Verus: program verification for practical engineering

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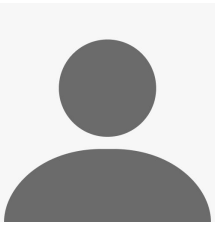

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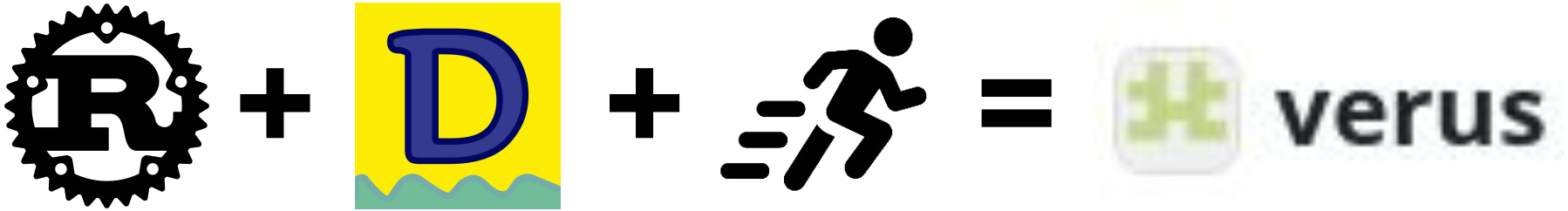
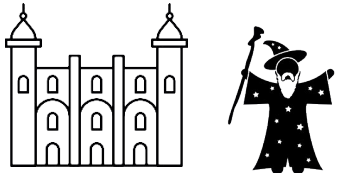
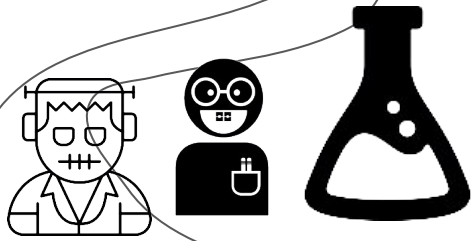
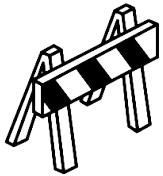

verus

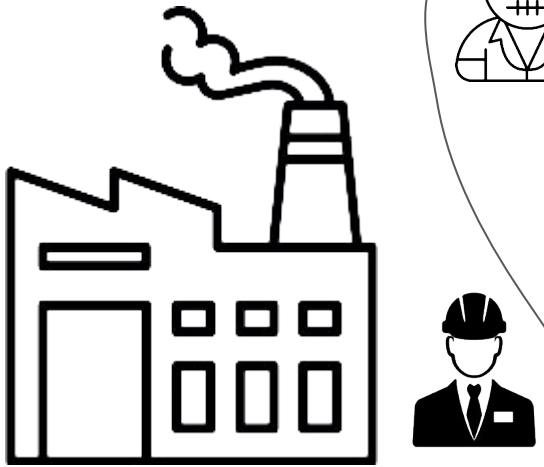
Why a new verifier?

