Pimp my Triton

Introducing Triton and Pimp a triton based plugin for R2

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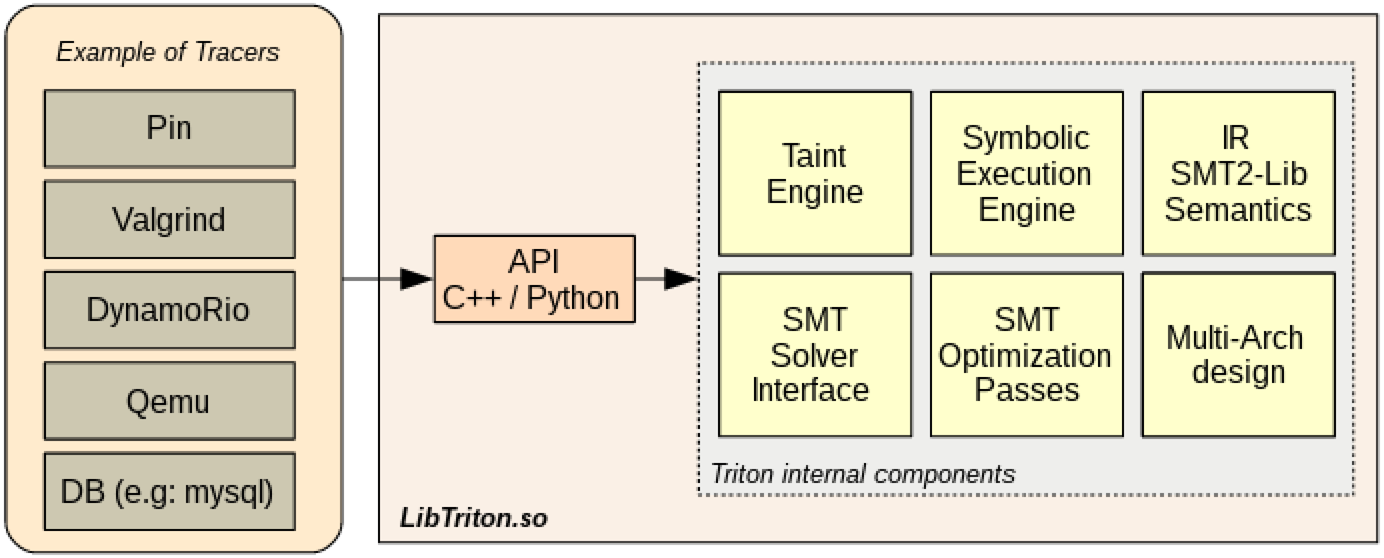
Triton Overview (Who ?)

- Developed by QuarksLab's Triton Team:
  - Jonathan Salwan (Main dev)
  - Florent Saudel
  - Pierrick Brunet
  - Romain Thomas

Great / reactive support on #qb_triton !!

Triton Overview (What ?)



Triton Overview (continued)

Triton is a dynamic binary analysis framework:

- **Features**
  - Dynamic Symbolic Execution engine.
  - Taint Engine.
  - SMT solver.
  - SMT simplification passes.
  - x86/x64 instruction semantics AST Representations.
  - Tracer Interface.
  - python bindings.
  - Bonus: Pin python API

