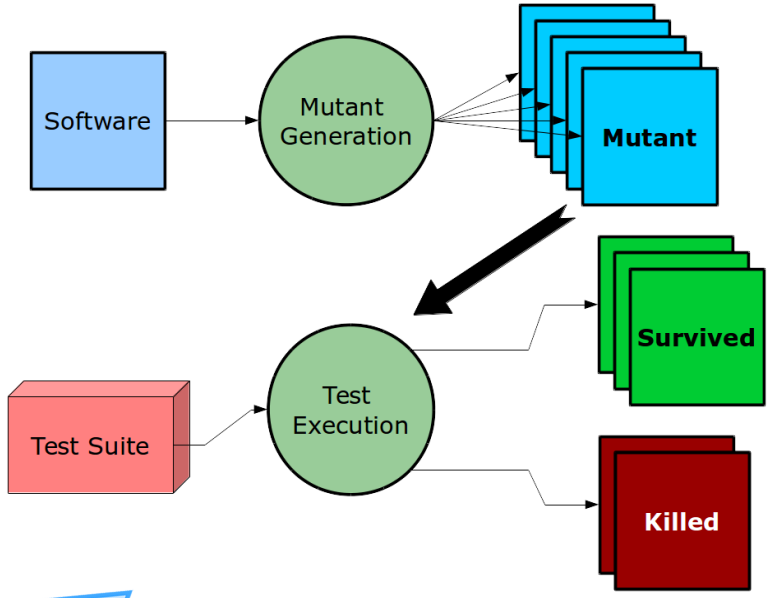


EXAMPLE



PROCESS

Mutation Coverage

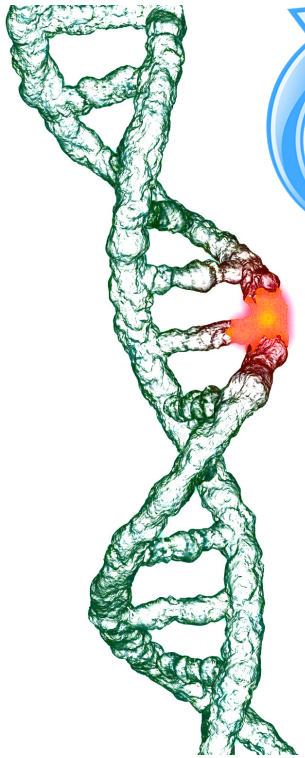


EXAMPLE

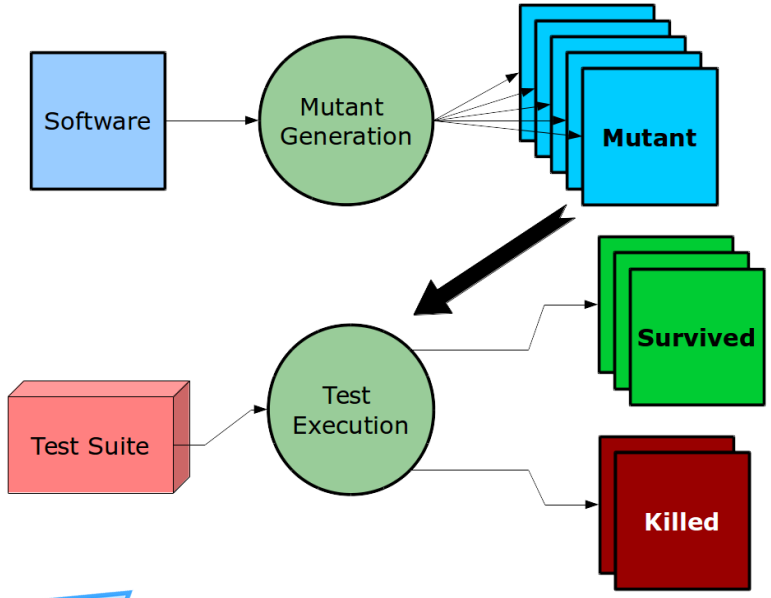
```
if ( x > 0 && y <= 0) x++;
```

```
if ( x <= 0 && y <= 0) x++;
if ( x > 0 && y > 0) x++;
if ( x > 0 || y <= 0) x++;
if ( x > 0 && y <= 0) x--;
```