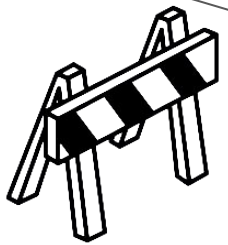






barriers to further research

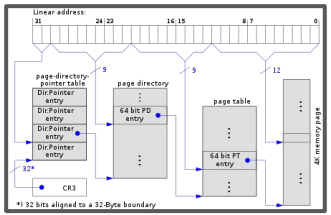




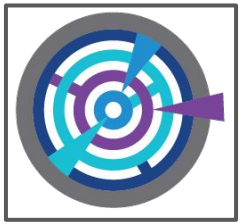
barriers to productive use

Design choices driven by observed burdens

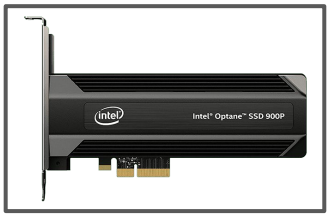
OS Page Table



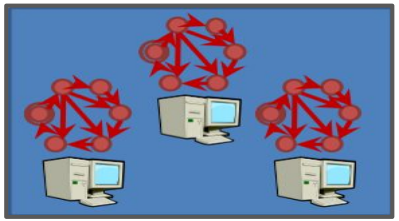
Write-Optimized Key-Value Store



Persistent-Memory Log

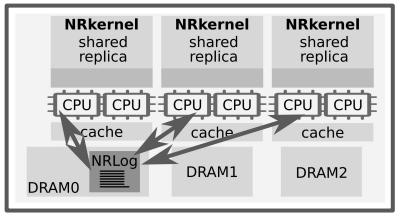


Distributed Key-Value Store



Concurrent Memory Allocator

NUMA-aware Replica Library



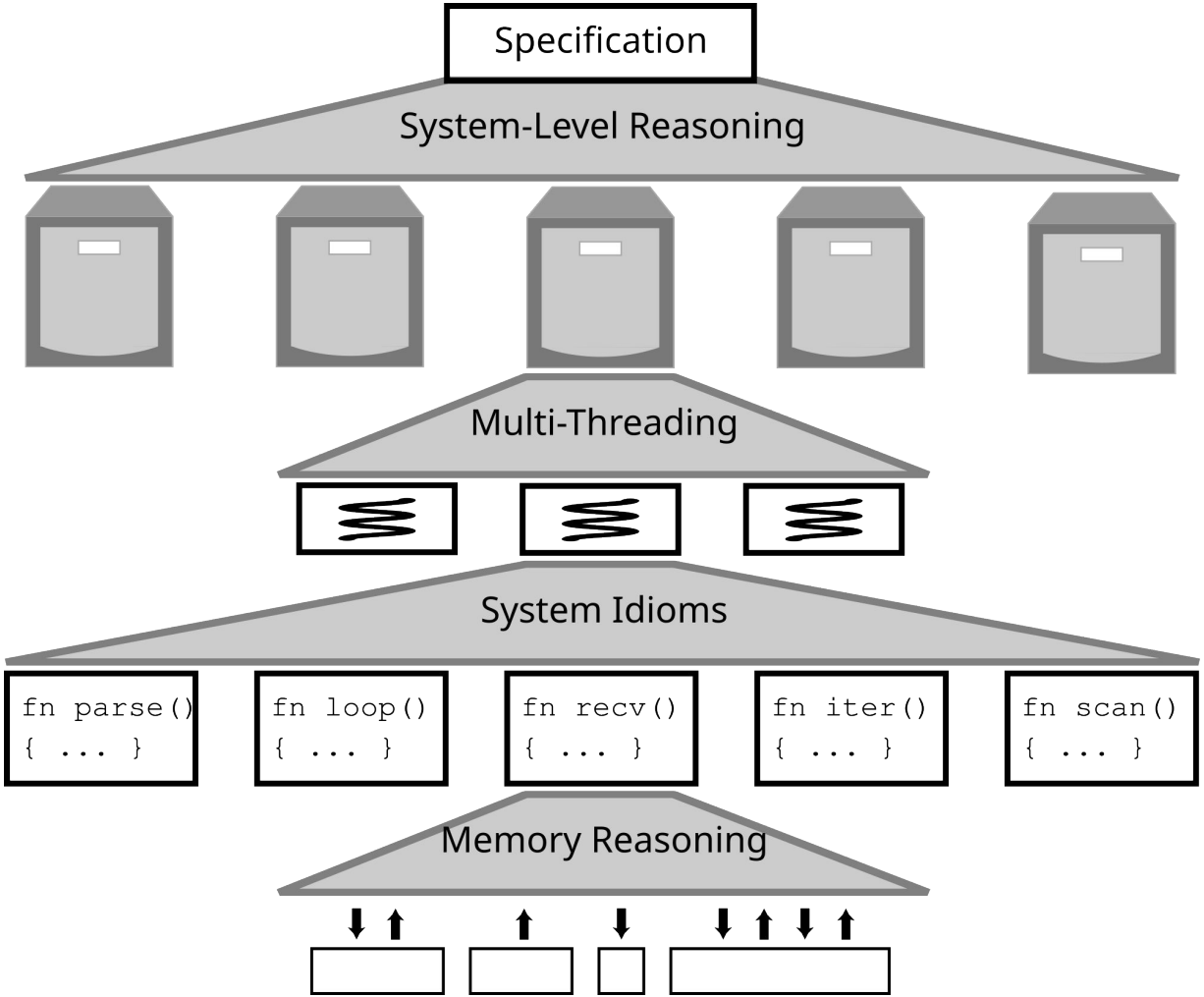
Automation: *faster* proofs

context: general SMT-based automation by default

problem: sluggish SMT queries

solution: efficiency-optimized verification condition generation

- easy wins: Rust ownership, aggressive context pruning
- tradeoffs: conservative triggers, total spec fn


Specification
System-Level Reasoning
Multi-Threading
System Idioms
fn parse() { ... }
fn loop() { ... }
fn recv() { ... }
fn iter() { ... }
fn scan() { ... }
Memory Reasoning

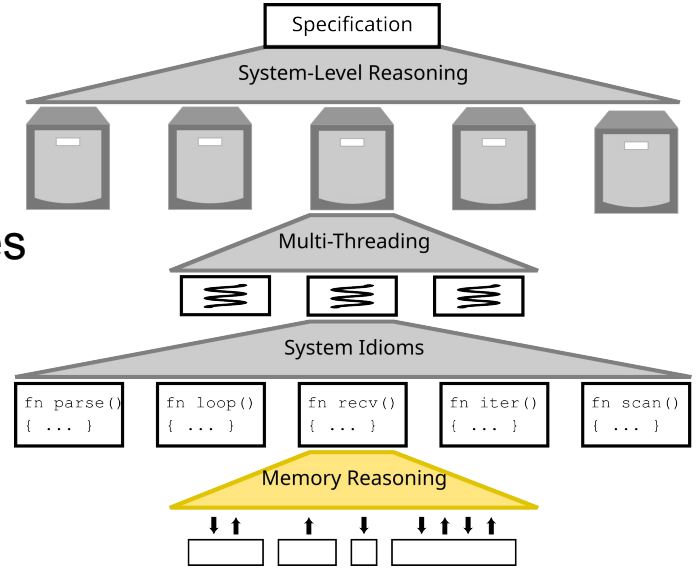
Memory reasoning

context: performant code mutates rich data structures

problem: framing-based reasoning
is objectively awful [OOPSLA22]

solution:

- Rust ownership by default
- Sophisticated borrow checker:
elegant syntax for common patterns