Dynamic Symbolic Execution Engine

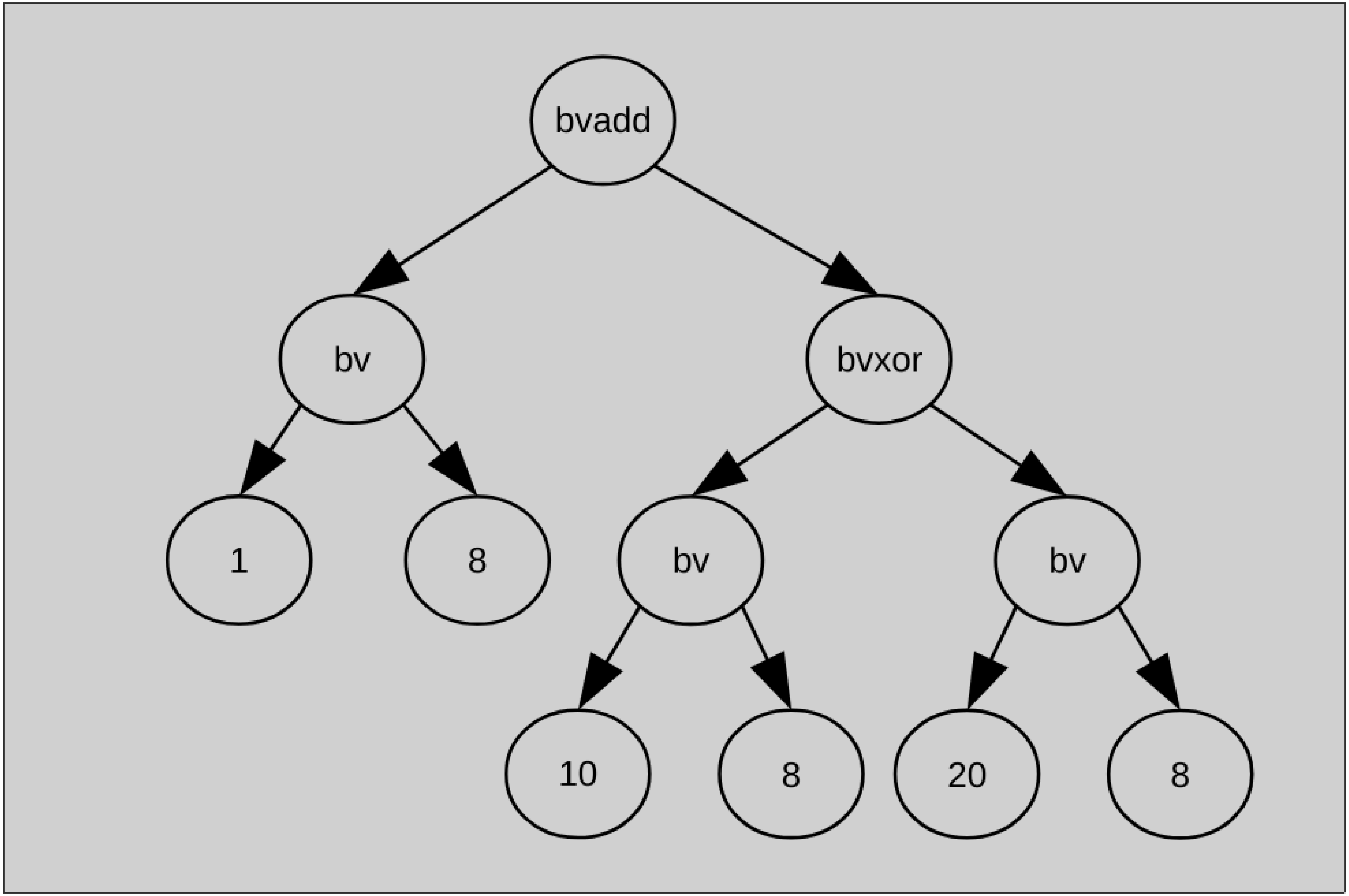
This engine maintains:

- a table of symbolic registers states
- a map of symbolic memory states
- a global set of all symbolic references

Ast representation

```
mov al, 1
mov cl, 10
mov dl, 20
xor cl, dl
add al, cl
```

Ast representation



Ast representation

Triton translates the x86 and the x86-64 instruction set semantics into AST representations on the
SSA form:

```
Instruction: add rax, rdx
Expressions: ref!41 = (bvadd ((_ extract 63 0) ref!40) ((
```

