JavaSMT 5.0 in CPAchecker

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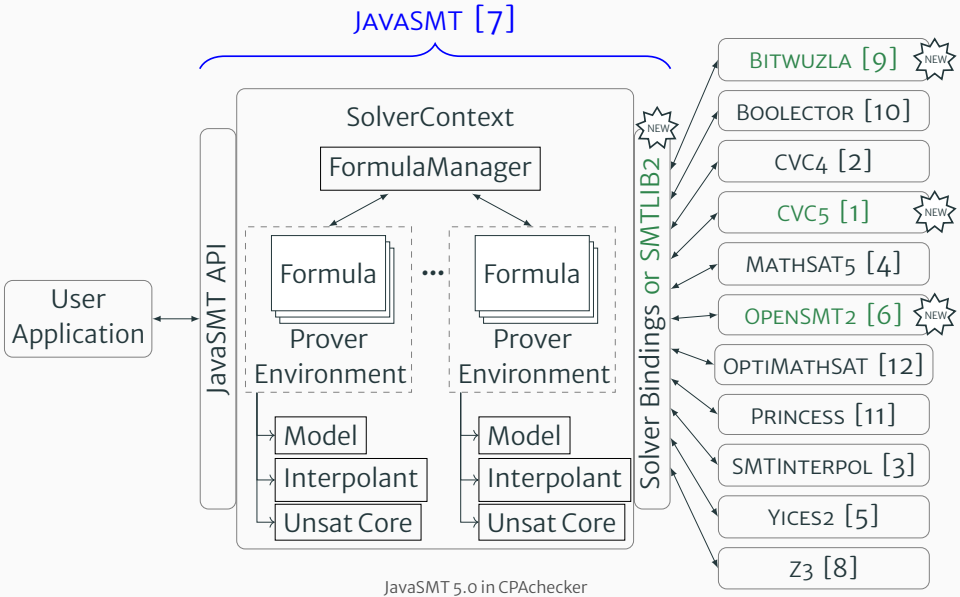
What is JavaSMT?

What is JavaSMT?

- Common API layer for SMT solvers
- SMT backend of CPAchecker
- Low overhead and automatic memory cleanup
- Java based and usable on Unix, Windows* and MacOS*
- Visit us here: `https://github.com/sosy-lab/java-smt`

* Depending on the solver.