Systems-specific proof automation

context: performant systems code
relies on %, >>, constants

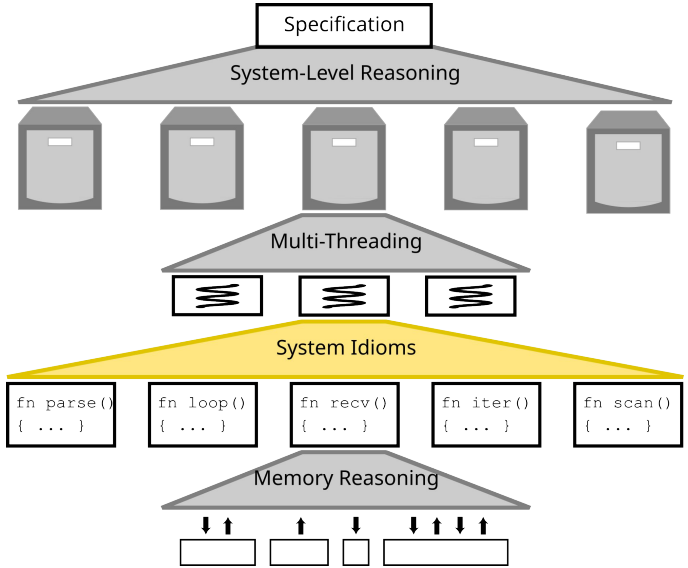
problem: mixed theories grieve Z3

solution: Local `assert_by` modes for

nonlinear (%),

bitvector (>>), and

assert-by-computation

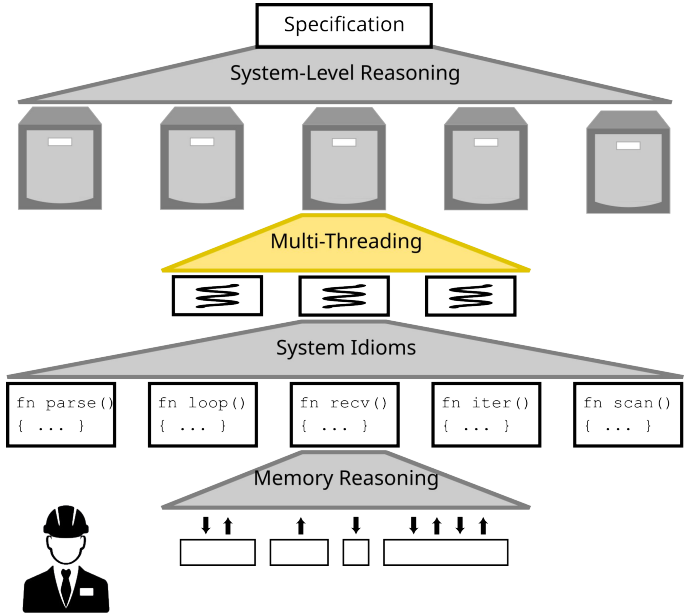


Thread concurrency

context: performant code exploits shared-memory threading

problem: separation logic is low-level

solution: VerusSync high-level "sharded state machine" expresses concurrency discipline

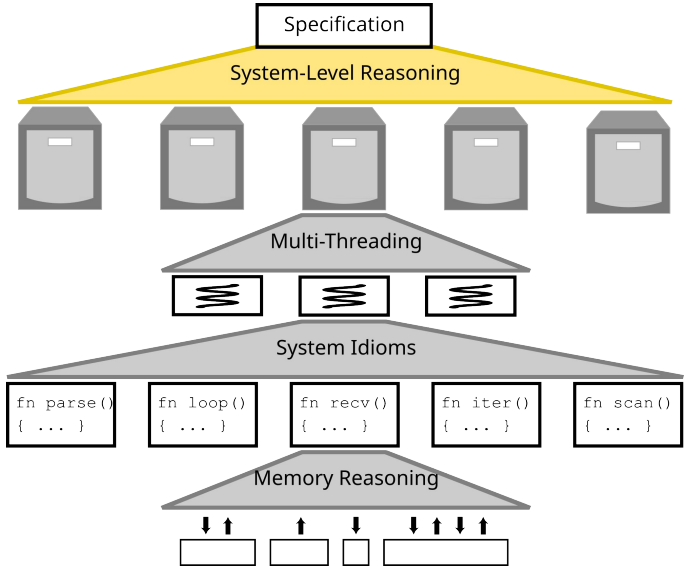


Systems-level reasoning

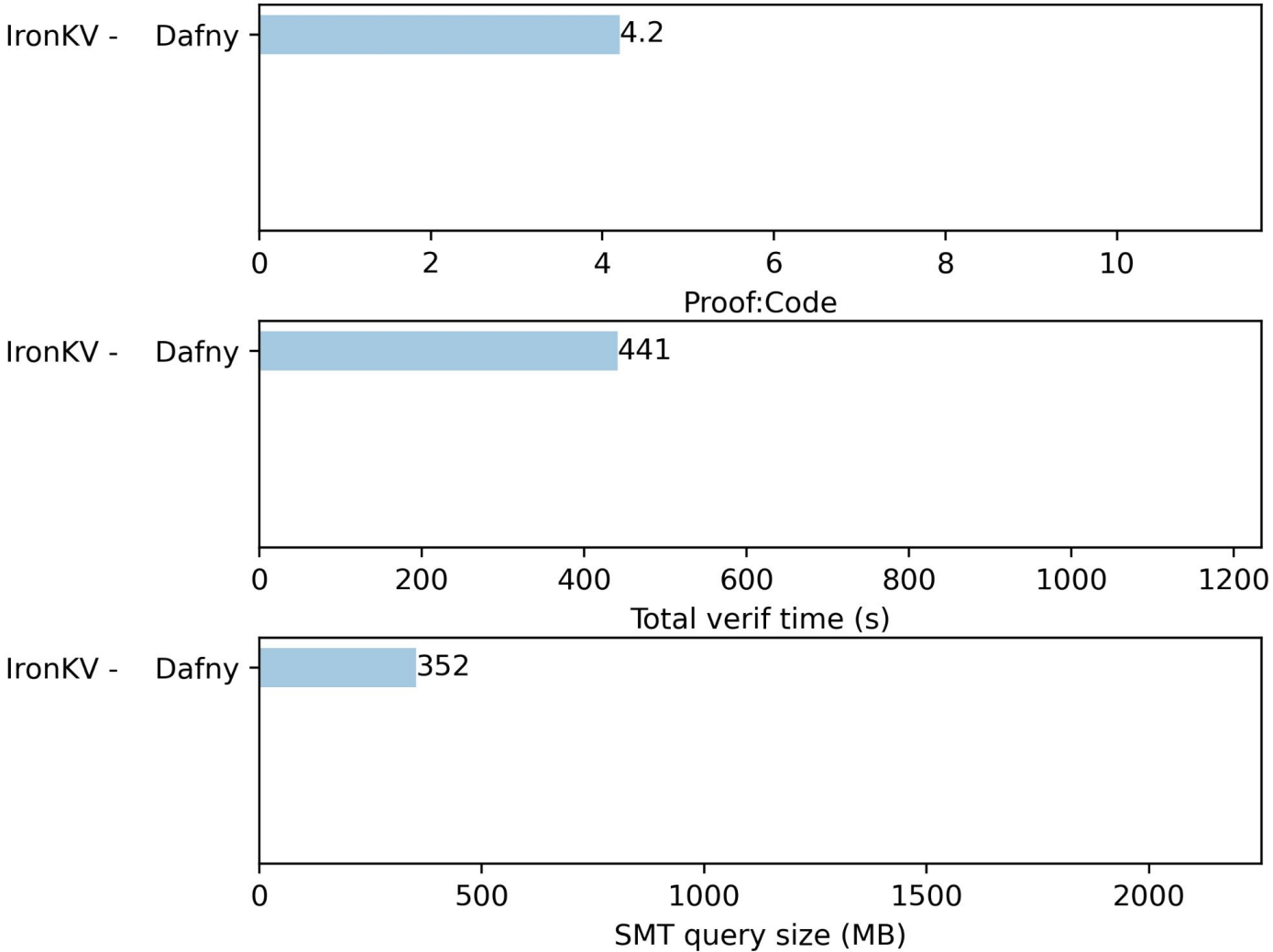
context: IronFleet style models *systems* as atomic state machines

