Testing Defensive Systems

1. NIDS

   Problem: Find an attack instance that eludes a NIDS.
   Solution: Attack generation using natural deduction.

   Shai Rubin · Somesh Jha · Bart Miller

2. Virus scanners

   Problem: Generate virus sample that evades AV tool.
   Solution: Guided attack generation using oracle access.

   Mihai Christodorescu · Somesh Jha

Problem

Given:

- a defensive system (NIDS, virus scanner)
- a known attack
- a set of transformation rules: TCP/IP fragmentation, code obfuscation, etc.

- How can we test, or even verify, that a defensive system detects all instances of a given attack?

NIDS Are Untrustworthy

- ~~Many false positives~~.
- More troubling, false negatives: attacker has succeeded to elude a NIDS.
- Attack transformation: alter an attack, but keep its semantics, so it no longer matches the NIDS signature.

Problem: How can we test, or even verify, that a NIDS detects all instances of a given attack?

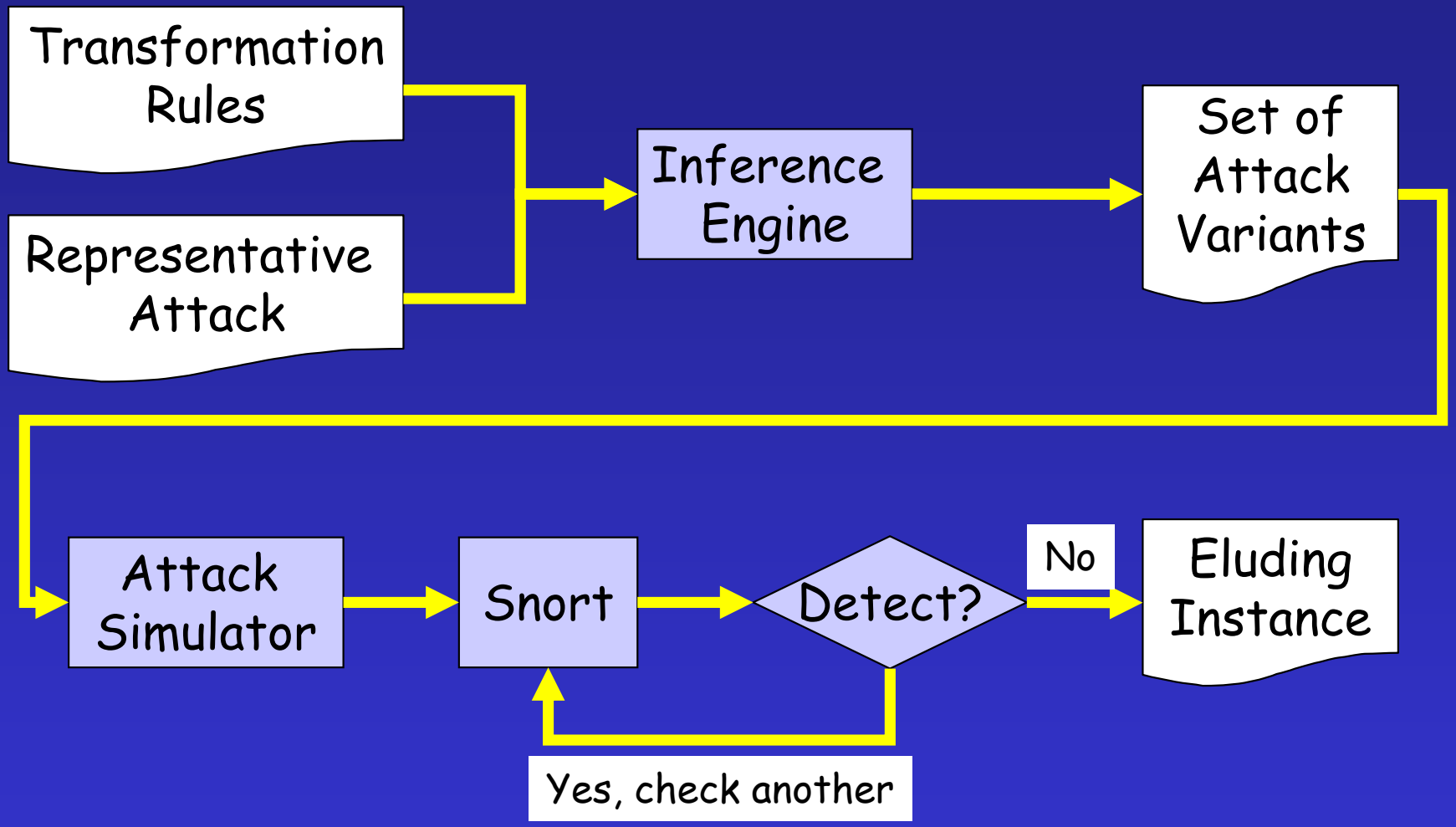
Previous Solutions

- Random testing
  - X Not exhaustive
  - X No control over testing
  - X Not always sound
- Manual testing
  - X Not efficient

