Obfuscating Transformations

Yury Lifshits

Mathematics & Mechanics Faculty
Saint Petersburg State University

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Outline

1 What is Obfuscator?

- Notion of Obfuscator
- Anatomy of Obfuscator
- Obfuscator Characteristics

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2 Library of Obfuscating Transformations

- Program Representation
- Data & Control : Basic Tricks
- Control Flow Obfuscation
- Even more transformations

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3 Obfuscation vs. Deobfuscation

- Classical Program Analysis
- Deobfuscation Hardness
- Further Research

Motivation: Java Virtual Machine

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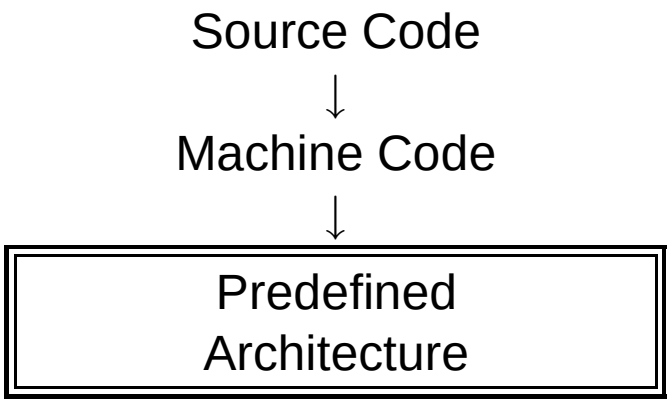

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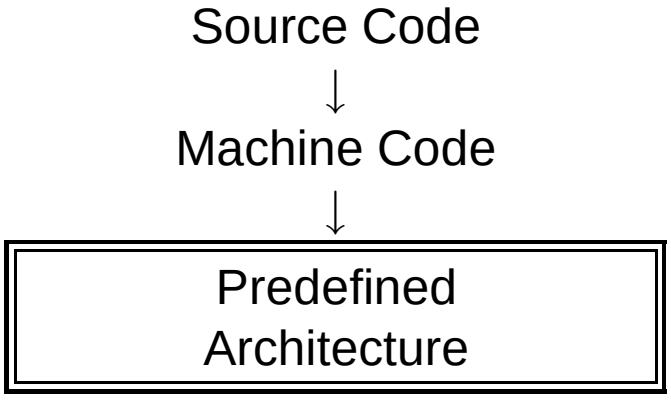

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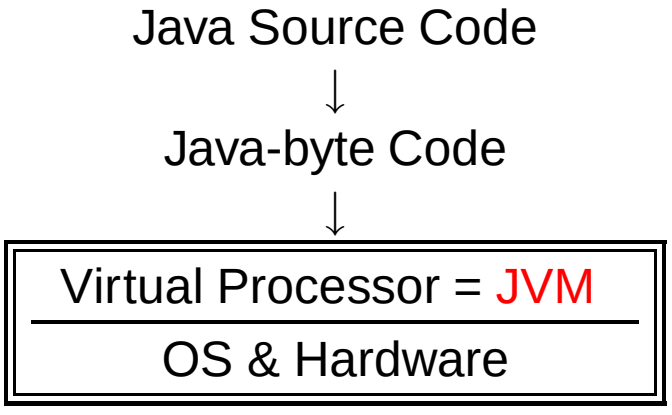

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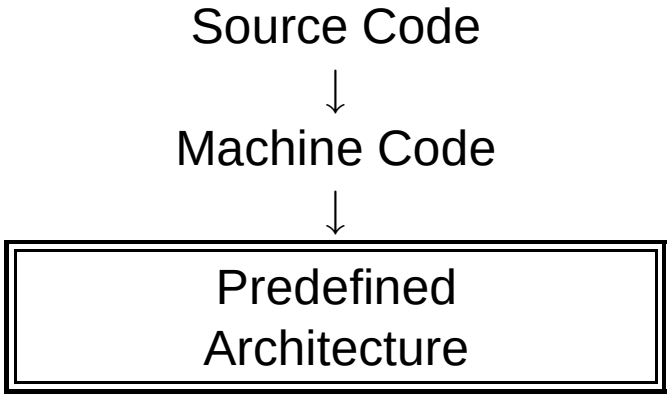