PROCESS



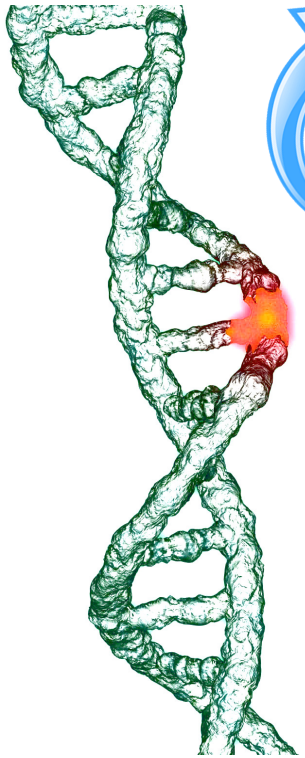
Mutation Coverage



EXAMPLE

```
if ( x > 0 && y <= 0) x++;
```

```
if ( x <= 0 && y <= 0) x++;
if ( x > 0 && y > 0) x++;
if ( x > 0 || y <= 0) x++;
if ( x > 0 && y <= 0) x--;
```



PROCESS

75%

Mutation Coverage

Little
DARWIN

Works on Java source code

Works on Java source code

Works regardless of build system and testing framework

LITTLEDARWIN PROJECT REPORT

Project Summary

Number of Files	Mutation Coverage
26	62.0 295/476

Breakdown by File

Name	Mutation Coverage
../main/java/com/addthis/codec/binary/BufferIn.java	0.0 0/2
../main/java/com/addthis/codec/binary/BufferOut.java	0.0 0/2
../main/java/com/addthis/codec/binary/CodecBin2.java	86.4 89/103
../main/java/com/addthis/codec/config/ConfigNodeCursor.java	81.2 13/16
../main/java/com/addthis/codec/config/ConfigTraversingParser.java	53.3 16/30
../main/java/com/addthis/codec/config/Configs.java	32.6 14/43
../main/java/com/addthis/codec/jackson/CaseIgnoringEnumDeserializer.java	28.6 2/7
../main/java/com/addthis/codec/jackson/CodecBeanDeserializer.java	60.0 6/10
../main/java/com/addthis/codec/jackson/CodecBeanDeserializerModifier.java	50.0 2/4
../main/java/com/addthis/codec/jackson/CodecDeserializers.java	50.0 1/2
../main/java/com/addthis/codec/jackson/CodecIntrospector.java	100.0 14/14
../main/java/com/addthis/codec/jackson/CodecJackson.java	80.0 4/5
../main/java/com/addthis/codec/jackson/CodecTypeDeserializer.java	76.9 20/26
../main/java/com/addthis/codec/jackson/CodecTypeIdResolver.java	42.9 3/7
../main/java/com/addthis/codec/jackson/CodecTypeResolverBuilder.java	100.0 3/3
../main/java/com/addthis/codec/jackson/IndexReportingObjectArrayDeserializer.java	80.0 8/10
../main/java/com/addthis/codec/jackson/Jackson.java	21.7 5/23
../main/java/com/addthis/codec/jackson/KeyReportingMapDeserializer.java	21.9 7/32
../main/java/com/addthis/codec/jackson/MissingPropertyException.java	100.0 1/1
../main/java/com/addthis/codec/jackson/UnderscorePropertyIgnorer.java	100.0 1/1
../main/java/com/addthis/codec/plugins/PluginMap.java	93.1 27/29
../main/java/com/addthis/codec/plugins/PluginRegistry.java	33.3 1/3
../main/java/com/addthis/codec/plugins/Plugins.java	0.0 0/1
../main/java/com/addthis/codec/reflection/CodableClassInfo.java	69.2 9/13
../main/java/com/addthis/codec/reflection/CodableFieldInfo.java	47.8 33/69
../main/java/com/addthis/codec/reflection/Fields.java	80.0 16/20

