Developing an Open-Source, State-of-the-Art Symbolic Model-Checking Framework for the Model-Checking Research Community

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Evolution of Model-Checking Algorithms

1. BDD-based
2. SAT-based / bounded model checking
3. IC3 / k-liveness

Evolution of Model-Checking Algorithms

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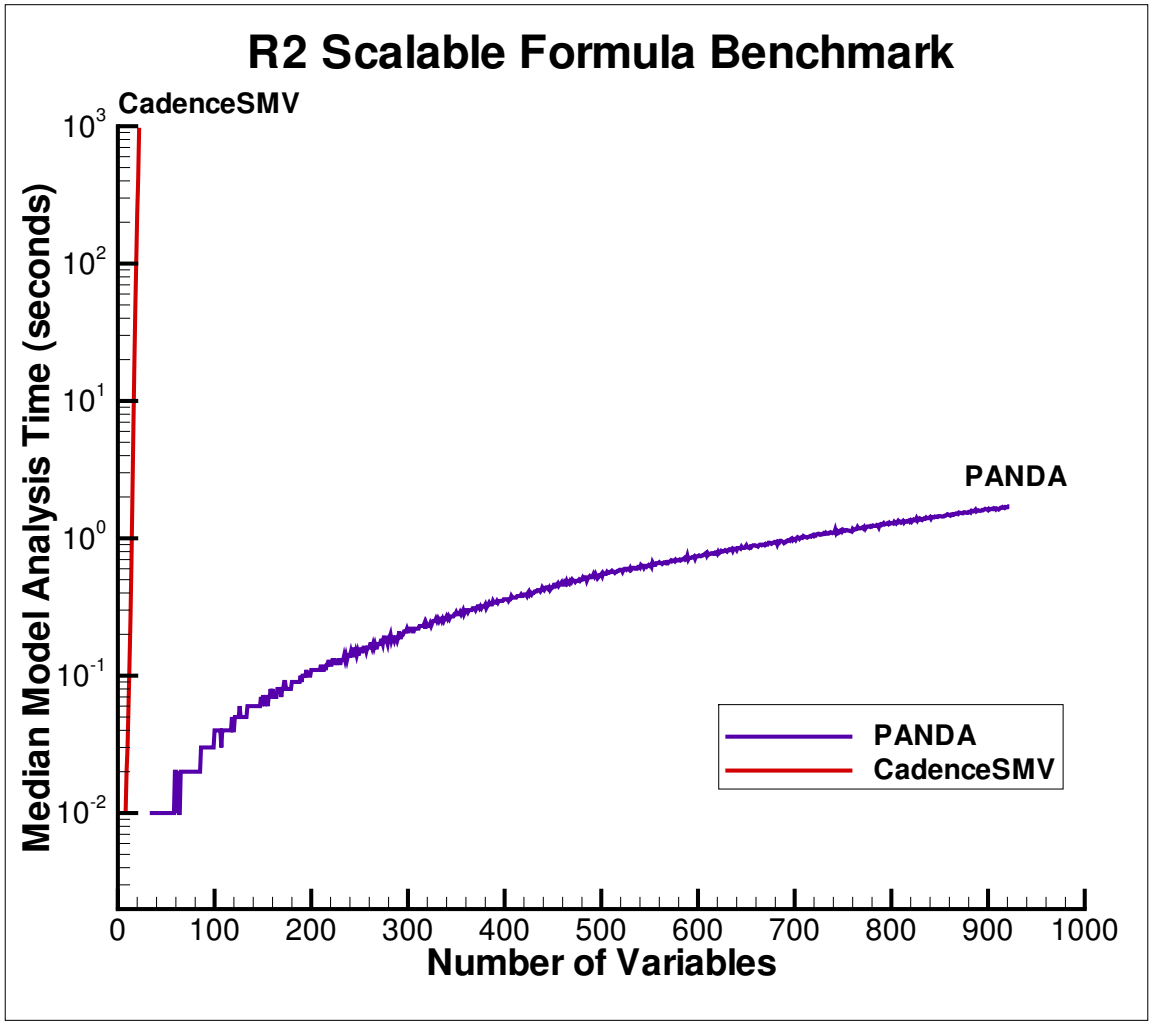
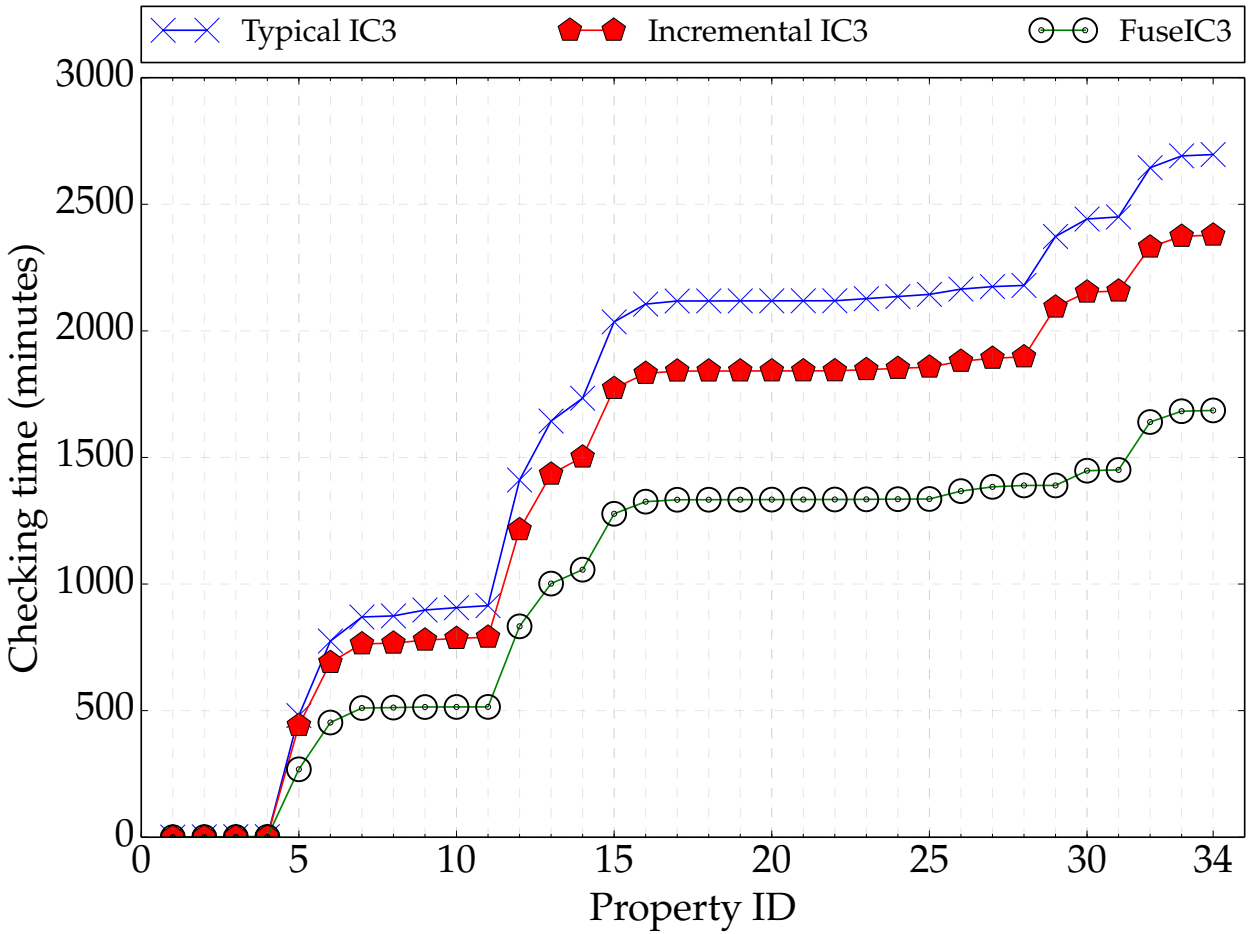
Symbolic model checking progressed from bit-level to word level

The Problem[1]



[1] K.Y.Rozier and M.Y.Vardi, "A Multi-Encoding Approach for LTL Symbolic Satisfiability Checking," FM 2011.