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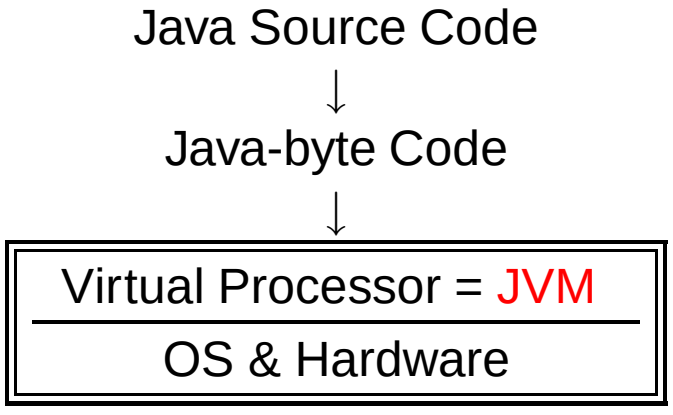

Java Virtual Machine: implemented on huge number of hardware architectures / operating systems

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Anatomy of Obfuscator I

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3. Repeats **step 2** until task completed or constraints exceeded

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  - Update internal representation

Quality of Obfuscation

Slide from Lecture 1

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So you supposed to explain it to me...

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Strength can be measured by:

- ⇨ Potency

  $\frac{E(P')}{E(P)} - 1$
- ⇨ Resilience

  Trivial, weak, strong, full, one-way
- ⇨ Cost

  Free, cheap, costly, expensive
- ⇨ Stealthy

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  Level of inheritance, coupling, number of methods triggered by another method, non-cohesiveness

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- ⇨ Cost by not using efficiency enhancing mechanisms

  Caching is rarely possible; losing module structure

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  - Destroy long patterns in program

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What is *program* from our point of view?

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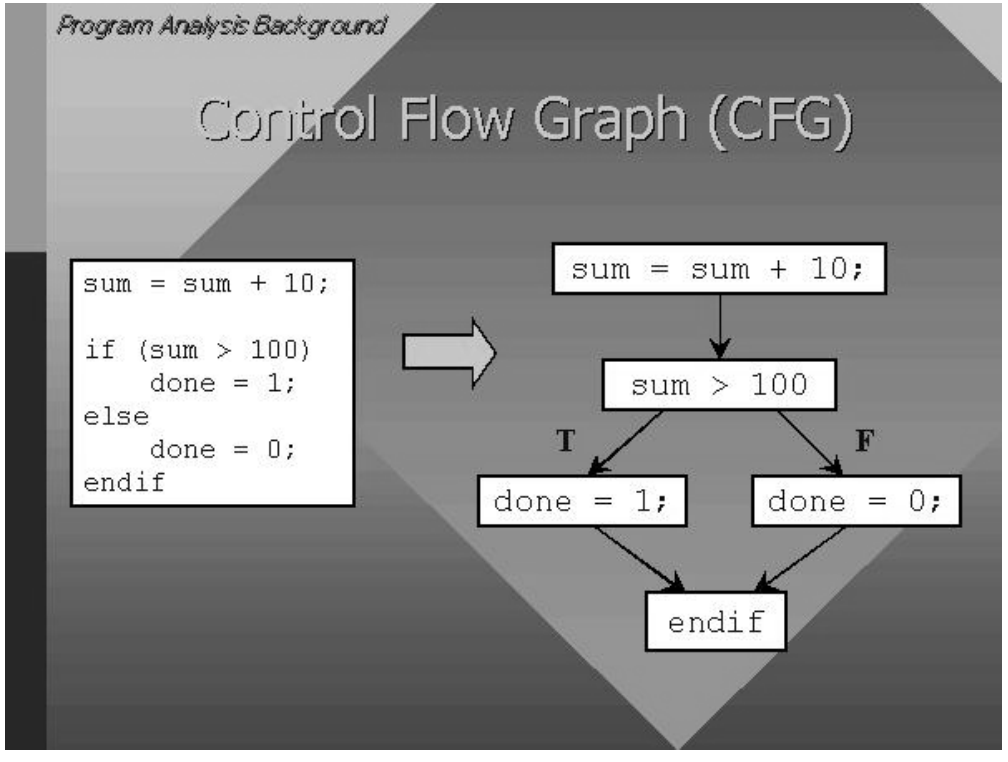