LITTLEDARWIN FILE REPORT

File Summary

Number of Mutants	Mutation Coverage	
16	81.2	13/16

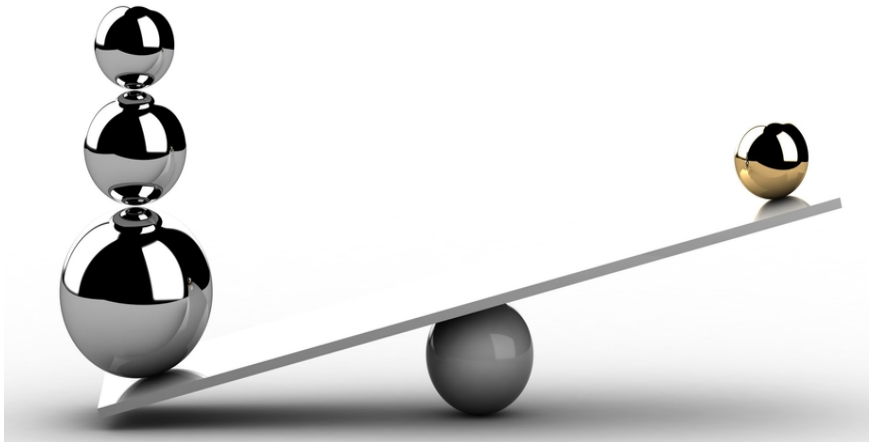
Detailed List

Survived Mutant	Build Output	Killed Mutant	Build Output
1.java	1.txt	2.java	2.txt
4.java	4.txt	3.java	3.txt
14.java	14.txt	5.java	5.txt
		6.java	6.txt
		7.java	7.txt
		8.java	8.txt
		9.java	9.txt
		10.java	10.txt
		11.java	11.txt
		12.java	12.txt
		13.java	13.txt
		15.java	15.txt
		16.java	16.txt

- Mutation analysis tool → LittleDarwin
- Branch coverage tool → JaCoCo

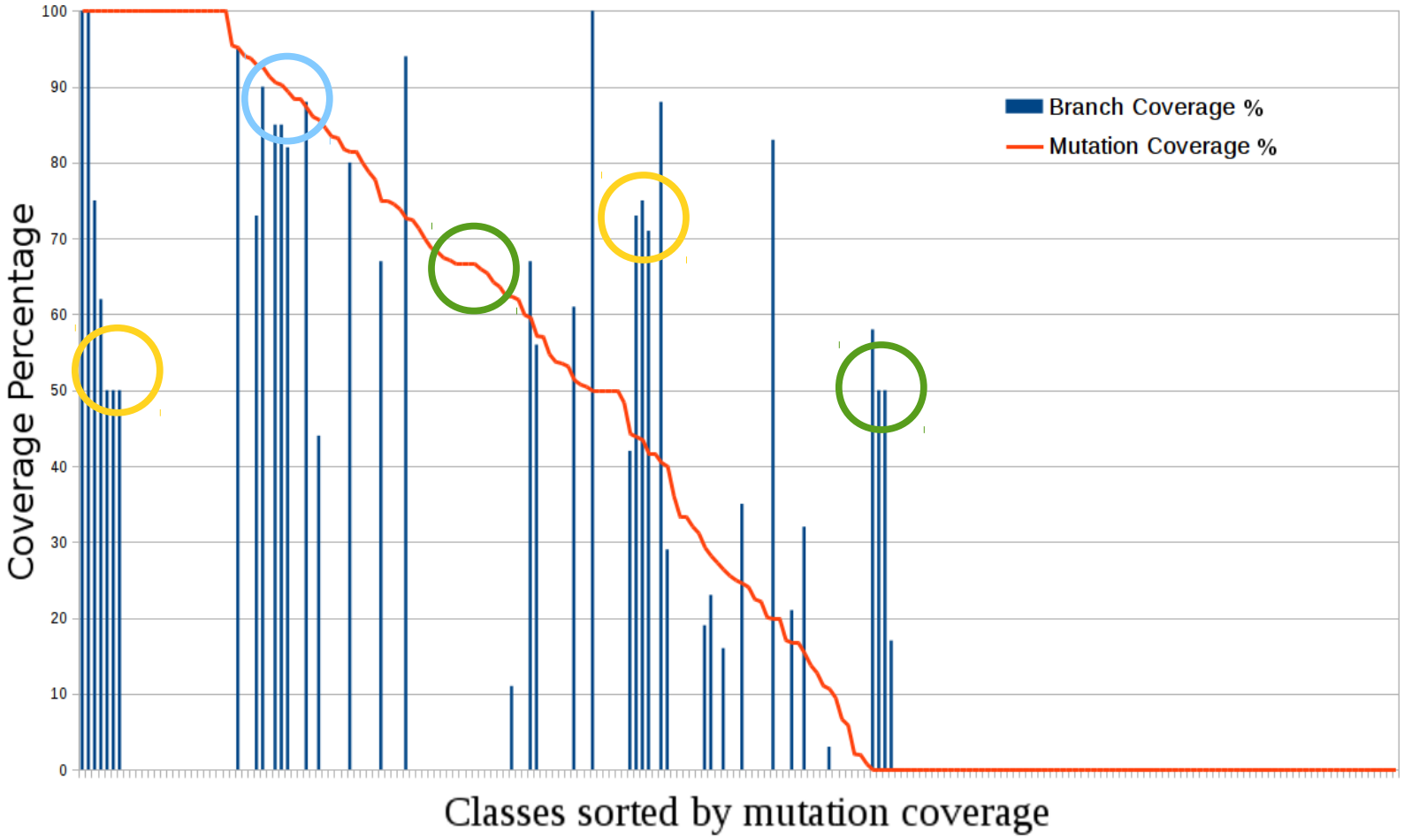
- System under test → Agfa HealthCare Segmentation

