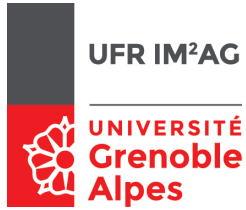




# Software security, secure programming

## Tools for code security analysis

Master M2 Cybersecurity

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:

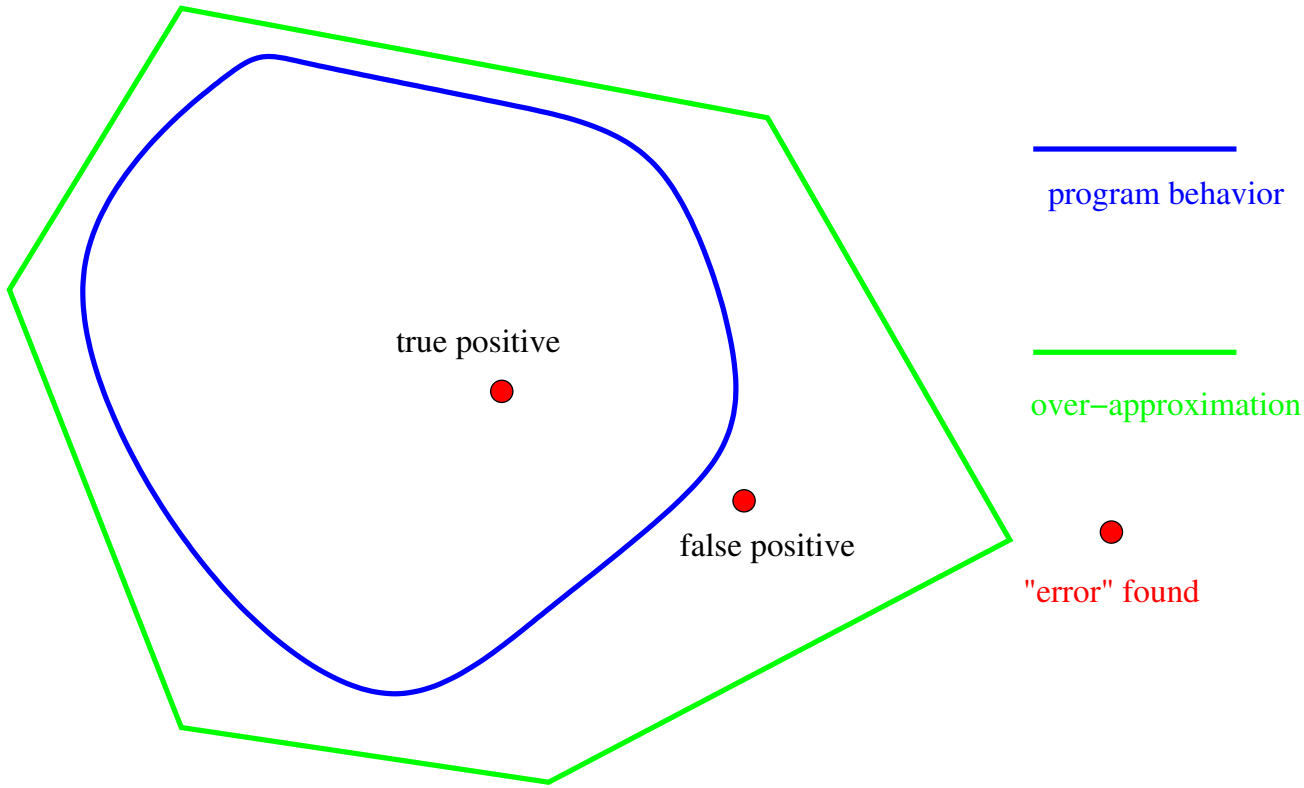
*all non-trivial semantic properties of programs are undecidable*
*[Rice theorem]*

Possible **work-arounds:**

- Approximate enough the program behavior to make the analysis decidable $\Rightarrow$ 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

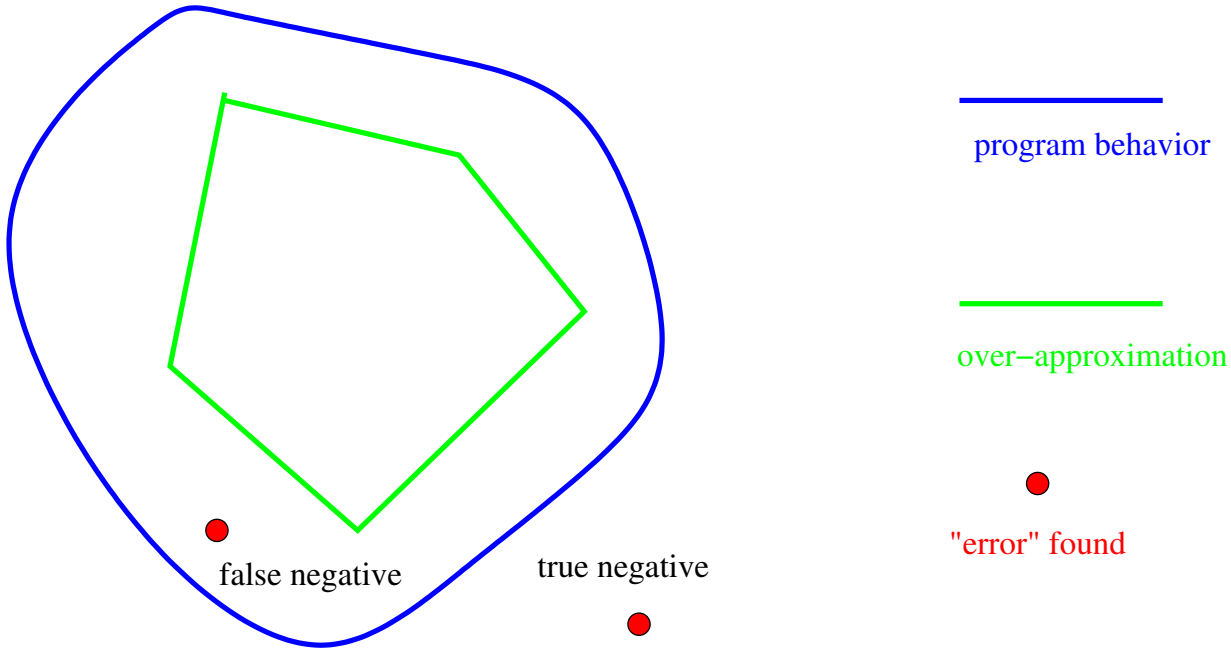
# Over-approximation of the program behavior




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

**Not Complete:** may reject correct programs . . .
(∃ “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