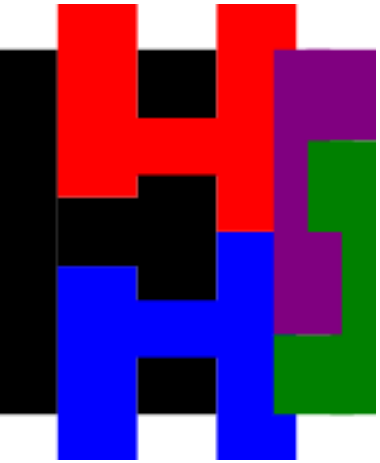
FuseIC3: An Algorithm for Checking Large Design Spaces[2]



Model checking **34 formulas** over **1,620 models** is **5.48x faster**

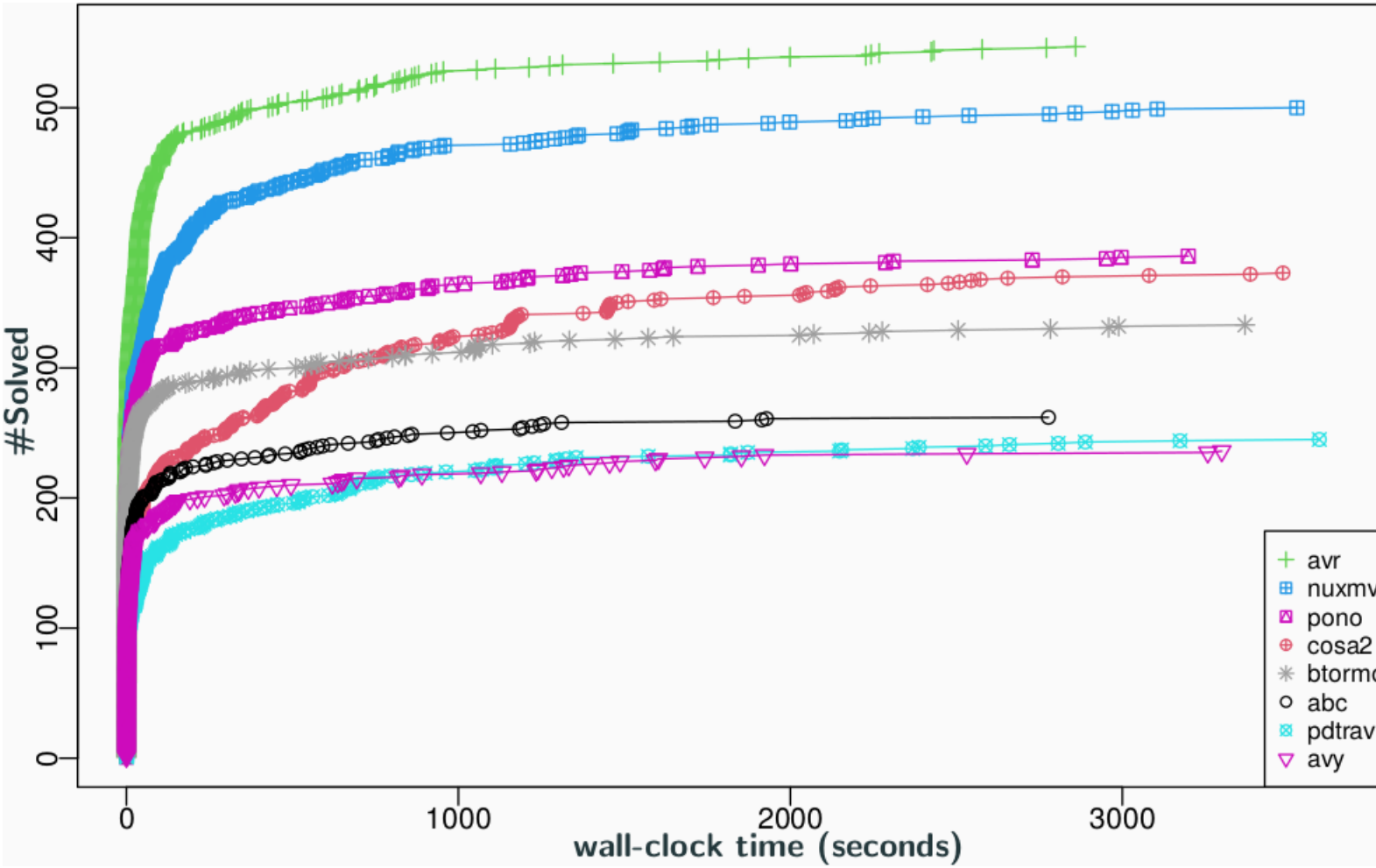
[2] Rohit Dureja and Kristin Yvonne Rozier. "FuseIC3: An Algorithm for Checking Large Design Spaces." In Formal Methods in Computer-Aided Design (FMCAD), IEEE/ACM, Vienna, Austria, October 2-6, 2017.

