Mutation Analysis

Guillermo Polito

guillermo.polito@inria.fr
@guillep

Goals

- Introduce Mutation Analysis as a technique to assess test quality
- The competent developer hypothesis
- Computing mutation scores

What is a good test?

“A good test is a test that catches bugs”

- me

How do we know if a test catches bugs?

How do we know if a test catches bugs?

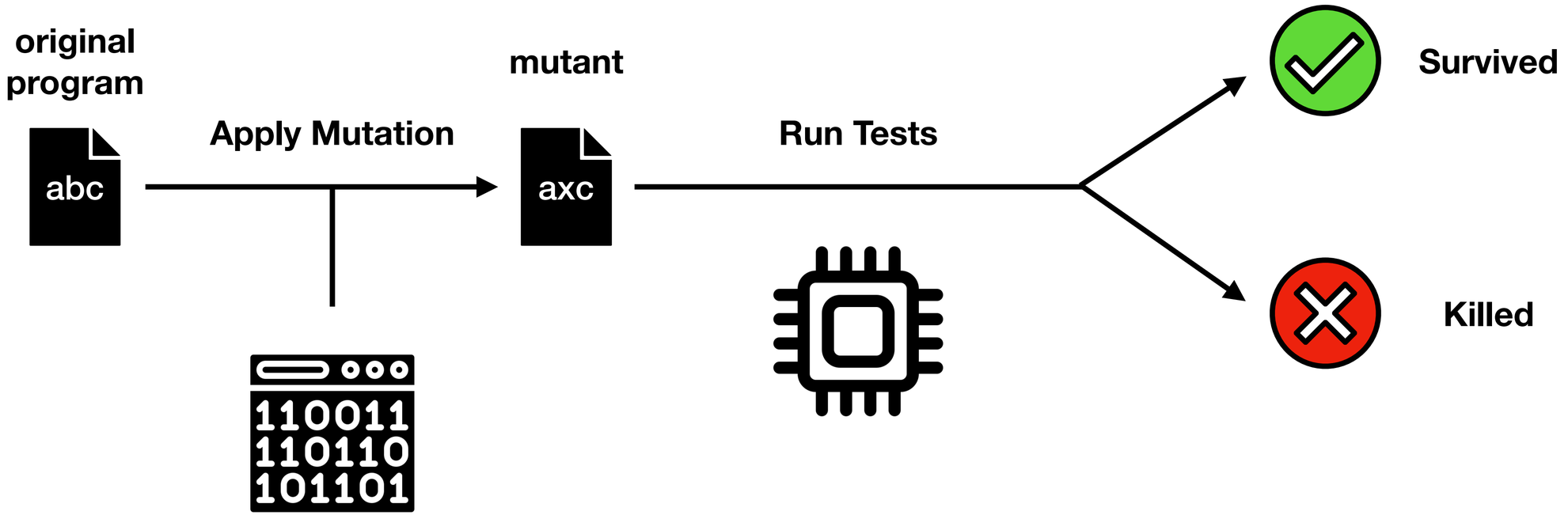
- Introduce artificial bugs
- See if the test suite detects them

- What kind of bugs?

Competent developer hypothesis

- Developers are capable people
- Mistakes/bugs are small details easily overseen. E.g.,
  - Missing `+/- 1` in a loop
  - An inverted conditional
  - Signed/unsigned

Mutation Analysis



Mutation Score

- Run each mutation independently

- Score:

$$\frac{\#\text{Killed}}{\#\text{Mutants}}$$

The insight

- Survived mutants were either
    1. not covered
    2. had effects not asserted
    3. or were semantically **equivalent**. E.g. `A+B=A-B if B=0`

1) and 2) call to ***improve our tests***

3) ***bias*** our results

Problems of Mutation Analysis

```
Runtime = Time(tests) * #Mutants
```

Possible Extensions and Next Steps

- Select a subset of mutants to run
- Select a subset of tests

- High-order mutants
- Language/Application-specific mutations

- Use mutation testing to evaluate your fuzzer!

Takeaways

- We can automatically assess test case quality
- Mutations introduce artificial bugs and mimic developer issues

- Expensive to run
- Trivial and Equivalent mutants bias results and should be manually inspected

Material

- Mutation Testing Advances: an Analysis and Survey. Advances in Computers Journal. Papadakis et al