problem: embedded TLA+ makes ugly boilerplate

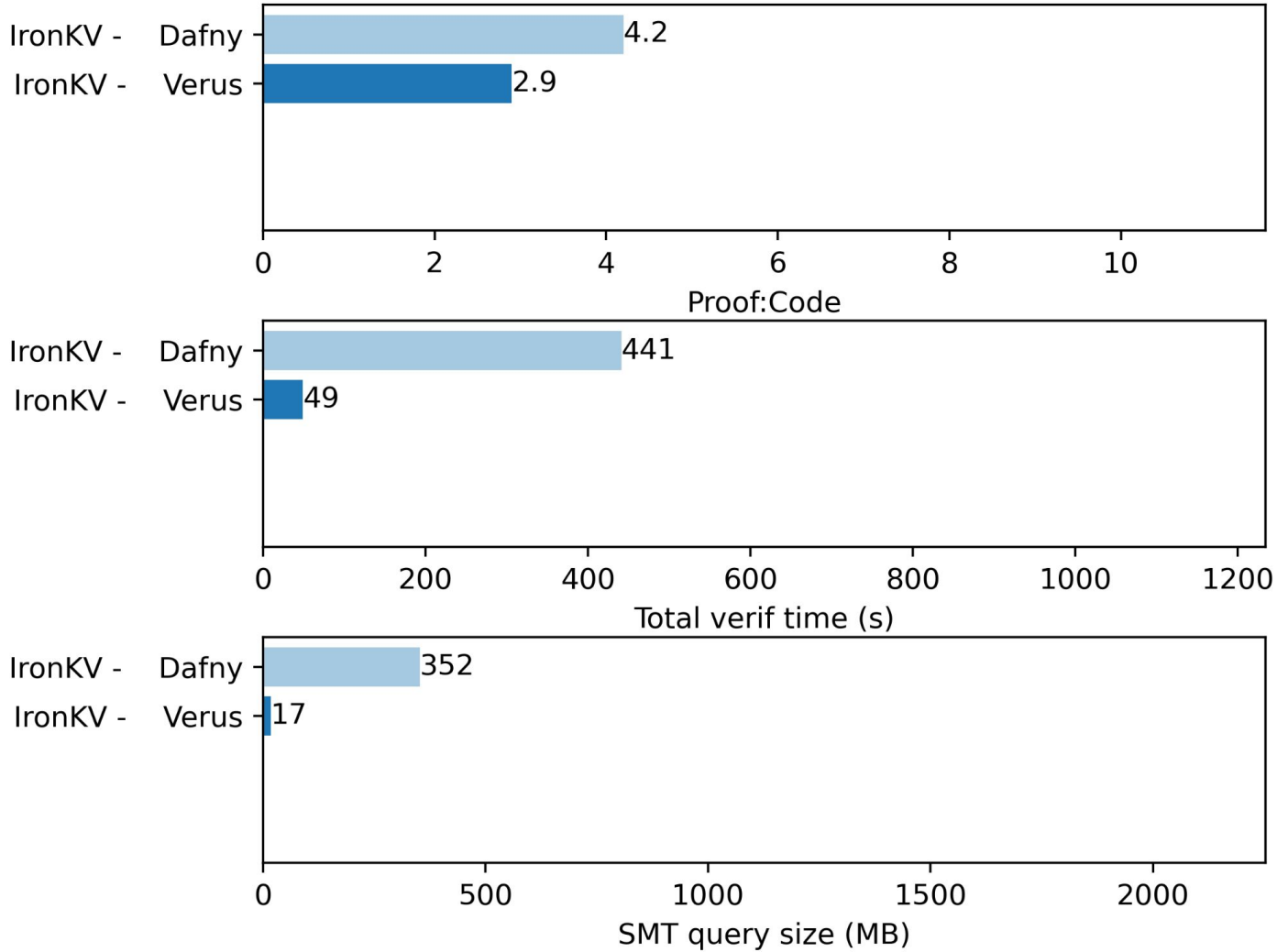
solution: native atomic state machine syntax