Our Approach

- Formally represent attackers' abilities as transformation rules of a natural deduction system.
- Use inference engine to exhaustively apply the rules to generate all possible mutations.
  - √ exhaustive
  - √ sound
  - √ efficient

AGENT: Attack Generation for NIDS Testing



Current Status

- Issues addressed:
  - Formulating rules
  - Finding a representative attack
  - Large set of mutations (millions)

- Results:
  - Prototype implemented (TCP + Payload mutations)
  - Four serious vulnerabilities in Snort (reported + fixed)

AV Tools Are Untrustworthy

- Critical problem: false negatives
  - An active virus sneaked in undetected
- Program obfuscation
  - Alter a virus through various transformations
  - Maintain virus semantics
  - Mutated virus is no longer detected

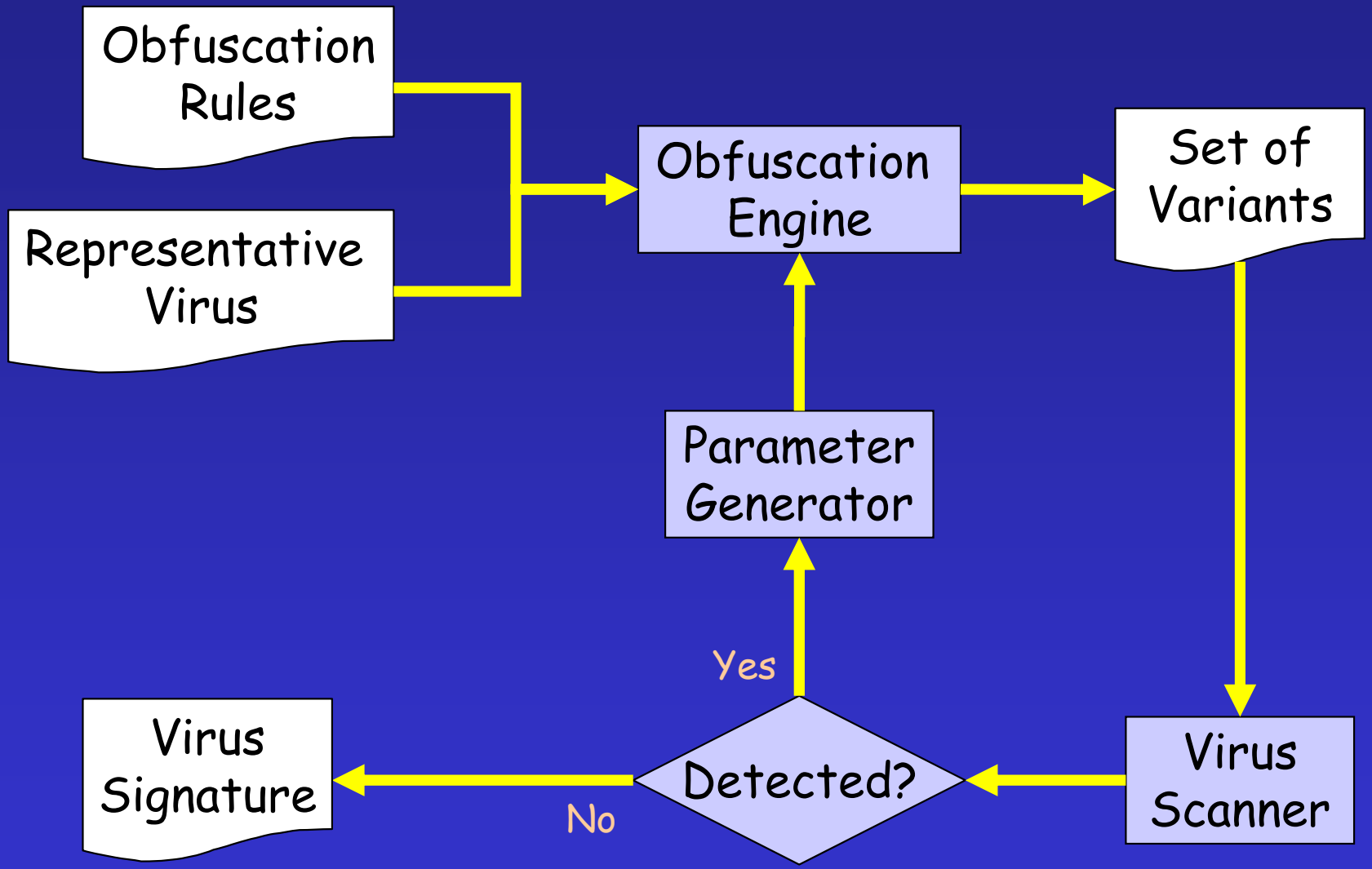
Problem: How can we test the limits of a virus scanner with respect to the mutations of a given virus?