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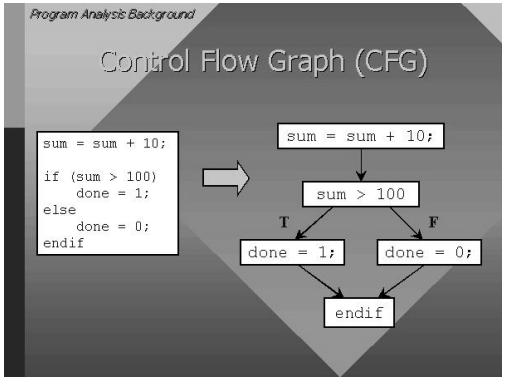

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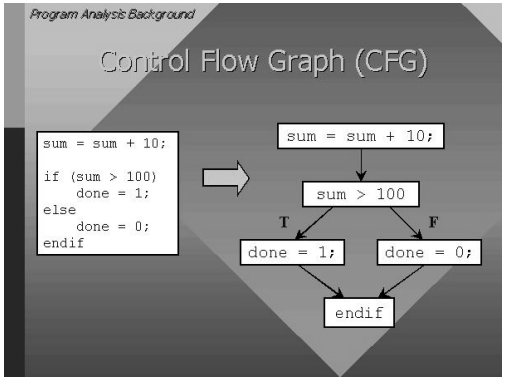

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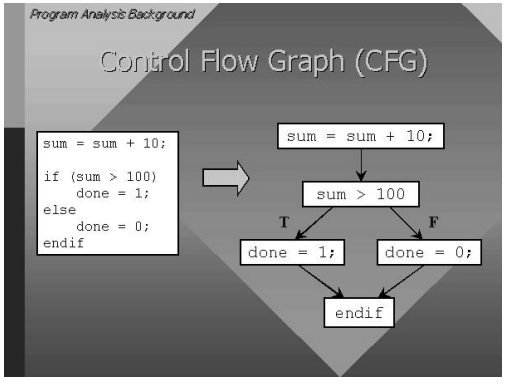

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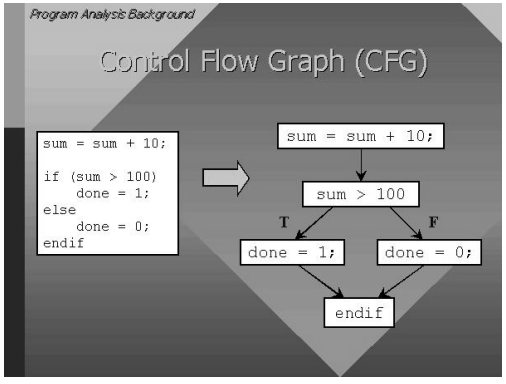

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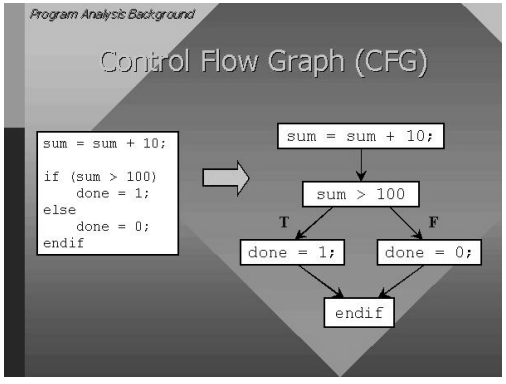

