Thorn: CHC-Based Software Verification

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What is Thorn?

Thorn Theta config delegating to CHC solvers

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Constrained Horn Clauses

- Logical formulas of the form
  $\varphi \wedge p_1(\bar{x}_1) \wedge ... \wedge p_n(\bar{x}_n) \implies h(\bar{x})$
- Uninterpreted predicates $\rightarrow$ invariants
- Solvers: **Eldarica**, **Golem**, **Z3**

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SV-COMP 2026 Categories

- ReachSafety
- MemSafety
- NoOverflows
- **Concurrency** (novel for CHC)
- **Termination** (novel encoding)

CHC Encoding

Program as Control Flow Automaton

- Locations $\rightarrow$ uninterpreted predicates $L(\bar{v})$
- Edges $\rightarrow$ implications:

$$L_{src}(\bar{v}) \wedge \mathit{edge}(\bar{v}, \bar{v}') \implies L_{dst}(\bar{v}')$$

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Example

```
int x = 0;          // L0
while (x < 5)       // L1
    x++;             // L2
assert(x == 5);     // L3 (err if !=)
```

CHC system:

$$\begin{aligned}
\top &\implies L_0(0) \\
L_0(x) &\implies L_1(x) \\
L_1(x) \wedge x < 5 &\implies L_2(x) \\
L_2(x) &\implies L_1(x+1) \\
L_1(x) \wedge x \geq 5 &\implies L_3(x) \\
L_3(x) \wedge x \neq 5 &\implies \bot
\end{aligned}$$

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- Interleavings → nondeterministic choice
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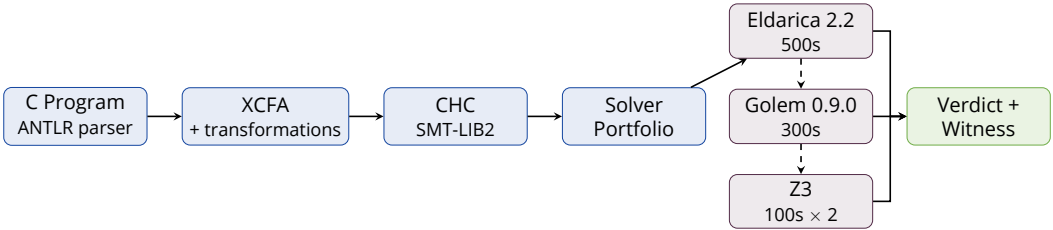
Termination Ranking functions

- Introduce step counter k
- Assert no state revisited:

$$L(\bar{v}, k) \wedge L(\bar{v}, k') \wedge k \neq k' \implies \bot$$

- SAT model $\rightarrow$ ranking function $g = k_{\max} - f(\mathit{loc}, \bar{v})$
- UNSAT $\rightarrow$ lasso-shaped counterexample (nontermination)

Architecture



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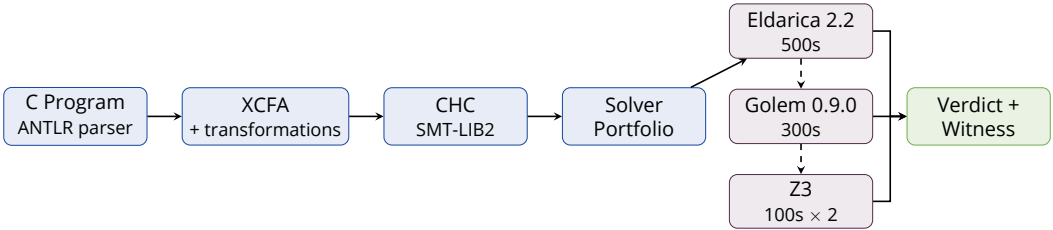

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- Solvers tried sequentially
- Timeout/error → next solver
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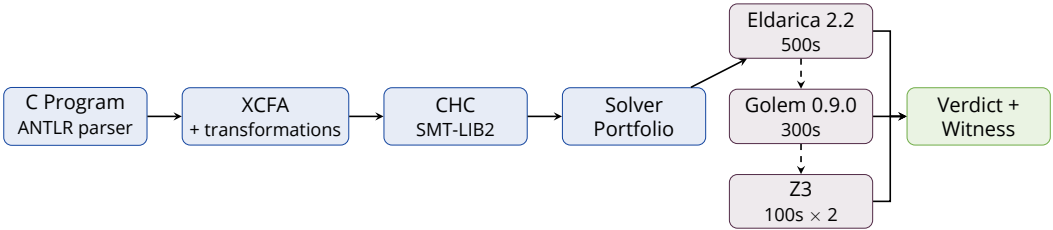

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Witness generation

- SAT model → location invariants (correctness witness)
- UNSAT proof → counterexample trace (violation witness)

Summary

Strengths	Proofs, concurrency

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- Unbounded thread creation not supported
- May struggle with large programs/bitvectors
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Part of Theta — open-source, Apache 2.0

github.com/ftsrg/theta theta.mit.bme.hu