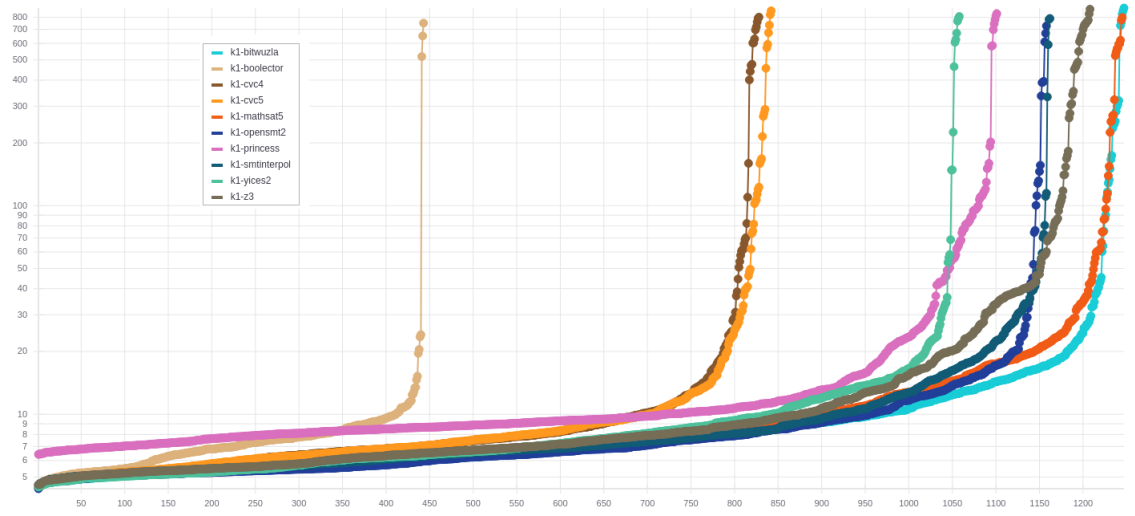
JavaSMT: New SMT Solvers



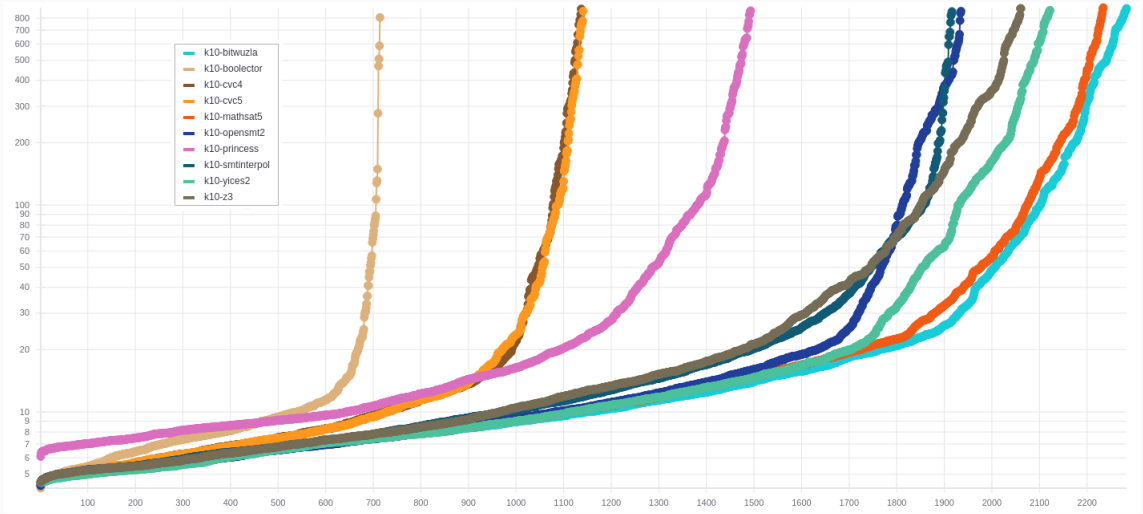
Performance of the New SMT Solvers

- Ran CPAchecker using BMC
- SV-COMP24 ReachSafety task-set
- SV-COMP24 settings, but 2 cores only
- Each solver run with 1 and 10 loop unrollings
- This is no case-study!
- Default encoding uses Bitvector theory for Integers
- Princess, SMTInterpol, OpenSMT2 do not support Bitectors and use other encodings

Performance of the New SMT Solvers using BMC (1 unrolling)



Performance of the New SMT Solvers using BMC (10 unrollings)



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- Coworker: No....

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Example

```
Configuration config = Configuration.defaultConfiguration();

SolverContext ctx =
    SolverContextFactory.createSolverContext(config, ..., Solvers.MATHSAT5);

FormulaManager mgr = ctx.getFormulaManager();

BooleanFormulaManager bMgr = mgr.getBooleanFormulaManager();
BooleanFormula varA = bMgr.makeVariable("a");
// a AND not a
BooleanFormula formula = bMgr.and(varA, bMgr.not(varA));

SolverContext ctxTwo =
    SolverContextFactory.createSolverContext(config, ..., Solvers.MATHSAT5);

try (ProverEnvironment prover = ctxTwo.newProverEnvironment()) {
        prover.addConstraint(formula);
        boolean isUnsat = prover.isUnsat(); // Exception:
                                            // Formula "and" expected argument of type Bool but received Bool
}
```

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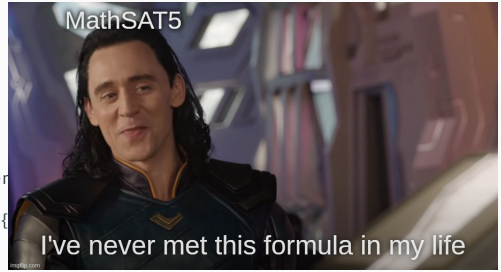

Common Errors that Repeatedly Happen

- Using formulas on distinct contexts/threads etc.
- Using the same solver on distinct threads

→ Different solvers support different things

→ Hard to know what solver supports what

→ Solution: automatic checks via a "Debug-Mode"

Example for Debug-Mode

```
Configuration config =
    Configuration.builder().setOption("solver.debugMode", "true").build();

SolverContext ctx =
    SolverContextFactory.createSolverContext(config, ..., Solvers.MATHSAT5);

FormulaManager mgr = ctx.getFormulaManager();

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BooleanFormula formula = bMgr.and(varA, bMgr.not(varA));

SolverContext ctxTwo =
    SolverContextFactory.createSolverContext(config, ..., Solvers.MATHSAT5);

try (ProverEnvironment prover = ctxTwo.newProverEnvironment()) {
        prover.addConstraint(formula);  // An exception is thrown that explains the issue
        boolean isUnsat = prover.isUnsat();
}
```

Future Work

- Add support for SMT-LIB2 only SMT solvers
- Support solver independent Interpolation
- Support solver independent Quantifier Elimination

References i

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Features of the New SMT Solvers

CVC5

- Successor of CVC4
- Integer, Rational, String, Separation-Logic, Bitvector, Floating-Point, Array and Quantifier support
- Features: Interpolation, Quantifier Elimination, Unsat-Core
- No support for concurrent usage!

Features of the New SMT Solvers

Bitwuzla

- Successor of Boolector
- Bitvector, Floating-Point, Array and Quantifier support
- Features: Quantifier Elimination, Assumption Solving, Unsat-Core
- No support for concurrent usage!

Features of the New SMT Solvers

OpenSMT2

- Integer, Rational and Array support
- Features: Interpolation (only QF_UF, QF_LIA and QF_LRA logics!)
- User needs to specify a logic beforehand!