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How to inject quality bugs for Static Analysis Tool Exposition's test cases

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NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Lorraine INP

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"How do you change the world? Always work on something uncomfortably exciting"

– Larry Page, Alphabet CEO

Outline

Introduction

One of the biggest data breaches of all time

145 millions Americans affected

$59.5 billion annually

1. Context & environment

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Software Assurance Metrics And Tool Evaluation

- Improving software assurance
- Measuring the effectiveness of tools

Static analysis

Input → Tool analysis → Output

Source code

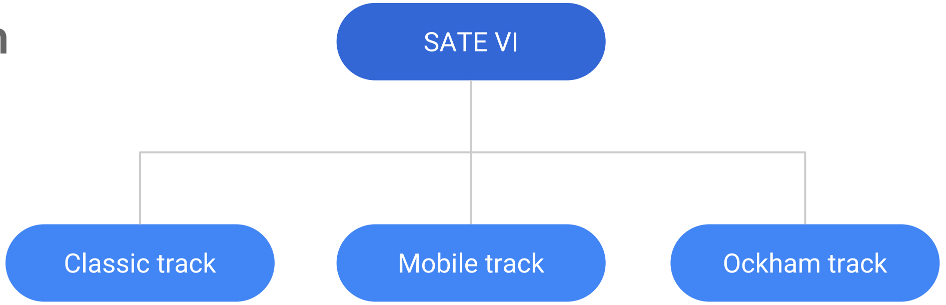
Warning reports

Limits

Complexity of real world software $\longrightarrow$ Use of approximations

Static Analysis Tool Exposition

- Encourage improvement of tools
- Speed tool adoption
- Enable empirical research

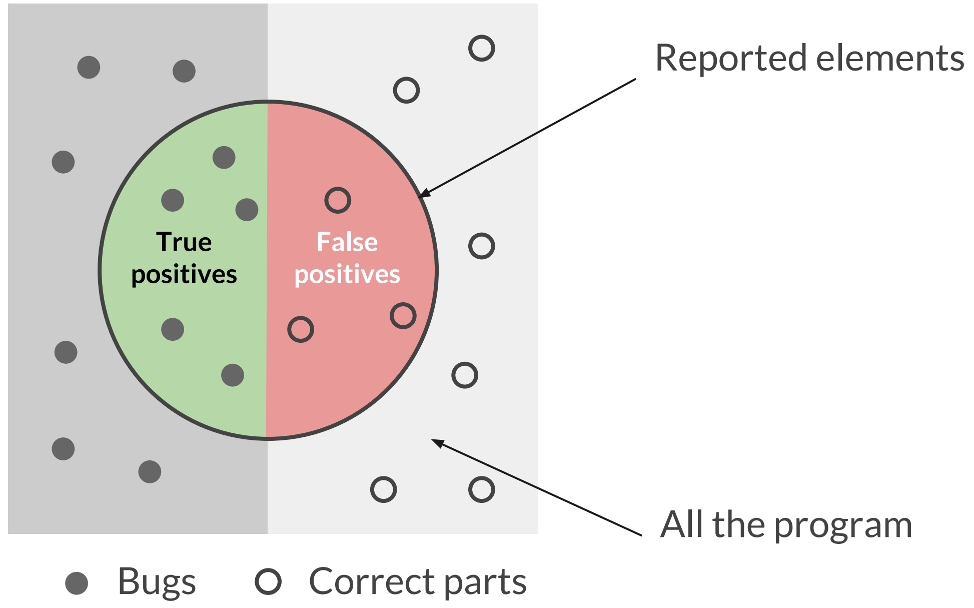


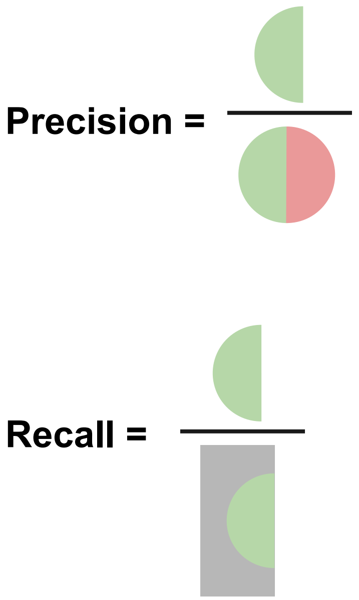
2. Presentation of the project

What do we want to know ?

