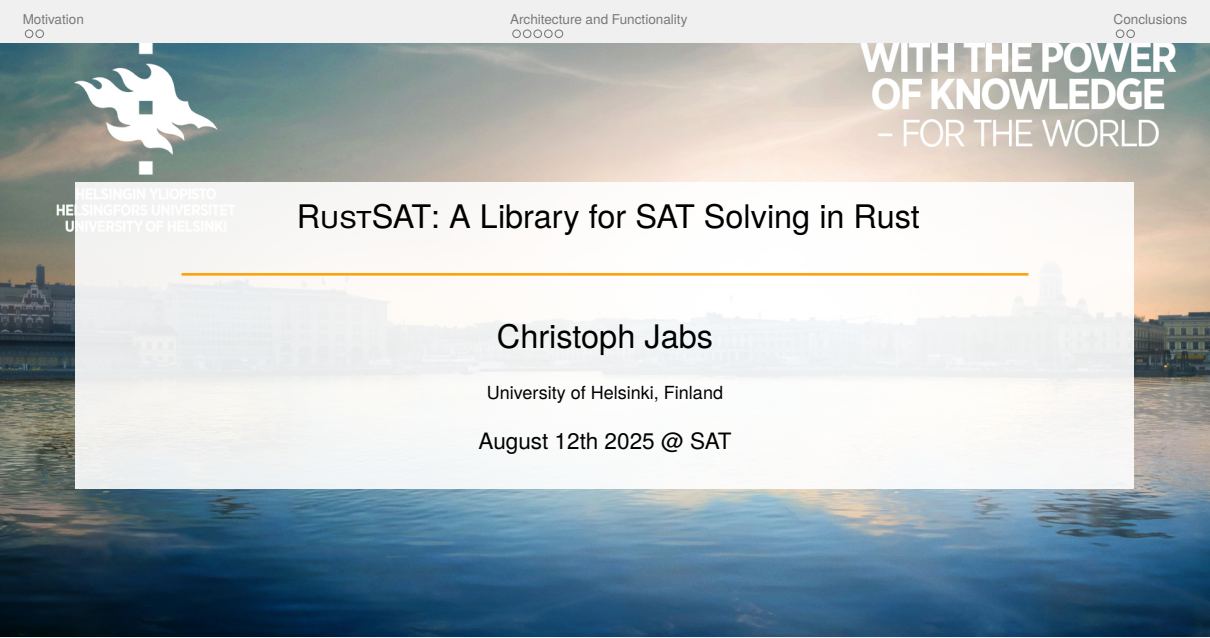

RustSAT: A Library for SAT Solving in Rust

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August 12th 2025 @ SAT

SAT Solving is Great

…but not always easy for non-experts

- SAT-based approaches are great for many applications
- Implementing SAT-based tools requires expert knowledge
- Reducing barriers of entry is important for increasing adoption of SAT technology
- Great examples
  - IPASIR: unifying solver interfaces
  - PySAT: making SAT accessible in Python
  - …

RustSAT: SAT solving in Rust

Contributions

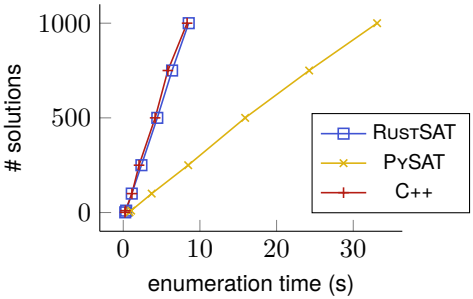
A library for easy and performant SAT solving in Rust

RustSAT: A Rust library for …

- working with SAT (and related) instances
- interfacing state-of-the-art SAT solvers
- encoding higher-level constraints to SAT

…with the aim of …

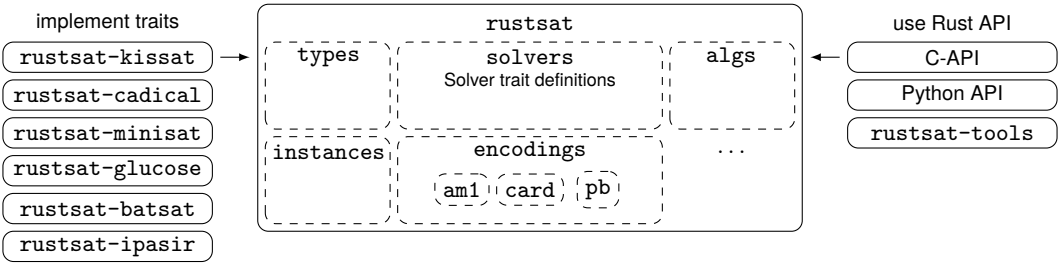
- a good user experience (automatically compiling/linking SAT solvers, good documentation, …)
- little to no performance overhead