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- ⇨ Jump targets start a block; jumps end a block

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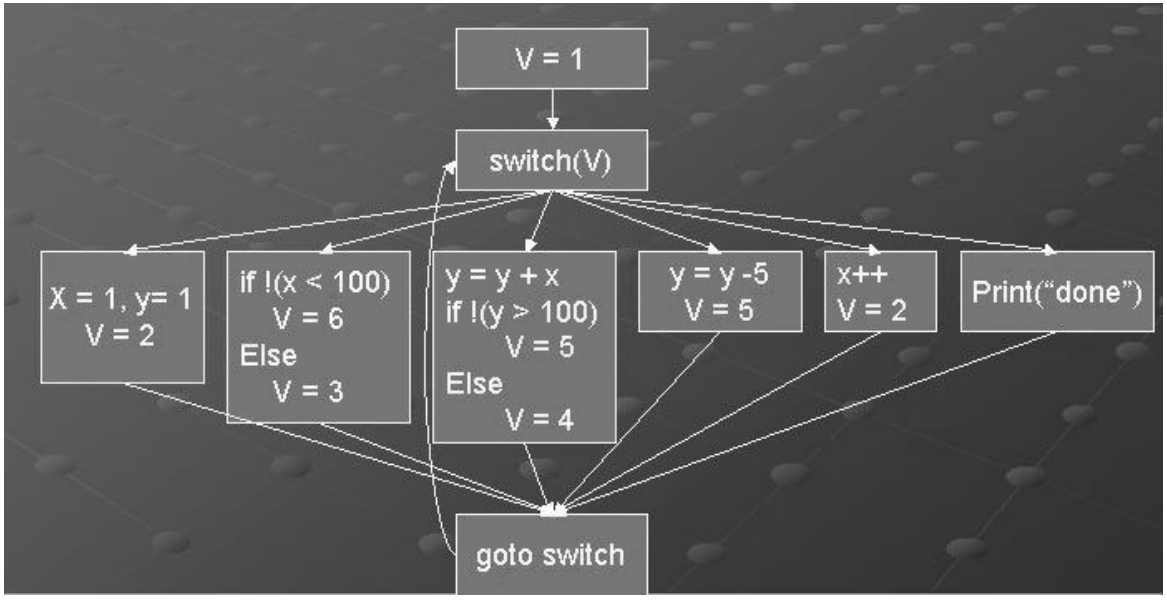

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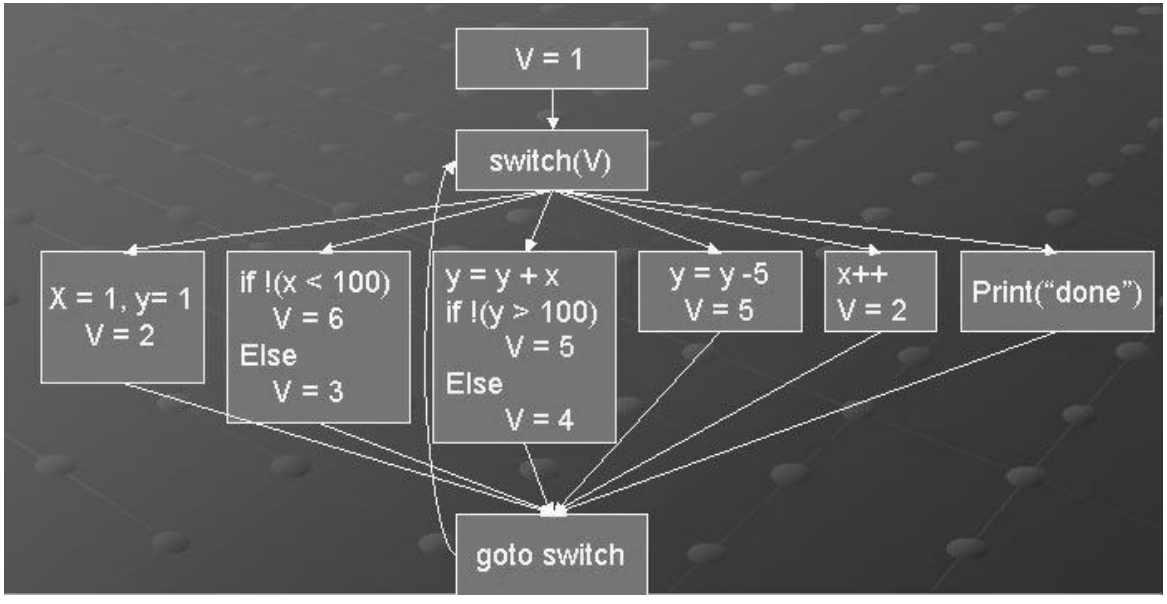

