Mutation Testing

2. Tocco Innovation Day
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Code Coverage

36.5% test coverage simply means
that 63.5% is definitely **not** tested

Code Coverage: Example Code

```java
public class ThresholdValidator {

    public boolean isValid(int number) {
        return !(number < 5);
    }
}
```

Code Coverage: Example Unit Test

```java
public class ThresholdValidatorTest {

    private ThresholdValidator validator;

    @Before
    public void setUp() {
        validator = new ThresholdValidator();
    }

    @Test
    public void should_return_true_when_over_threshold() {
        boolean actual = validator.isValid(6);
        assertThat(actual, is(true));
    }

    @Test
    public void should_return_false_when_under_threshold() {
        boolean actual = validator.isValid(4);
        assertThat(actual, is(false));
    }
}
```

Mutation 1

Original

```
public class ThresholdValidator {

    public boolean isValid(int number) {
        return !(number < 5);
    }
}
```

Mutant

```
public class ThresholdValidator {

    public boolean isValid(int number) {
        return = !(!(number < 5));
    }
}
```

Mutation 2

Original

```
public class ThresholdValidator {

    public boolean isValid(int number) {
        return !(number < 5);
    }
}
```

Mutant

```
public class ThresholdValidator {

    public boolean isValid(int number) {
        return !(number >= 5);
    }
}
```

Mutation 3

Original

```java
public class ThresholdValidator {

    public boolean isValid(int number) {
        return !(number < 5);
    }
}
```

Mutant

```java
public class ThresholdValidator {

    public boolean isValid(int number) {
        return !(number <= 5);
    }
}
```

Additional test needed

```java
public class ThresholdValidatorTest {

    ...

    @Test
    public void should_return_true_when_on_threshold() {
        boolean actual = validator.isValid(5);
        assertThat(actual, is(true));
    }
}
```

Quis custodiet ipsos custodes?

Who will guard the guards themselves?

Who watches the watchmen?

Who tests the tests?

Mutation testing

Create an alternate SUT

This alternate system will be called a mutant

Run the tests against the mutant

Mutation testing

If at least one test fails - the mutant is **killed**

If no tests fail, then our test suite is not complete - the mutant has **survived**

Demo pitest.org

mvn org.pitest:pitest-maven:mutationCoverage

```xml
<plugin>
  <groupId>org.pitest</groupId>
  <artifactId>pitest-maven</artifactId>
  <version>1.1.11</version>
</plugin>
<plugin>
  <groupId>org.pitest</groupId>
  <artifactId>pitest-maven</artifactId>
  <version>1.1.11</version>
  <configuration>
    <targetClasses>
      <param>ch.tocco.nice2.optional.order.impl.action.invoice.*</param>
    </targetClasses>
    <targetTests>
      <param>ch.tocco.nice2.optional.order.impl.action.invoice.*</param>
    </targetTests>
  </configuration>
</plugin>
```

Demo

```
============================================================
- Timings
============================================================
> scan classpath : < 1 second
> coverage and dependency analysis : 9 seconds
> build mutation tests : < 1 second
> run mutation analysis : 15 minutes and 9 seconds
------------------------------------------------------------
> Total  : 15 minutes and 18 seconds
============================================================
- Statistics
============================================================
>> Generated 350 mutations Killed 317 (91%)
>> Ran 507 tests (1.45 tests per mutation)
- Mutators
============================================================
> org.pitest.mutationtest.engine.gregor.mutators.ConditionalsBoundaryMutator
>> Generated 3 Killed 3 (100%)
> KILLED 1 SURVIVED 0 TIMED_OUT 2 NON_VIABLE 0
> MEMORY_ERROR 0 NOT_STARTED 0 STARTED 0 RUN_ERROR 0
> NO_COVERAGE 0
------------------------------------------------------------
> org.pitest.mutationtest.engine.gregor.mutators.IncrementsMutator
>> Generated 3 Killed 3 (100%)
> KILLED 0 SURVIVED 0 TIMED_OUT 3 NON_VIABLE 0
> MEMORY_ERROR 0 NOT_STARTED 0 STARTED 0 RUN_ERROR 0
> NO_COVERAGE 0
------------------------------------------------------------
> org.pitest.mutationtest.engine.gregor.mutators.VoidMethodCallMutator
>> Generated 111 Killed 103 (93%)
> KILLED 19 SURVIVED 2 TIMED_OUT 84 NON_VIABLE 0
> MEMORY_ERROR 0 NOT_STARTED 0 STARTED 0 RUN_ERROR 0
> NO_COVERAGE 6
------------------------------------------------------------
> org.pitest.mutationtest.engine.gregor.mutators.ReturnValsMutator
>> Generated 94 Killed 75 (80%)
> KILLED 27 SURVIVED 3 TIMED_OUT 48 NON_VIABLE 0
> MEMORY_ERROR 0 NOT_STARTED 0 STARTED 0 RUN_ERROR 0
> NO_COVERAGE 16
------------------------------------------------------------
> org.pitest.mutationtest.engine.gregor.mutators.NegateConditionalsMutator
>> Generated 139 Killed 133 (96%)
> KILLED 51 SURVIVED 0 TIMED_OUT 82 NON_VIABLE 0
> MEMORY_ERROR 0 NOT_STARTED 0 STARTED 0 RUN_ERROR 0
> NO_COVERAGE 6

[INFO] ------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------
[INFO] Total time: 15:21 min
[INFO] Finished at: 2017-01-19T11:45:53+01:00
[INFO] Final Memory: 17M/571M
[INFO] ------------------------------------------------------------
```