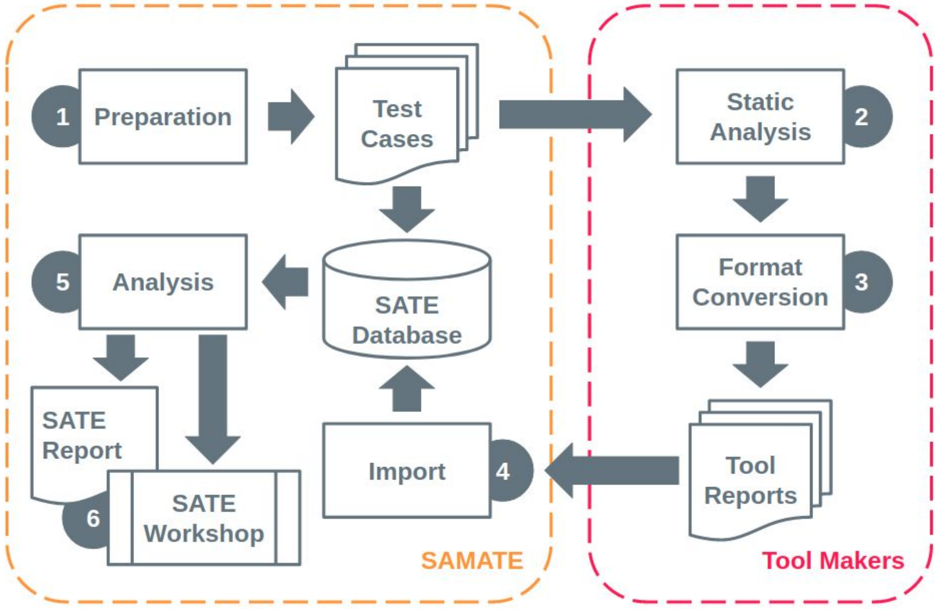
1. What proportion of defects can a tool find?
   Recall and coverage
2. How noisy is a tool?
   Precision and discrimination
3. How similar are unrelated tools?
   Overlap