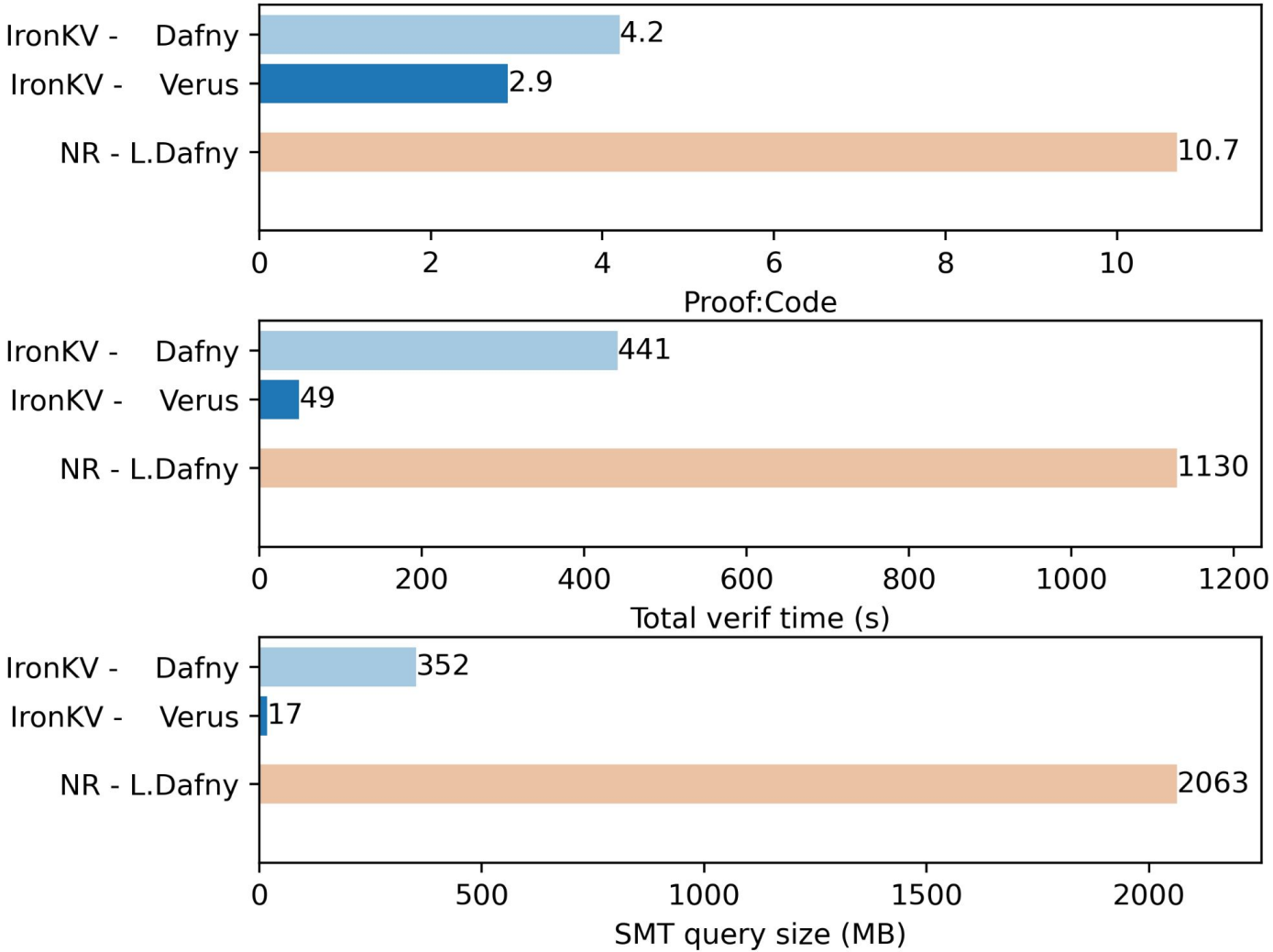
Macrobenchmarks



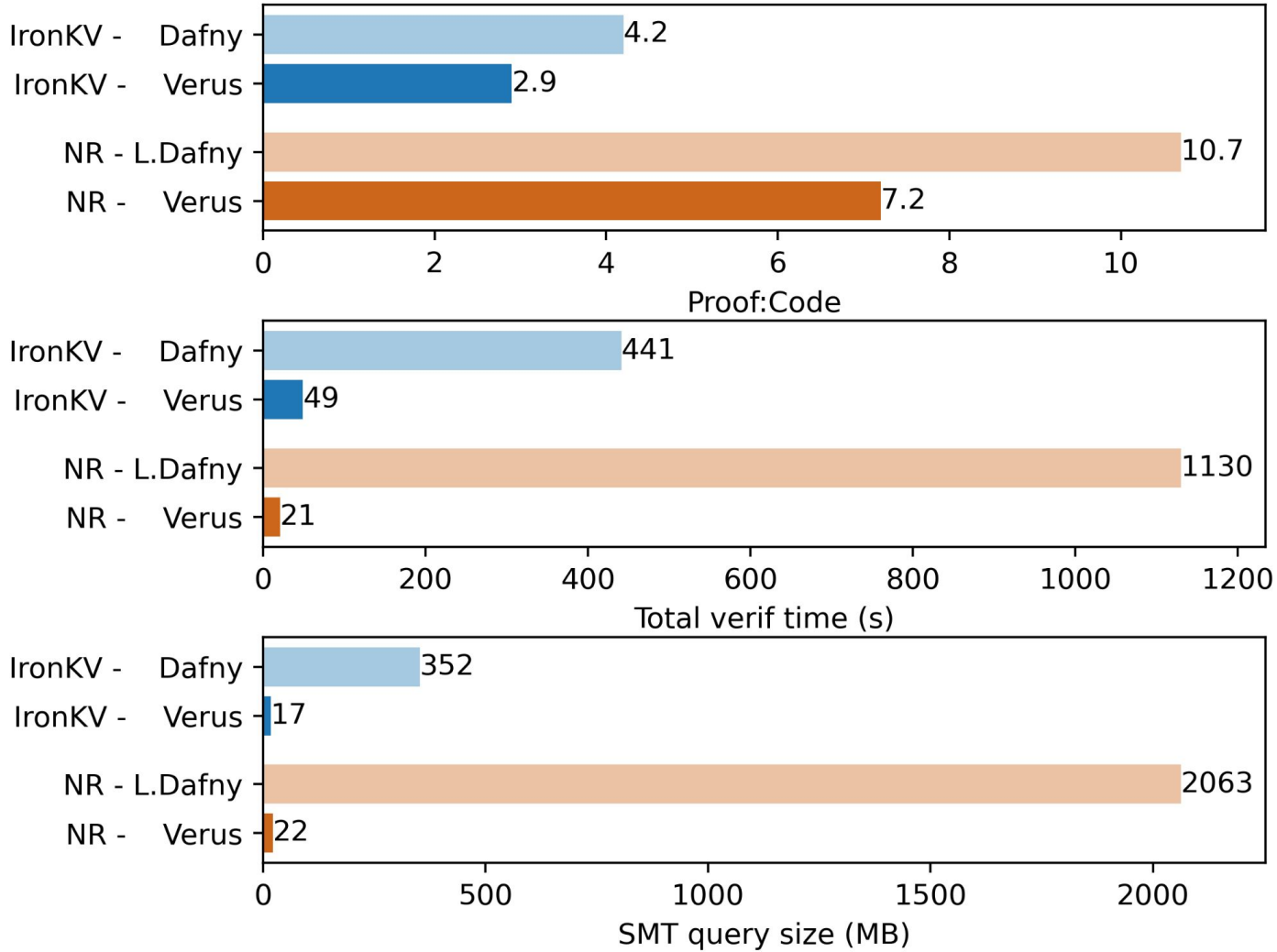
Macrobenchmarks



Macrobenchmarks



Macrobenchmarks



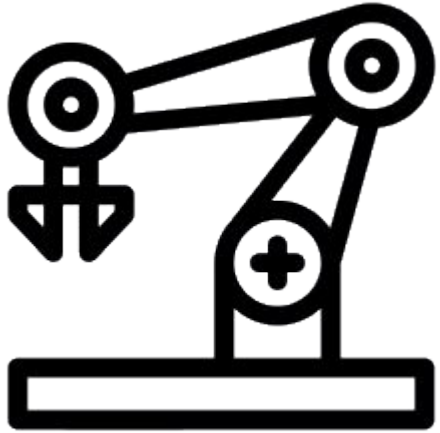
Conclusion

Verus is a new verifier aimed at practical use + new research.