HWMCC: Hardware Model Checking Competition (2020)



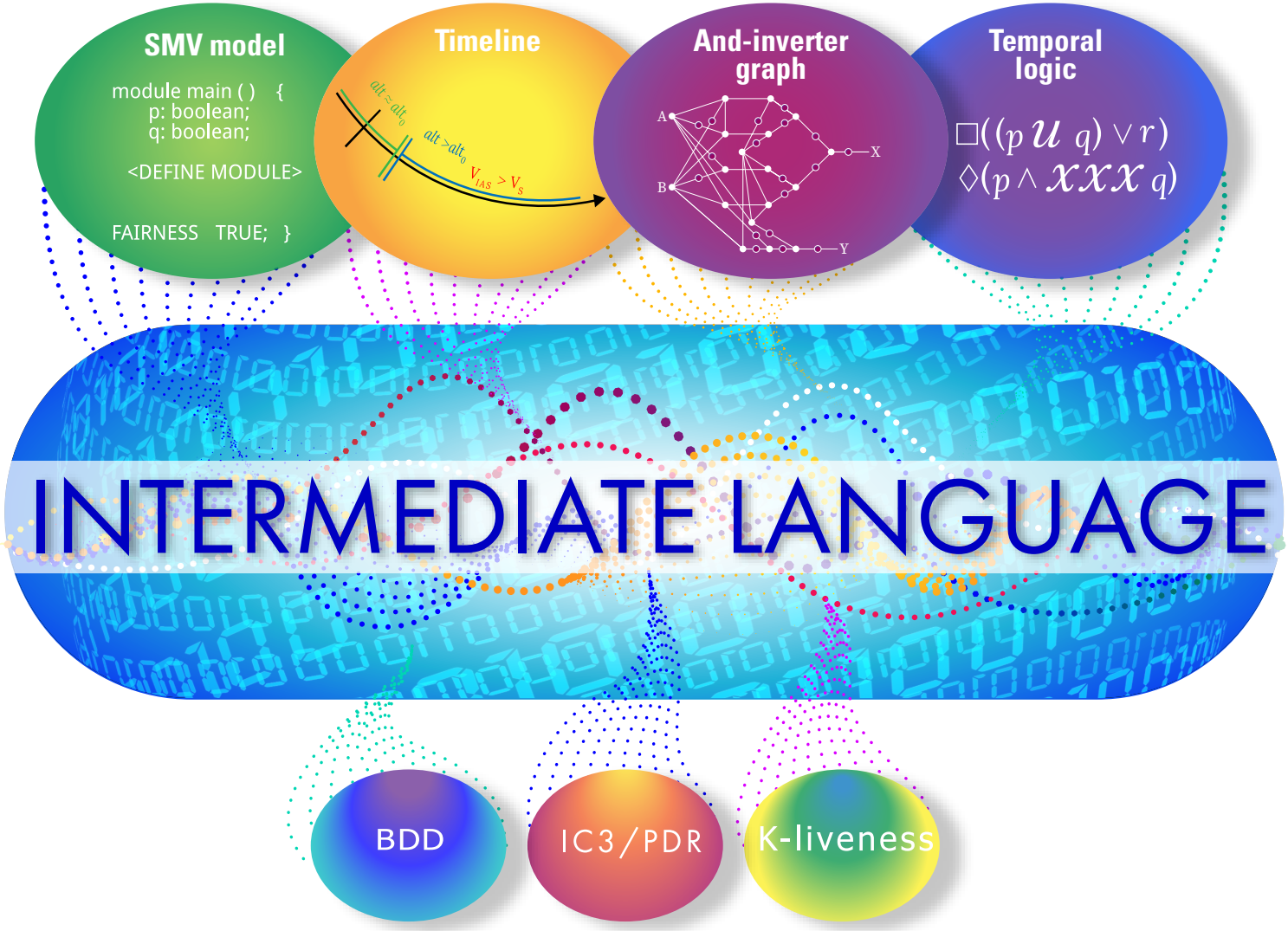
Word-level reasoning

BTOR2



The Problem Continues...

- nuXmv, CadenceSMV, others are **closed source**
- ABC, HWMCC tools are **limited to low-level modeling languages**
- No **open-source, research-enabling connection** between:
  - Rich modeling languages with real-world benchmark models
  - State-of-the-art back-end MC algorithms


SMV model
module main ( ) {
p: boolean;
q: boolean;
<DEFINE MODULE>
FAIRNESS TRUE; }
Timeline
alt ≥ alt0
alt >alt0
VIAS > Vs
And-inverter graph
A
B
X
Y
Temporal logic
□((p U q) ∨ r)
◊(p ∧ XXX q)
INTERMEDIATE LANGUAGE
BDD
IC3/PDR
K-liveness

Goals for Intermediate Language

- Allow adding a **modeling language** via **translation to/from IL**
- Allow adding an **MC algorithm** via **translation to/from IL**
- IL is efficient/accessible so as to **encourage usage in future MCs**
- IL suitable for on-going **community standard**

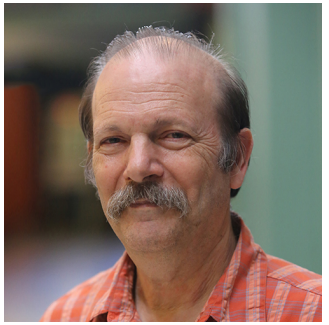
Core Design Team

Investigators:

K.Y. Rozier