Precision & Recall

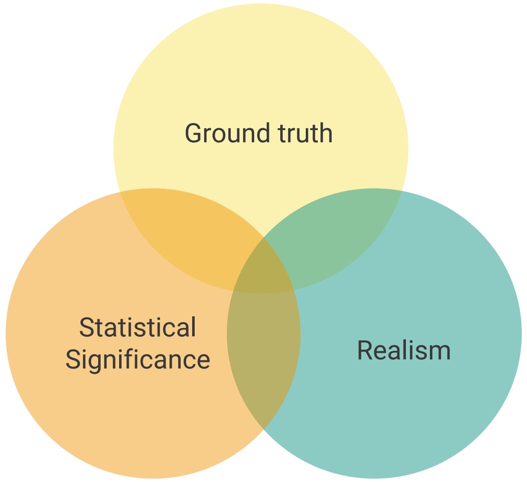




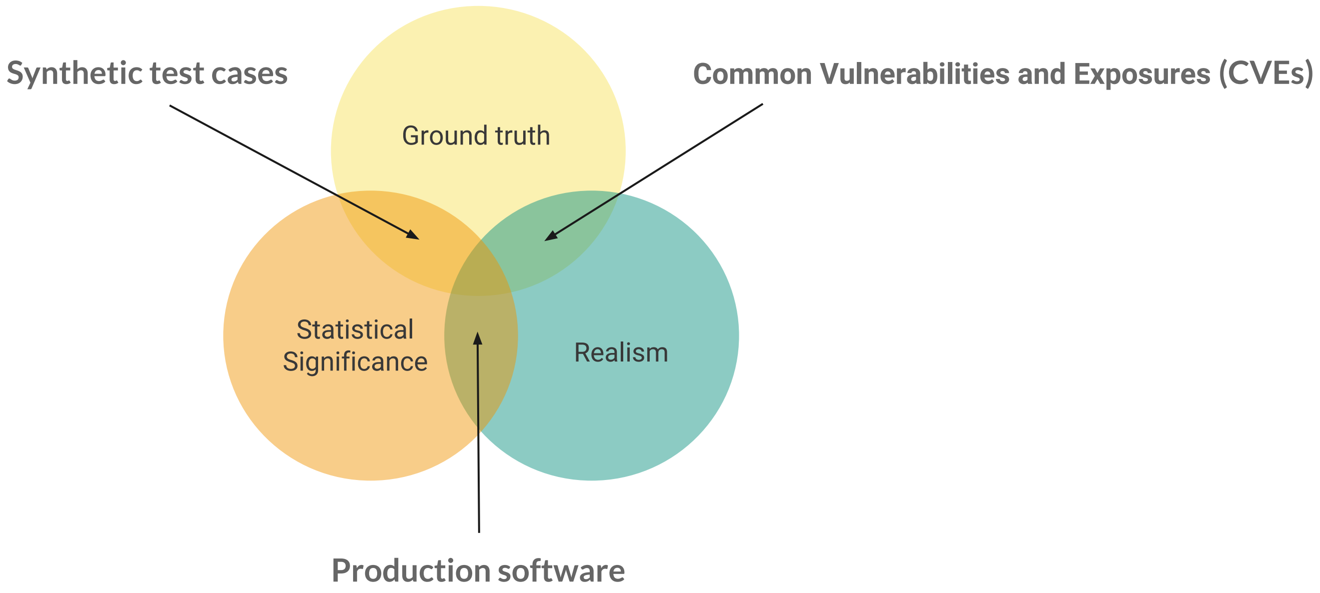
How to assess static analyzers ?



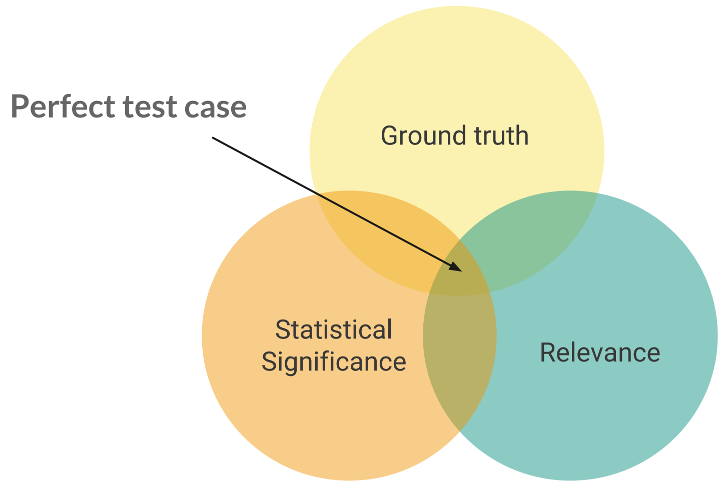
Test case's characteristics



Existing test cases



Benefits of bug injection in Production Software



3. Design of the solution

How to inject quality bugs in Production Software?