Where `ref!41` is the new expression of RAX and, `ref!40` is the previous expression of RAX, and `ref!39` is the expression of RDX

Ast representation (continued)

One instruction may have more than one expression in order to handle flag semantics as well:

```
Instruction: add rax, rdx
Expressions: ref!41 = (bvadd ((_ extract 63 0) ref!40) ((
             ref!42 = (ite (= (_ bv16 64) (bvand (_ bv16
             ref!43 = (ite (bvult ref!41 ((_ extract 63 0
             ref!44 = (ite (= ((_ extract 63 63) (bvand (
             ref!45 = (ite (= (parity_flag ((_ extract 7
             ref!46 = (ite (= ((_ extract 63 63) ref!41)
             ref!47 = (ite (= ref!41 (_ bv0 64)) (_ bv1 1
```

Two forms:

- Z3 AST / SMT2 LIB (default)
- Python AST (human readable)

Ast representation (python)

emulating the code:

```
# Build an instruction
inst = Instruction()

# Setup opcodes
inst.setOpcodes(opcodes)

# Setup Address
inst.setAddress(addr)

# Process everything
processing(inst)

# Display instruction
print inst

# Display SymbolicExpressions
print inst.getSymbolicExpressions()
```

Demo ?

SMT simplification

2 possible ways for simplifications:

- provide simplification callbacks through `addCallback(cb, CALLBACK.SYMBOLIC_SIMPLIFICATION)` and call `simplify(expr)`
- ask Z3 to simplify an expressions `simplify(expr, True)`

Demo ?

Constraint resolution

Just like Z3, Triton provides the ablity to generate models (inputs) based on some constraints.
--> Need symbolic variables !

Two methods:

- With getPathConstraints/getBranchConstraints helper function.
- Building your own constraint.

Demo ?

Constraint resolution

Define a symbolic variable:

- `convertMemoryToSymbolicVariable`
- `convertRegisterToSymbolicVariable`

Constraint resolution

Building a constraint

```
# get the symbolic expression of the register/memory
# you want to play with:

raxExpr = buildSymbolicRegister(REG.RAX)
memExpr = buildSymbolicMemory(
    MemoryAccess(0x00400546, 8)
)

# Write the constraint:
cstr = ast.assert_(
  ast.land(
      ast.equal(raxExpr, ast.bv(42, 8)),
      ast.equal(memExpr, ast.bv(42, 4))
  )
)
```

Demo ?

Constraint resolution

Triton also keeps a table of every symbolized branch it meets.
Symbolized branch: a branch instruction whos condition depends on the inputs. (IP's expression depends on the input)
`GetPathConstraints()` will return that table.
For each constraint, we'll be able to get the expression of each branch (the taken and the other one)

Demo ?

Generating a simplified / deobfuscated binary thanks to Arybo

What is Arybo

Developped by Quarks Lab (Adrien Guinet)

A **powerfull** tool in order to manipulate expressions.

Generating a simplified / deobfuscated binary thanks to Arybo

Three simple APIs:

- `tritonexprs2arybo` : converts a Triton expression to Arybo Expression
- `tritonast2arybo` : converts a Triton symbolic variable to arybo symbolic variable
- `to_llvm_function` : generates an llvm ir function.

Demo ?

Triton in radare thanks to Pimp

https://github.com/kamou/pimp.git

`r2pm -i pimp` (oooold version)

Commands:

- pimp.init: Initialize the Triton context (syncs registers only. Memory will be synced on demand)
- pimp.input: Declare symbolic variables (memory only)
- pimp.take: Take the jump
- pimp.avoid: Avoid the jump
- pimp.dcusi: Continue until symbolized instruction
- pimp.dcusj: Continue until symbolized jump
- pimp.dcu: Continue until address

Triton in radare thanks to Pimp (demo)

Future of Pimp:

- Simplification "database".
- Inplace simplification.
- Opaque predicate detection and CFG modification.
- Any ideas welcome.

Questions ?