Try it out:	`play.verus-lang.org`
Install it:	`github.com/verus-lang/verus`
Ask users:	`verus-lang.zulipchat.com`

backup

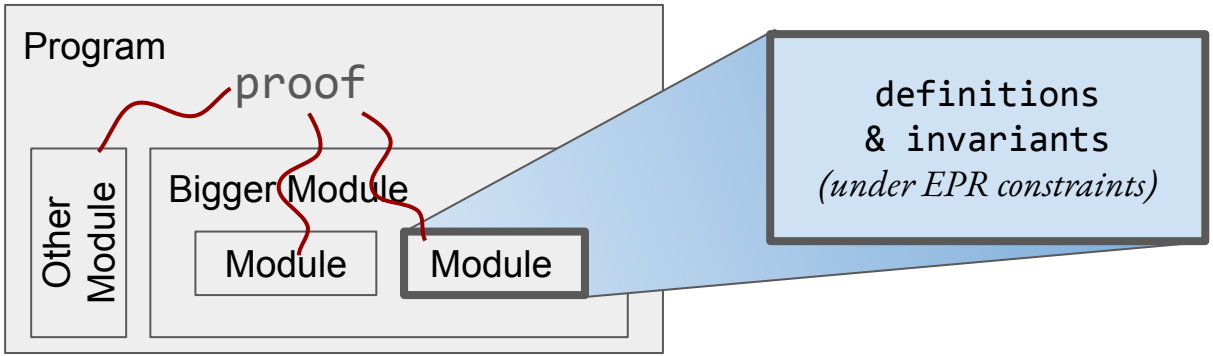
Automation: *fully automatic* proofs



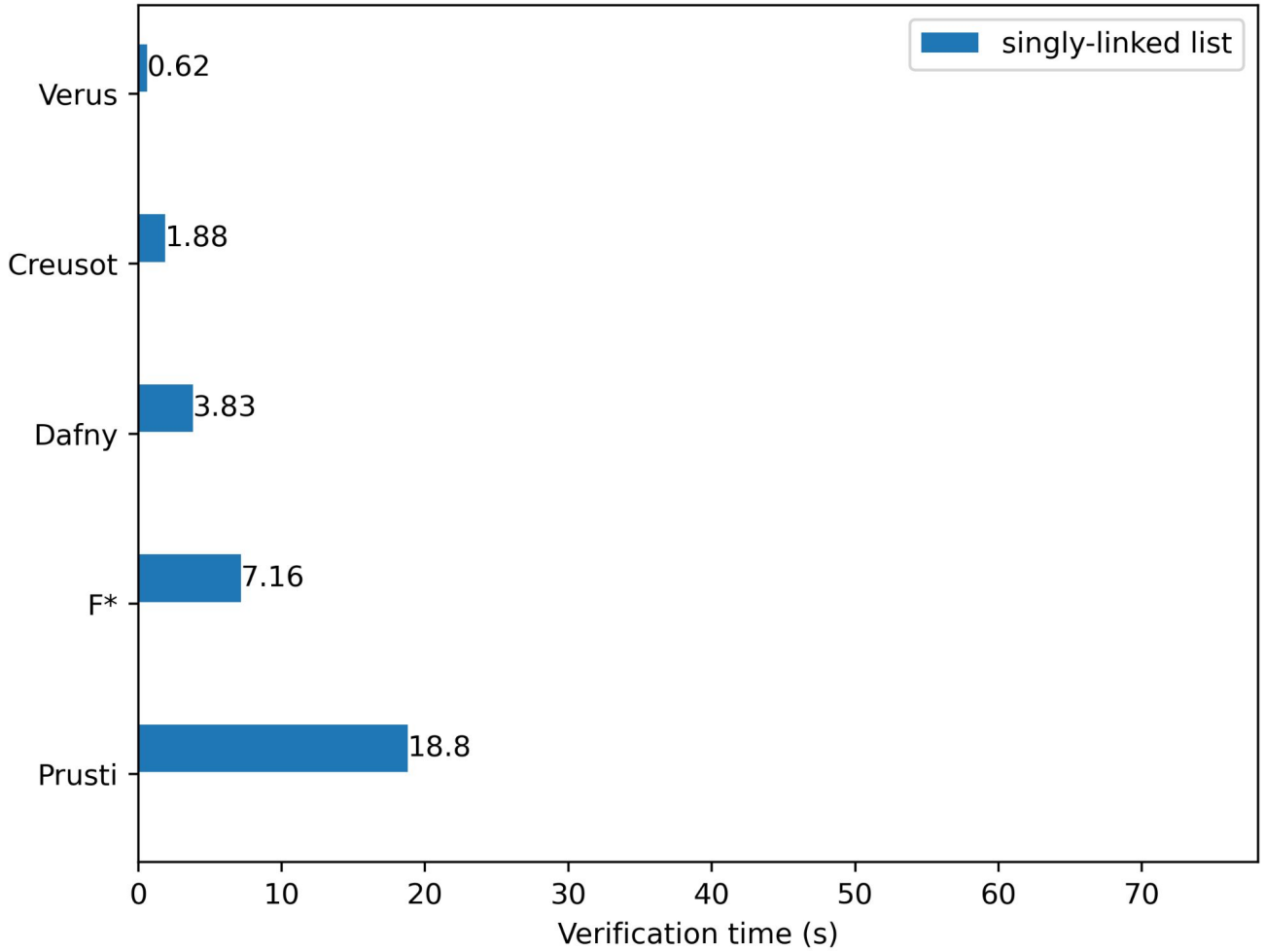
context: exploit full automation (ivy, mypyvy, pushbutton)