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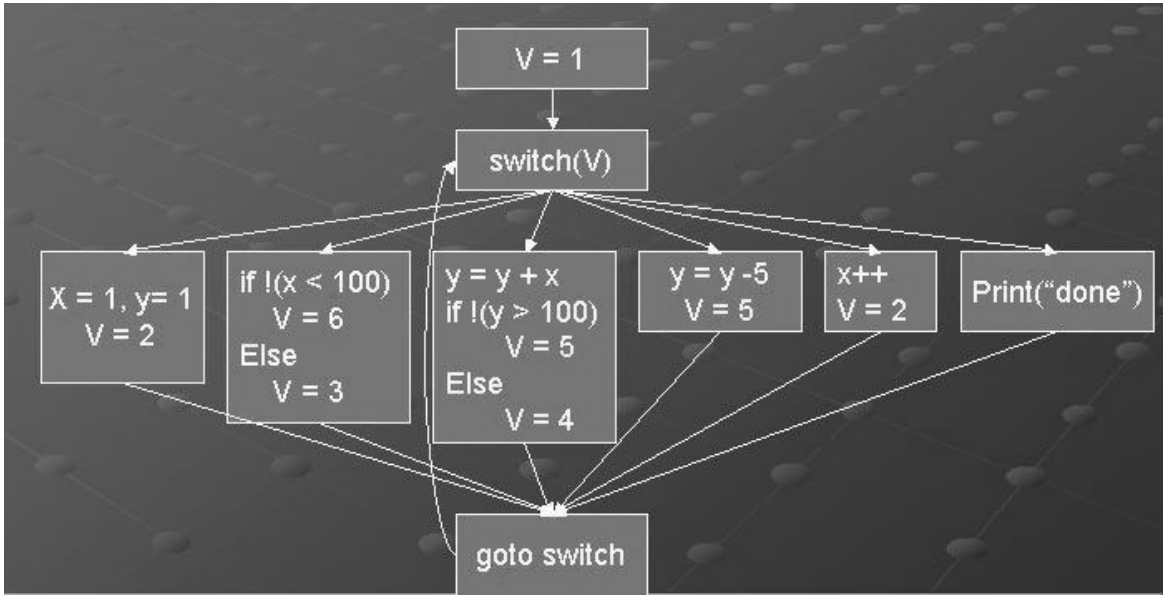

