MoXIchecker: An Extensible Model Checker for MoXI

Salih Ates[1], Dirk Beyer[1], **Po-Chun Chien**[1], and Nian-Ze Lee[2,1]

[1]LMU Munich · [2]National Taiwan University

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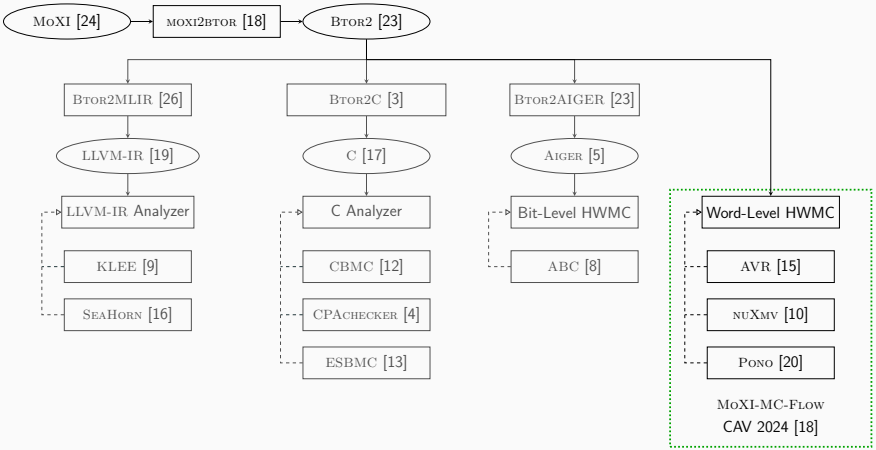
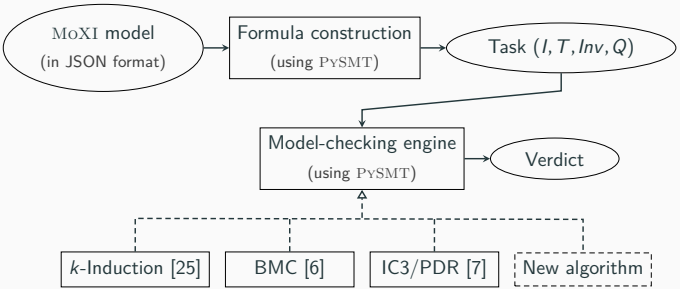
Previous Work: Transformation-Based Verification for MoXI



- Btor2 [23] only supports `QF_ABV` → restricted theories

Our Work: MoXIchecker

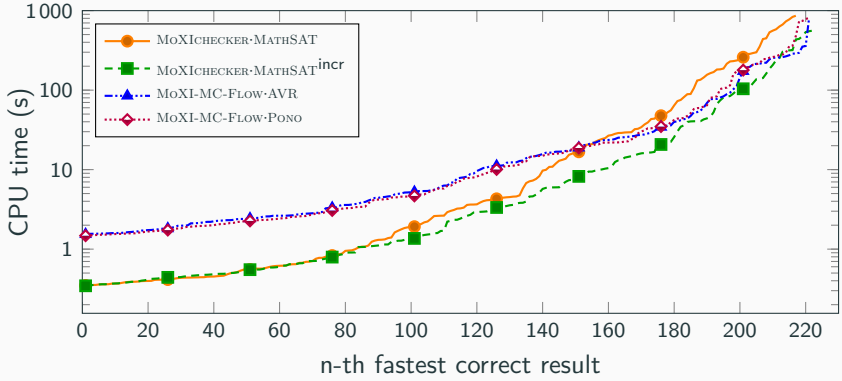


VSTTE 2024 [1]