EXPERIMENT

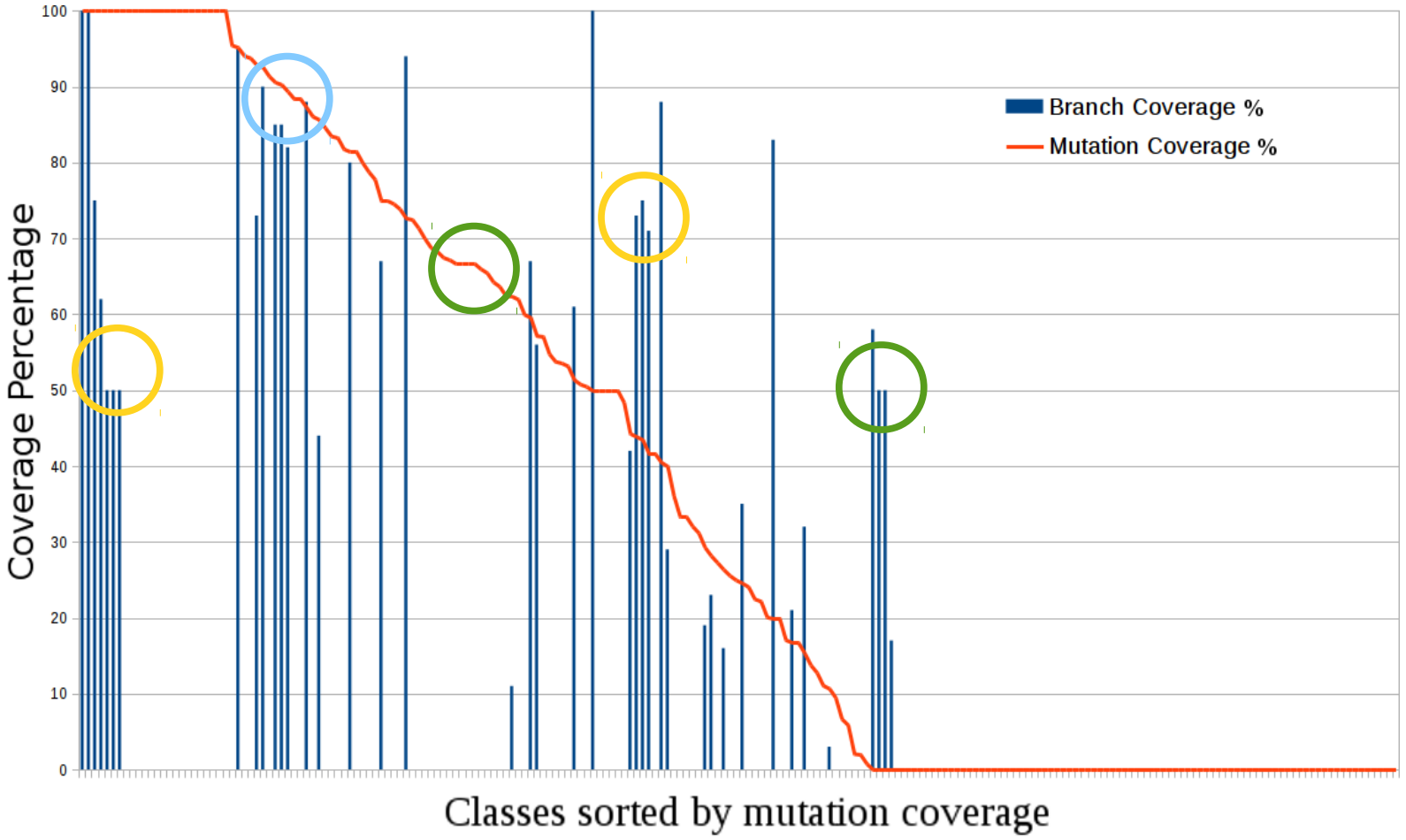


- Category 1 → Similar coverage
- Category 2 → Higher mutation coverage
- Category 3 → Higher branch coverage
- Category 4 → Only mutation coverage available
- Category 5 → Only branch coverage available

COMPARISON CRITERIA


100
90
80
70
60
50
40
30
20
10
0
Coverage Percentage
Branch Coverage %
Mutation Coverage %
Classes sorted by mutation coverage

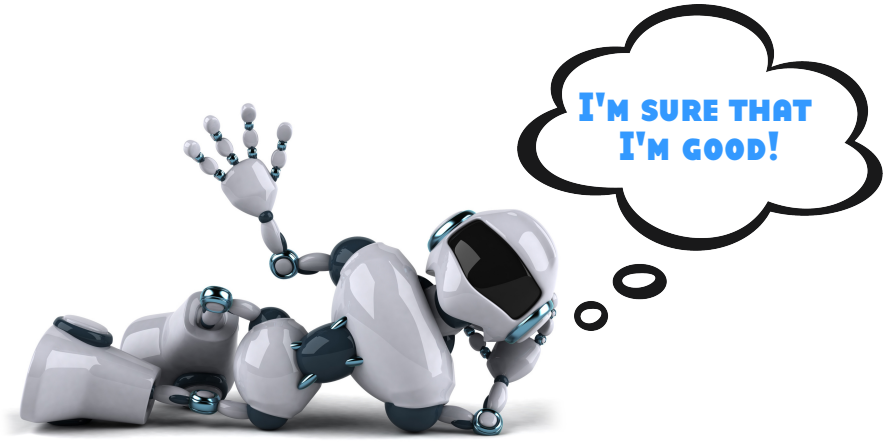
RESULTS