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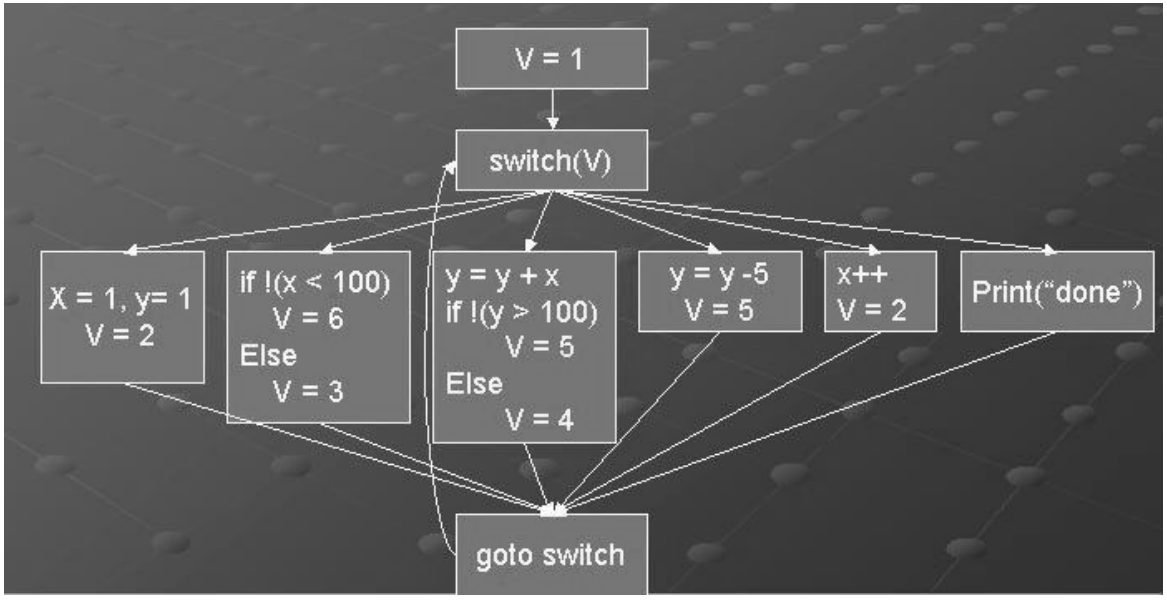

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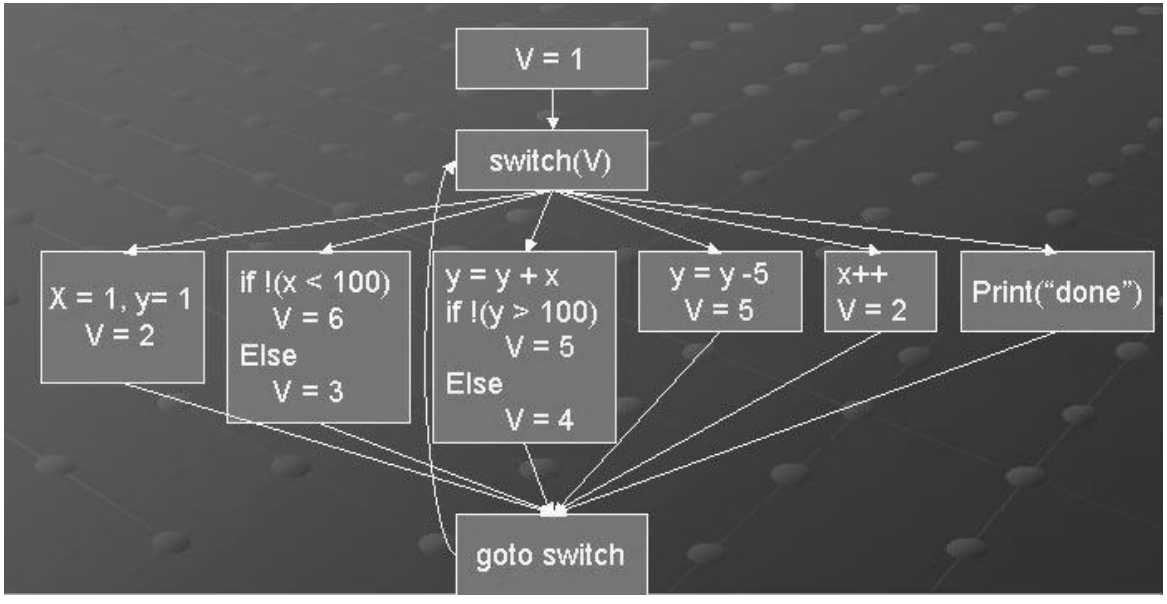

Step by step:

- ⇨ Write down a list of all basic blocks
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- ⇨ Replace all calls by indirect pointing
- ⇨ Write a single dispatcher to maintain all control flow

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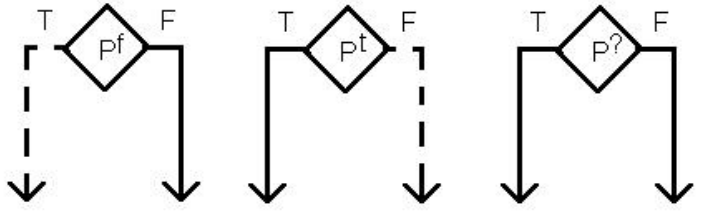

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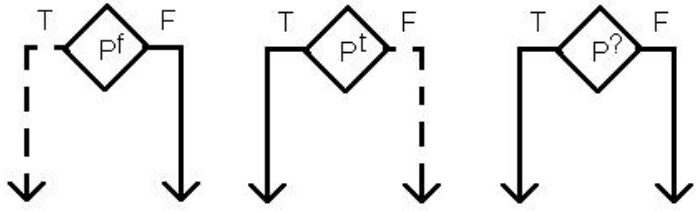

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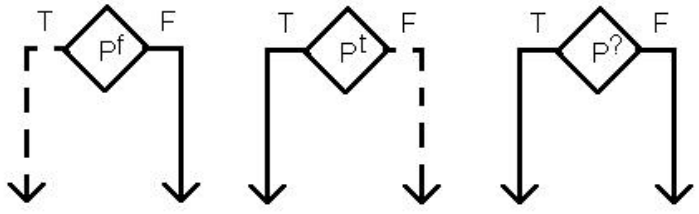

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Examples:

$$((q + q^2) \ mod \ 2) \ = \ 0$$

Opaque predicates

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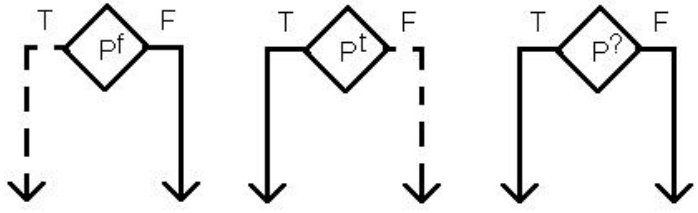

Opaque predicates: every time the same value
Difficult to discover by automatical static analysis

Examples:

$$((q + q^2) \ mod \ 2) \ = \ 0$$

$$((q^3) \ mod \ 8) \ = \ 0 \ \text{OR} \ ((q^3) \ mod \ 8) \ = \ 1$$

Functions Unifying

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Idea: merge functions and call universal function with additional parameter
Difficulty: different signatures (input-output specifications)

Solution: unify signatures (in groups)

Even more transformations

Question: Can you invent more?

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- ⇨ Reuse identifiers
- ⇨ Introduce misleading comments :-)
- ⇨ Modify inheritance relations
- ⇨ Convert static data to procedural data
- ⇨ Store part of the program as a text and interpret it only during runtime
- ⇨ Remove library calls

Current Techniques: Pro and Contra

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- ✔ Universal
- ✔ Good against static analysis

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- ✘ Even no hope for that
- ✘ Weak against dynamic attacks

Classical Program Analysis

What's about program analysis?

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Is Deobfuscation Hard?

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Alias analysis of obfuscated programs is NP-hard!

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Good Luck with this stuff!

Summary

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Question Time!

Not covered by the talk

Obfuscation vs. watermarking
Obfuscation for watermarking
Making disassembling hard.
Decompiled – uncompilable for Java
General idea – make program dictionary as short as possible
Preventive obfuscation
Profiling in the obfuscator
Reducible and non-reducible graphs
Are obfuscating transformations comparable, e.g. one OT is every time better than another OT?
Program Analysis classification

For Further Reading

Collberg - Thomborson - Low

Series of papers

http://www.cs.arizona.edu/~collberg/research/publications/