problem: all-or-nothing

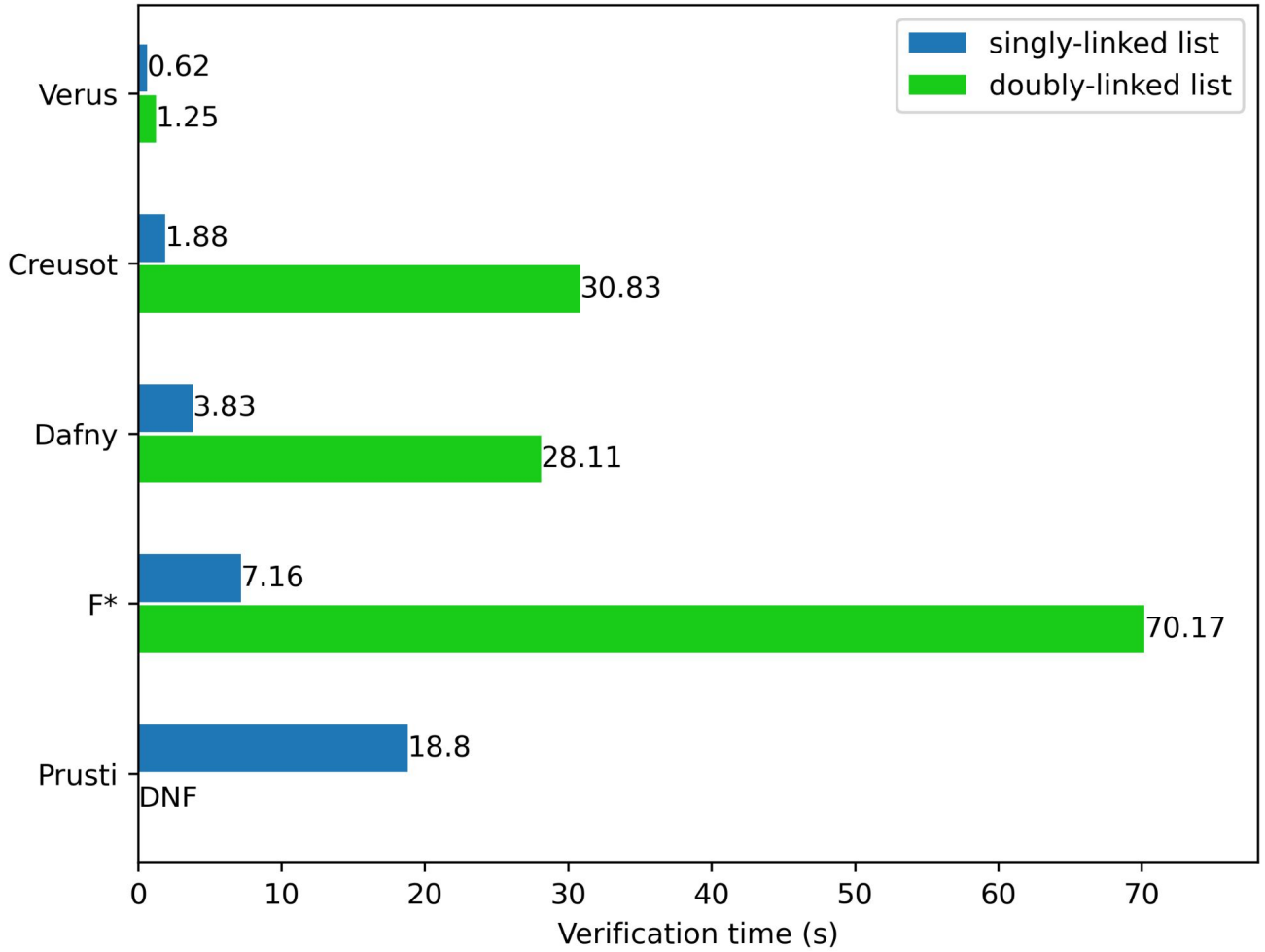
solution: opt-in integration



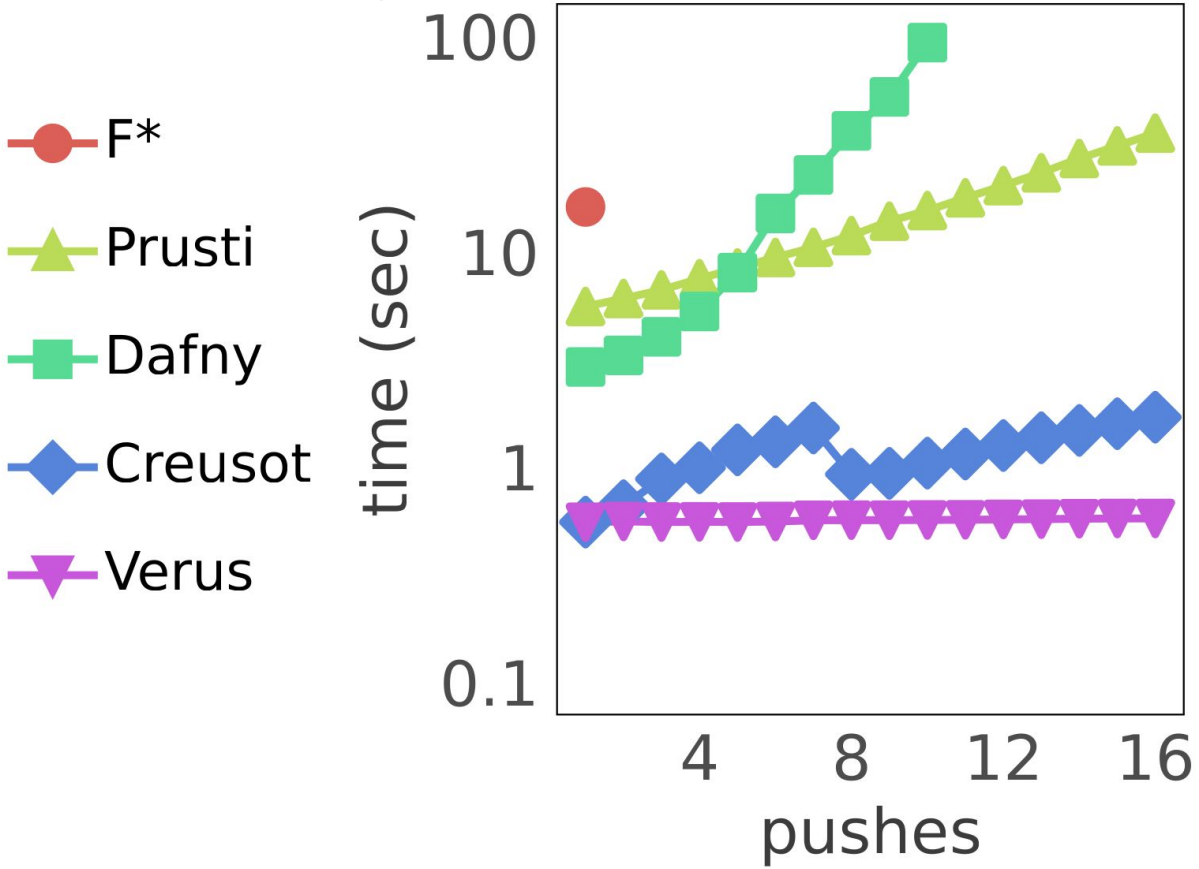
Millibenchmarks



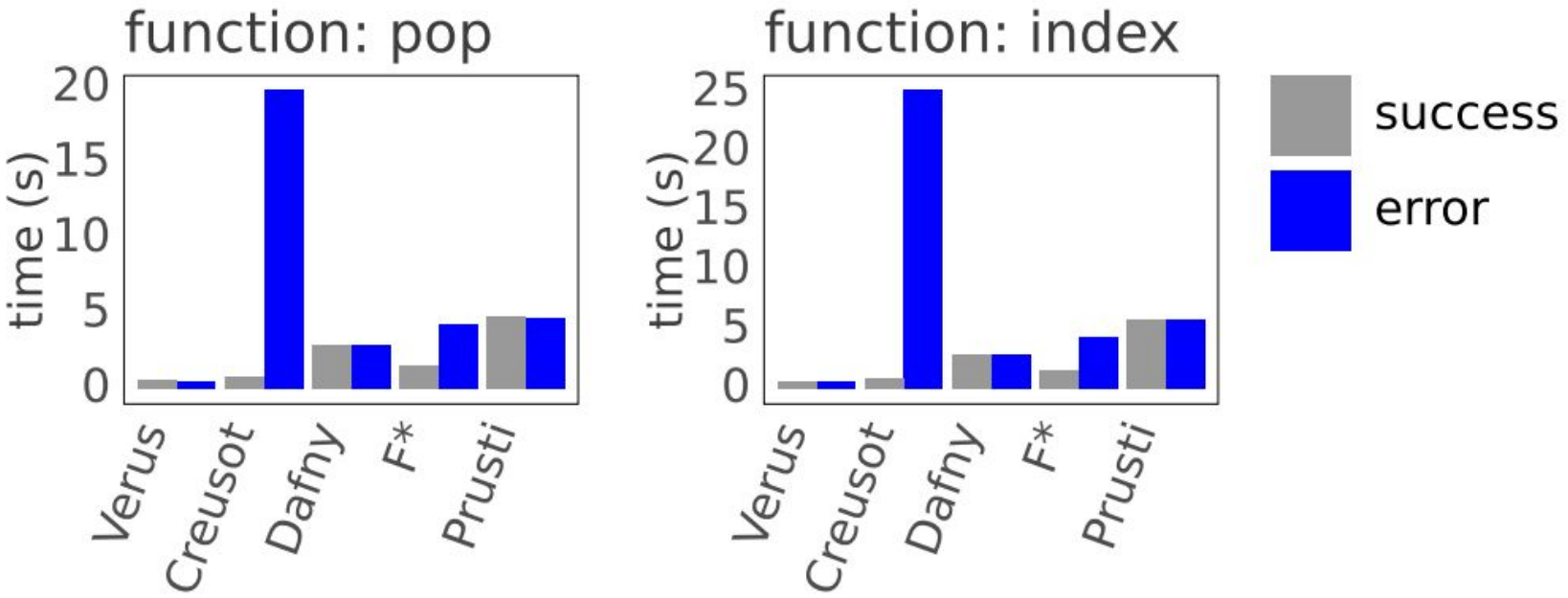
Millibenchmarks



Verus scales with fn complexity



Verifier is fast on failures



Future Directions

Improving Rust compatibility / feature coverage => more practically usable

Verify Rust standard library

Proof stability improvements

Experiments with other backends