102 8 8 90 4

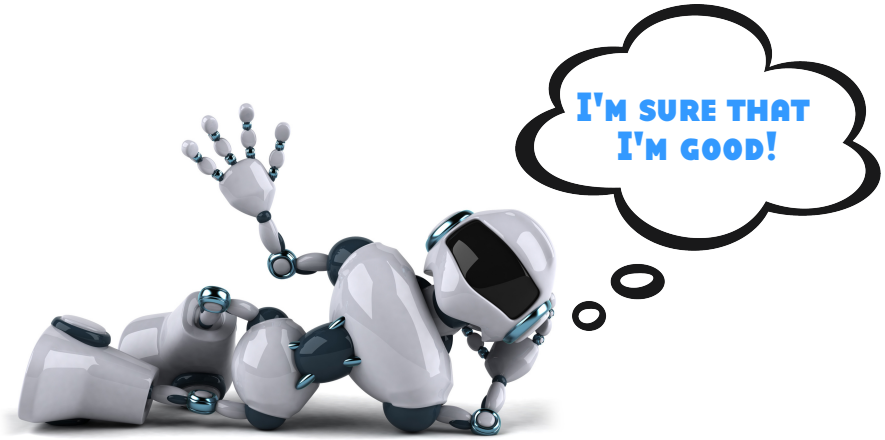
RESULTS

CONCLUSION



CONCLUSION

- Mutation analysis provides significantly more information about the test suite quality than branch coverage



CONCLUSION

- Mutation analysis provides significantly more information about the test suite quality than branch coverage

- This extra information comes at the cost of performance, but change-based mutation analysis can speed it up significantly

I WANT YOU