Natarajan Shankar

Cesare Tinelli

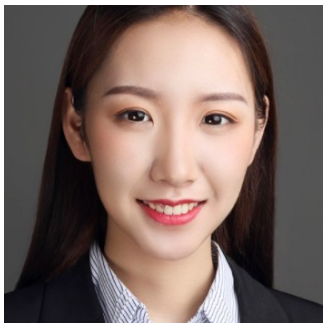


Moshe Vardi

Students:

Laura Gamboa Guzman

Chris Johannsen



Yi Lin

Technical Advisory Board (TAB)

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Bernhard Steffen (TU Dortmund)
Aaron Tomb (Amazon)
Stefano Tonetta (FBK)

Project Links

Home:

https://modelchecker.temporallogic.org

GitHub Organization:

https://modelchecker.github.io/

Intermediate Language Definition:

https://github.com/ModelChecker/IL/blob/main/description.md

Summary

The time has come for model-checking community standards

- **Participate:** name vote, email list, language design feedback, community forums
- Coming Next: **SMV** $\leftrightarrow$ **IL** $\leftrightarrow$ **BTOR2**
- **Contribute** future translators:
  - Your Modeling Language $\leftrightarrow$ Intermediate Language
  - Intermediate Language $\leftrightarrow$ Your Back-end MC Algorithm
- **Optimize! Expand! Compare! Research!**

modelchecker.temporallogic.org

SBMF Keynote: https://www.youtube.com/watch?v=XjkjVPOKVT8