UE SCLAM

Sécurité Logicielle

Tools for code security analysis

Master M2 Cybersécurité et Informatique Légale

Academic Year 2024 - 2025

Motivation

Most software ~~(are likely to)~~ contain security vulnerabilities . . .

There is a strong need for tools allowing to:

- detect potential vulnerabilities
- help to evaluate their exploitability/dangerousness

$\rightarrow$ Useful for:
developers, users of 3rd-party libraries/applications, code auditors, etc.

Other possible applications :

- malware (behavioral) analysis
- reverse engineering
- code (de-)obfuscation
- exploit generation
- variant analysis
- etc.

Several classes of tools

Syntactic vs Semantic

- syntactic: check compliance w.r.t. to coding rules/standarts
- **semantic**: check for behavioral inconsistencies

Static vs Dynamic

- static: check are performed at "compile time"
  (no concrete code execution)
- dynamic: on-line and/or offline checks require code execution steps

Black vs Grey vs White Box

- black box: no access required to the target code
- white box: full access required to the (source ?) target code
- grey box: partial access required to the target code

etc.

Taking into account the limits of computability ...

... no hope to get a fully automated (powerful) tool:

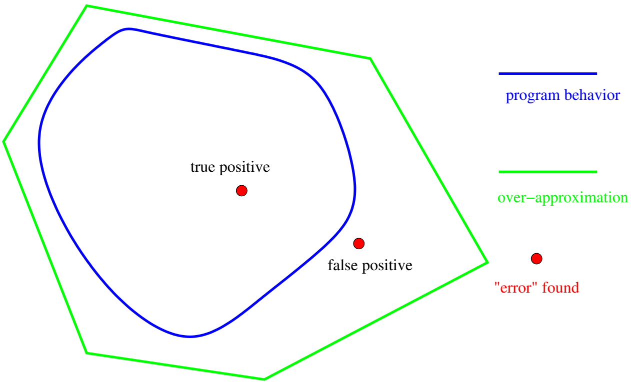
all non-trivial semantic properties of programs are undecidable
[Rice theorem]

Possible **work-arounds:**

- Approximate enough the program behavior to make the analysis decidable ⇒ the results may be no longer sound no complete
- use a semi-algorithm
  if the analysis terminates then it gives sound and complete results ...

In practice:
re-use & extend existing code analysis techniques used for compilation, test, verification

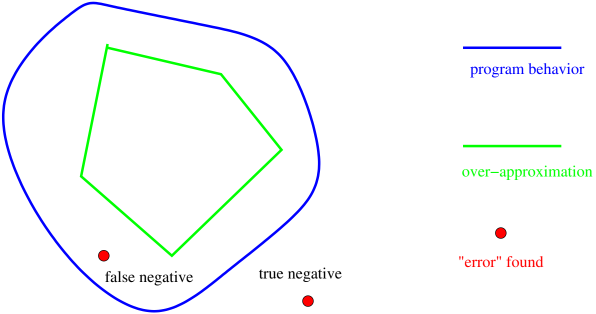
Over-approximation of the program behavior



Sound: “correct” verdicts are always reliable . . .
(never miss an “incorrect” execution)

Not Complete: may reject correct programs . . .
($\exists$ “false positives”)

Under-approximation of the program behavior



Unsound: “correct” verdicts are not reliable . . .
(may miss “incorrect” executions)

Complete: never reject correct programs . . .
(“incorrect” execution reported are real ones)

In the following . . .

An overview of:

- dynamic approaches:
  - **fuzzing**
  - **dynamic-symbolic execution**
- static approaches:
  - **value-set analysis**
  - **code-pattern** based vulnerability detection