PROGRAM ANALYSIS

Julian Cohen

PROGRAM ANALYSIS

Manual

versus

Automatic

CORE CONCEPTS

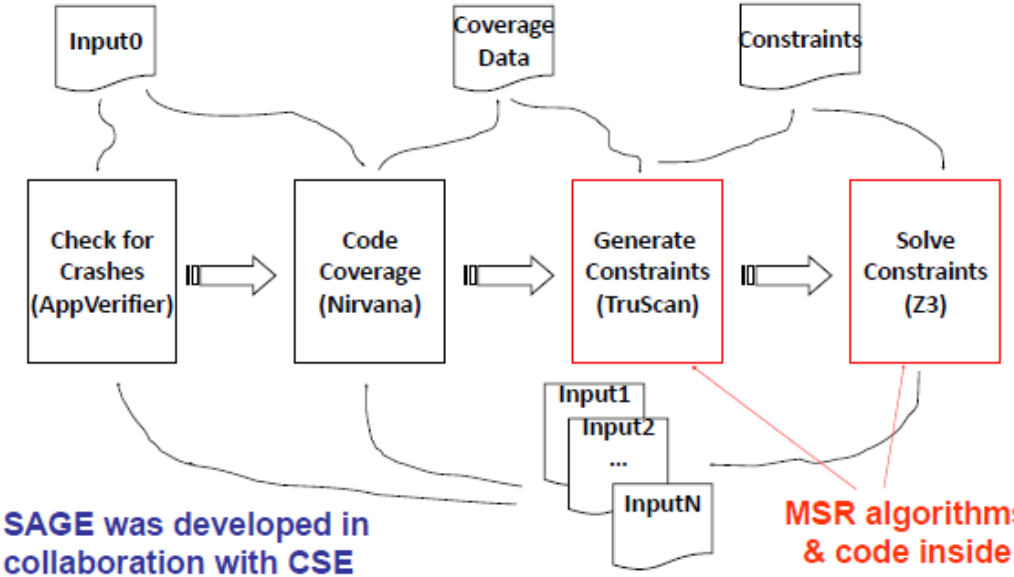
- The Halting Problem
- Rice's Theorem
- Code Analysis
- Automatic Testing
- Program Introspection
- Code Translation and Representation
- Code Coverage
- Data Flow Tracking
- Abstract Interpretation
- Symbolic Execution
- Constraint Solving
- Formal Verification

SYMBOLIC EXECUTION

CASE STUDY: SAGE

SAGE: Whitebox Fuzzing for Security Testing

Basic idea: 1.Run the program with first inputs,
2.gather constraints on inputs at conditional statements,
3.use a constraint solver to generate new test inputs,
4.repeat - possibly forever!



SAGE was developed in collaboration with CSE

MSR algorithms & code inside

Impact: since 2007

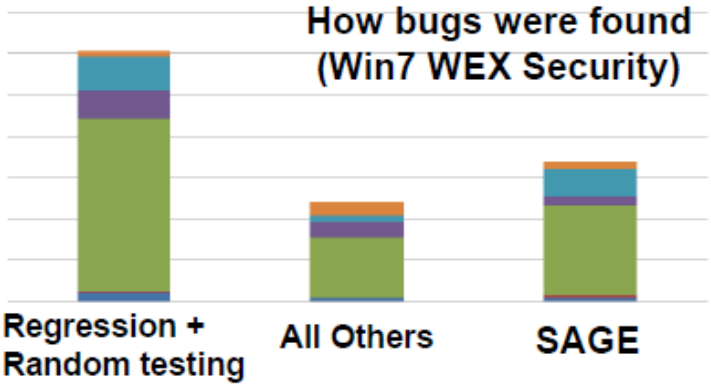
- 200+ machine years (in largest fuzzing lab in the world)
- 1 Billion+ constraints (largest SMT solver usage ever!)
- 100s of apps, 100s of bugs (missed by everything else…)
- Ex: 1/3 of all Win7 WEX security bugs found by SAGE →
- Bug fixes shipped quietly (no MSRCs) to 1 Billion+ PCs
- Millions of dollars saved (for Microsoft and the world)
- SAGE is now used daily in Windows, Office, etc.

The SAGE team:
MSR: E. Bounimova, P. Godefroid, D. Molnar
CSE: M. Levin, Ch. Marsh, L. Fang, S. de Jong,…
+ thanks to all the SAGE users!
Windows: N. Bartmon, E. Douglas, D. Duran, I. Sheldon
Office: T. Gallagher, E. Jarvi, O. Timofte

SAGE is the first whitebox fuzzer

Research Challenges:
- How to recover from imprecision ? PLDI'05, PLDI'11
- How to scale to billions of x86 instructions? NDSS'08
- How to check many properties together? EMSOFT'08
- How to leverage grammar specifications? PLDI'08
- How to deal with path explosion ? POPL'07,TACAS'08
- How to reason precisely about pointers? ISSTA'09
- How to deal with floating-point instr.? ISSTA'10
- How to deal with input-dependent loops? ISSTA'11

+ research on constraint solvers



CASE STUDY: KLEE