Our Approach

- Formalize attacker obfuscations as transformation rules

- Find the minimal obfuscation that renders an undetected virus variant
  - ✓ Automatic signature discovery
  - ✓ Minimal information needed:
    - Oracle access to virus scanner
  - ✓ Efficient binary search

Virus Scanner Test Generator



Past, Present & Future

Current Results:

- Prototype for Visual Basic worms implemented
- VB worm signatures discovered for several virus scanners

Future:

- Formalize search space
- Automatically discover detection heuristics
- Performance improvements

Testing Defensive Systems

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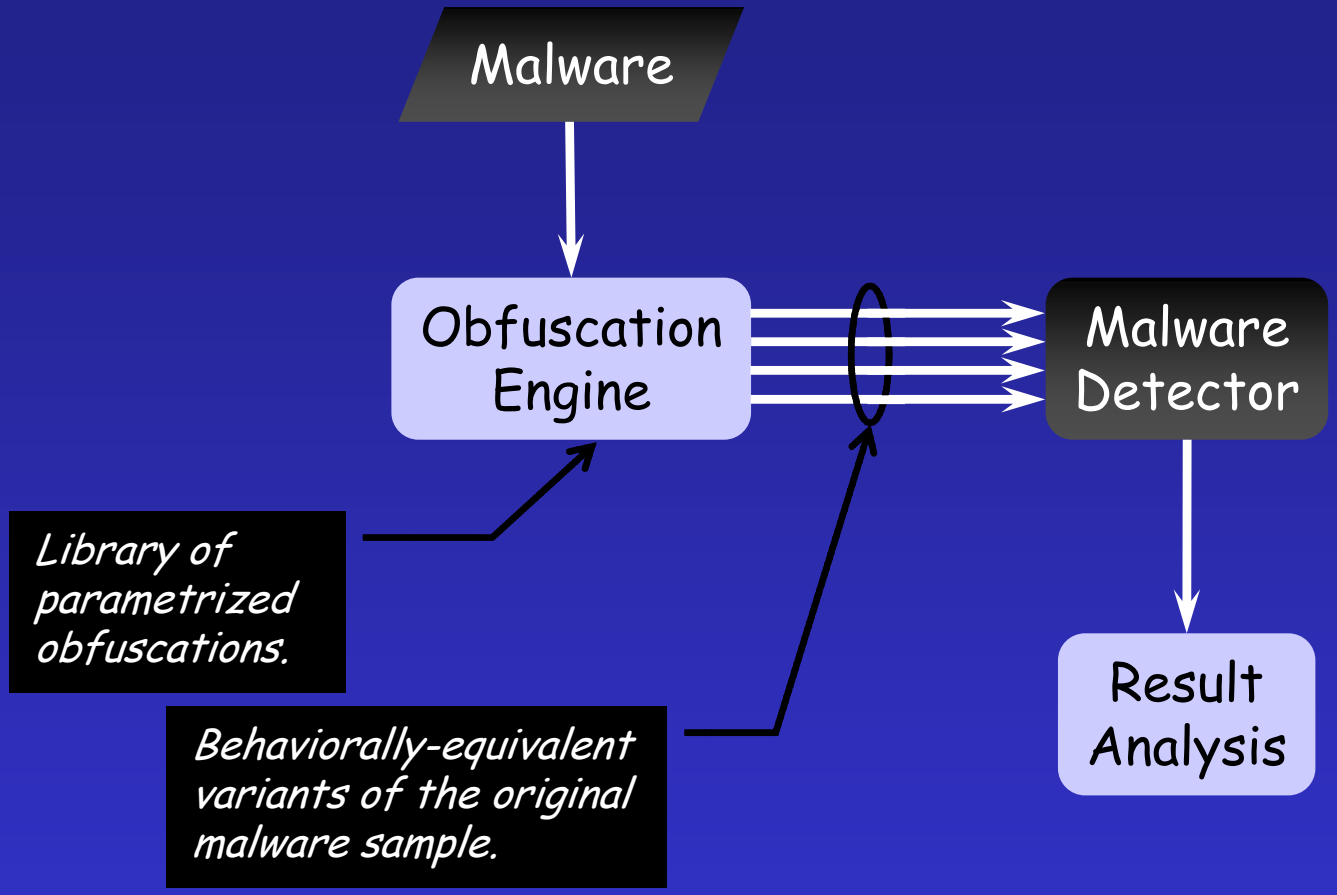
Automatic Test Generation



Code reordering parameters:

- program range
- type of reordering (physical, execution)
- new instruction order

The More You Know…

- Can the attacker precisely evade detection?

  Yes, use a signature discovery algorithm.

  Given: program P with n insns.

  Assume: signature has k program insns.

  Algorithm:
  1. Find the first signature instruction
     using binary search
     and opaque obfuscations
  2. Mask the found signature instruction
  3. Repeat until no more sig. insns found

Signature Discovery