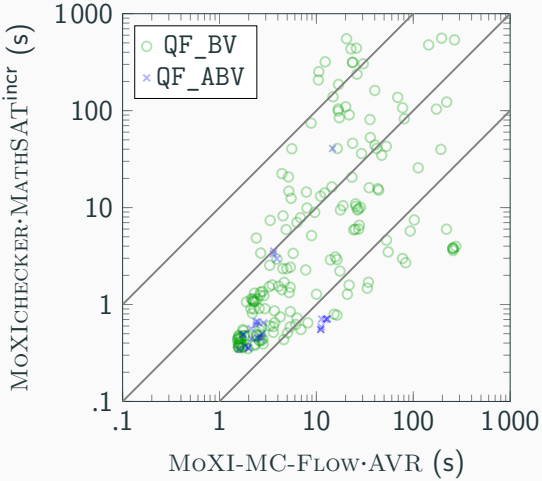
- Verify MoXI models directly (no translation step involved)
- Implemented in Python, based on PySMT [14]
- Supported theories: `QF_{BV,ABV,LIA,NIA,LRA,NRA}`
- Easily extensible: new theories and algorithms

MoXIchecker's Performance

- Compare to MoXI-MC-Flow on 453 QF_BV and QF_ABV tasks
- All configurations run k-induction



MoXIchecker's Run-Time Efficiency



- Avoids translation overhead
- Competitive against SOTA HWMC backends

MoXIchecker's Extensibility

Theories of Integers and Reals

Task	Theory	Verdict	MoXIchecker	MoXI-MC-Flow*
FibonacciSequence	QF_LIA	safe	safe	unsafe
IntIncrement	QF_LIA	unsafe	unsafe	safe
IntCounter	QF_LIA	safe	safe	timeout
IntMultiply	QF_NIA	safe	safe	unsafe
BoundedLinearGrowth	QF_LRA	safe	safe	unsupported
DoubleDelay2	QF_LRA	unsafe	unsafe	unsupported
OscillatingRatio	QF_NRA	safe	safe	unsupported
SafeNonlinearGrowth	QF_NRA	safe	safe	unsupported
NonlinearGrowth	QF_NRA	unsafe	unsafe	unsupported

*MoXI-MC-Flow approximates integers with fixed-size bit-vectors

Remark: Using Python and PySMT

Pros

- Slim code base (~700 LoC)
- East development
- Good for education

Cons

- Performance / efficiency
- Often exceed recursion limit when loading MoXI-JSON
- SMT solver support

Ongoing Development in MoXIchecker

- Preliminary support for `subsys`

gitlab.com/sosy-lab/software/moxichecker

Ongoing Development in MoXIchecker

- Preliminary support for `subsys`
- Enhancing existing engines and adding new ones
  - Implementing interpolation-based algorithms
  - Improving generalization for IC3/PDR

`gitlab.com/sosy-lab/software/moxichecker`

Ongoing Development in MoXIchecker

- Preliminary support for `subsys`
- Enhancing existing engines and adding new ones
  - Implementing interpolation-based algorithms
  - Improving generalization for IC3/PDR
- Performance optimization using Cython

`gitlab.com/sosy-lab/software/moxichecker`

Ongoing Development in Pono

- Pono: a SMT-based model checker
  - Frontends: BTOR2, SMV, VMT, and MoXI!
  - Backends: IC3/PDR, interpolation-based, BMC, *k*-induction, ...
- Joint work with Clark Barrett, Anna Eaton, Ahmed Irfan, Áron Ricardo Perez-Lopez, and Nestan Tsiskaridze (Stanford University)

Growing the MoXI Ecosystem

- Open-source tool suites, e.g., parser in C/C++ (cf. Btor2Tools and PyVMT)

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- Reduce nesting depth in MoXI-JSON format
  - `ModelChecker/moxi-mc-flow#29`
  - Currently, many tasks cannot be loaded with Python's builtin JSON parser

Growing the MoXI Ecosystem

- Open-source tool suites, e.g., parser in C/C++ (cf. Btor2Tools and PyVMT)
- Reduce nesting depth in MoXI-JSON format
  - `ModelChecker/moxi-mc-flow#29`
  - Currently, many tasks cannot be loaded with Python's builtin JSON parser
- Expand benchmark set: fairness, more theories, quantifiers, ...
- Tool competition

Conclusion

- MoXIchecker: extensible framework for direct MoXI model checking
  - Supported theories: `QF_{BV,ABV,LIA,NIA,LRA,NRA}`
  - Available algorithms: BMC, *k*-induction, IC3/PDR

@ GitLab

@ VSTTE 2024 [1]

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