`github.com/chrjabs/rustsat`

Architecture Overview

Core library, solver interfaces, external APIs



Working with Instances

Building, parsing, and converting

- Basic types (`Var`, `Lit`, `Clause`, ...)
- Instance types
  - `SatInstance`: Decision problem instance
  - `OptInstance`: Optimization problem instance
  - `Cnf`
- File parsing (DIMACS (W)CNF, OPB)
- Encoding to CNF
- ...

Unified Solver Interface

Plug & play SAT solvers thanks to Rust's type system

Functionality defined as `traits` (interfaces)

- `Solve`: one-shot solving
- `SolveIncremental`: *incremental* solving
- `PhaseLit`: user phases
- `LimitConflicts`, `LimitDecisions`, `LimitPropagations`
- ...

Included solvers

- Kissat (3.0.0 – 4.0.2) [Biere et al. 2024b]
- CaDiCaL (1.5.0 – 2.1.3) [Biere et al. 2024a]
- MiniSat (2.2.0) [Eén and Sörensson 2003]
- Glucose (4.2.1) [Audemard and Simon 2009]
- Batsat (0.6.0) [Cruanes and Hara n.d.]
- IPASIR [Balyo and Biere n.d.]
- Call solver binary

Higher-level Constraint Encodings

Optimized encodings, implemented in Rust, also available in a C and Python API

At-most-one constraints

- Pairwise [Prestwich 2021]
- Ladder [Gent and Nightingale 2004]
- Bitwise [Prestwich 2007]
- Commander [Klieber and Kwon 2007]
- Bimander [Nguyen and Mai 2015]

Cardinality constraints

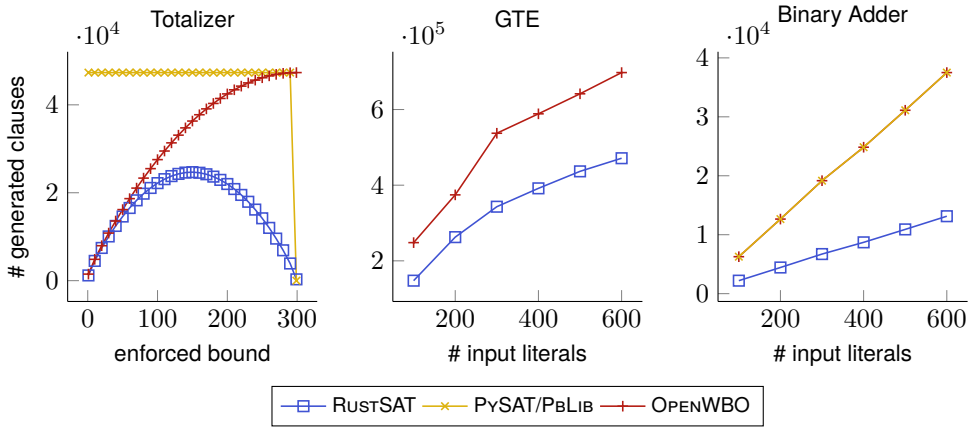
- Totalizer [Bailleux and Boufkhad 2003]

Pseudo-Boolean constraints

- Generalized totalizer [Joshi et al. 2015]
- Binary adder [Warners 1998]
- Dynamic polynomial watchdog [Paxian et al. 2018]

Cone of Influence Optimization

Removing “dangling” clauses from encodings



RustSAT in Use

Thanks to early adopters and their feedback

Rust projects

- Product configuration tool for automotive industry [Bruns 2024]
- Explaining pen and paper puzzles [Espasa et al. 2021]
- Scuttle multi-objective MaxSAT solver [Jabs n.d.]

Constraint encodings through C-API

- Loandra MaxSAT solver [Berg et al. 2024]
- MalloMax distributed MaxSAT solver [Schreiber et al. 2025]

RustSAT: A Library for SAT Solving in Rust

Summary and conclusions

Functionality

- Working with SAT instances
- Solver interfaces
- Higher-level constraint encodings

Design goals

- Polished user experience
- Little to no performance overhead

RustSAT repo, docs, paper, slides, and contact:

`christophjabs.info/sat25`

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