Requirements

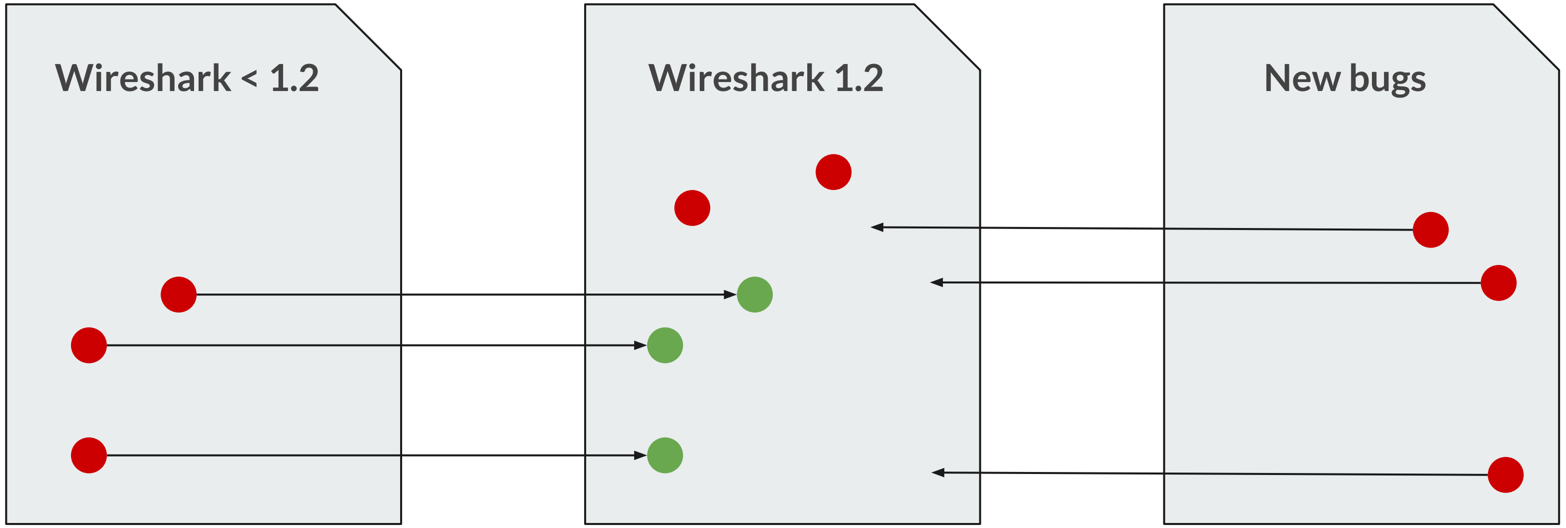
WIRESHARK A program

● Bugs

● Fixes

⚡ Triggering inputs

Different ways to inject bugs



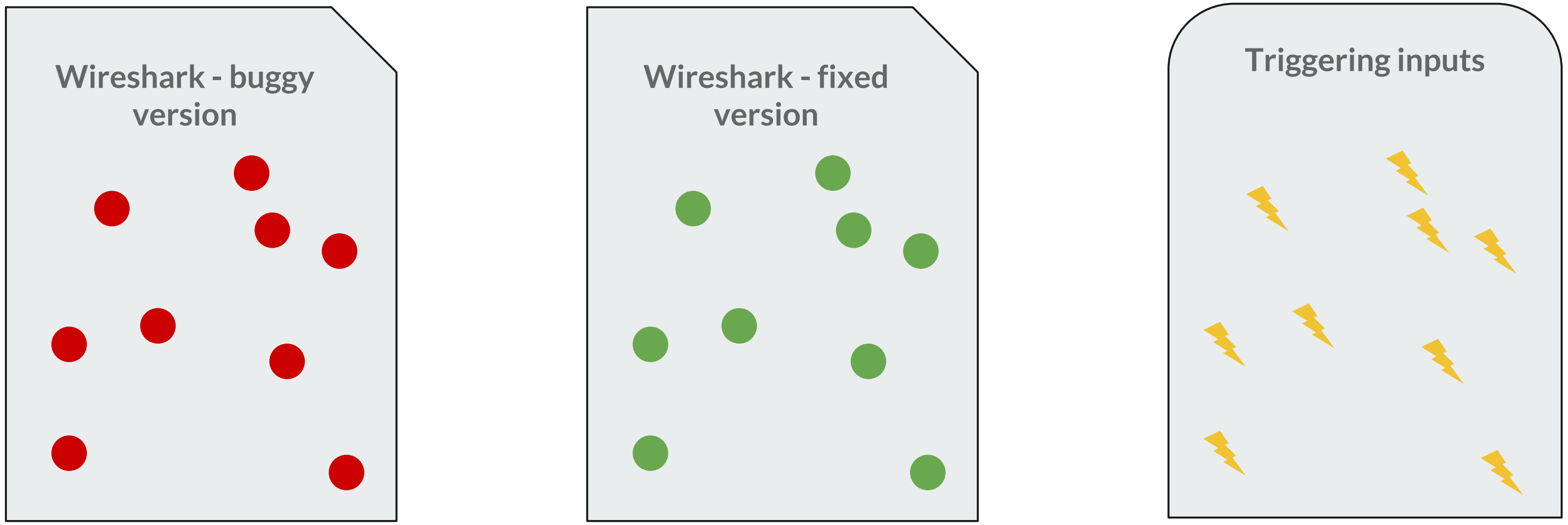
Different ways to inject bugs

	Pros	Cons
Existing bugs (reported)	● Real by definition ● Easy to add ● Come with triggering inputs & fixes	● Only a small amount existing
Injected bugs	● Choice of the category ● We can inject a lot of them	● Creating a bug, its fix and its triggering input is time-consuming

Suggested criteria for bug's quality

- Reflect a programmer's way of coding
- Bug complexity
- Span the execution lifetime of a program
- Come with an input that serves as an existence proof
- Manifest for a very small fraction of possible inputs

The prepared test case



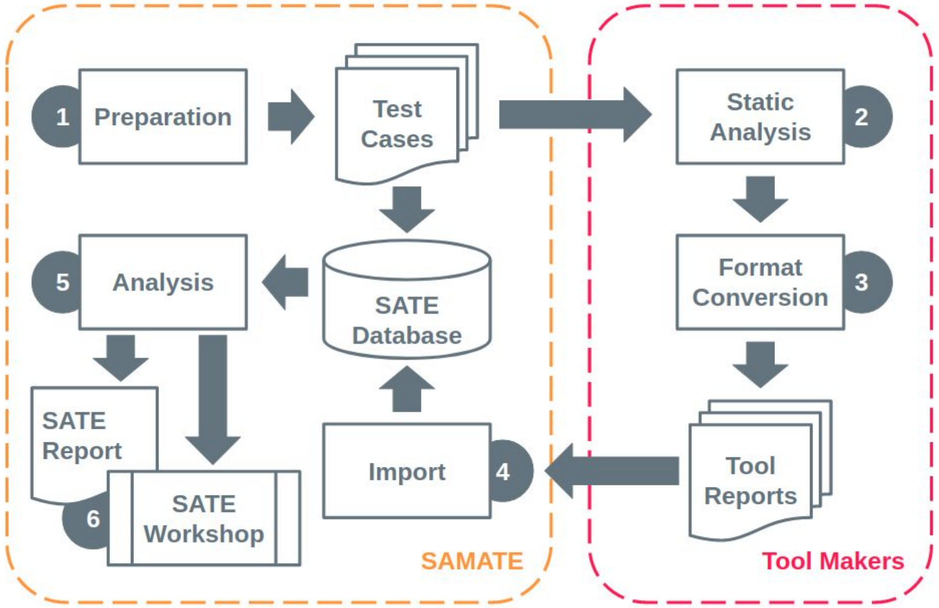
4. Results & future outlook

Results

New approach for assessing static analyzers in SATE VI.

~ 50 quality bugs injected

What now?


1 Preparation
Test Cases
Static Analysis 2
5 Analysis
SATE Database
Format Conversion 3
SATE Report
6 SATE Workshop
Import 4
Tool Reports
SAMATE
Tool Makers

Conclusion

- Awareness on software security
- Versatility
- Great experience at NIST

- SATE VI test cases ready
- 8 months of training so far

Any Questions?

Bug example

```
nresp = packet_get_int();

#if defined(BUG_7DD70701) // Compiling the version with the bug
if (nresp > 0 && nresp <  1048576) {
#else // Compiling the correct version
if (nresp > 0) {
#endif

response = malloc(nresp * sizeof(char*));

for (i = 0; i < nresp; i++)
        response[i] = packet_get_string(NULL);
}
```