Extending the MoXI Eco System

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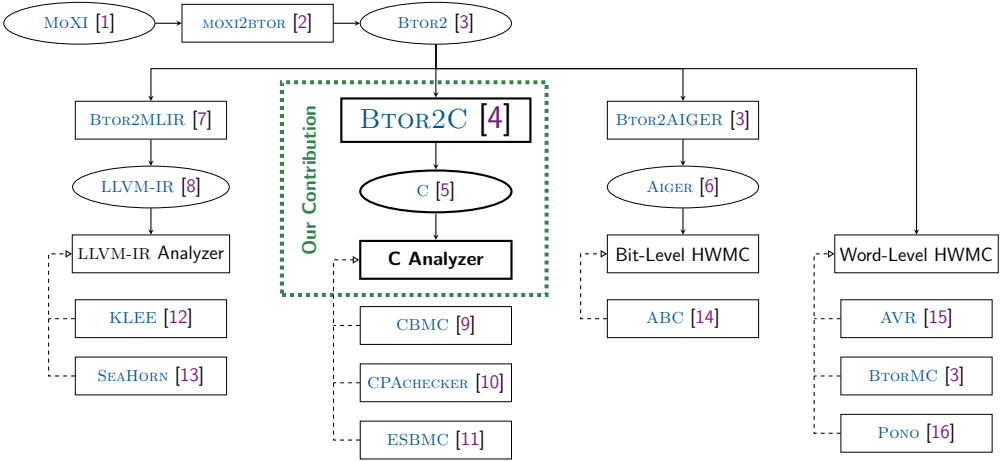
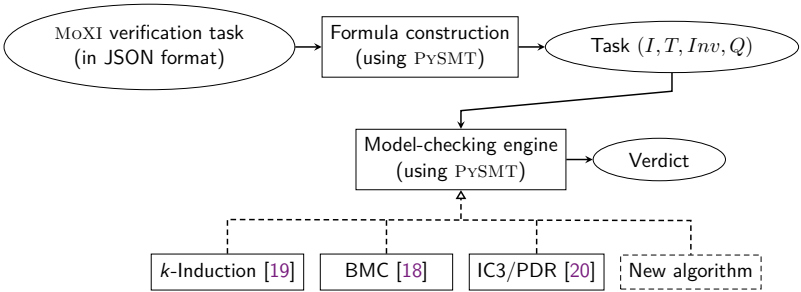
(i) Btor2C: Enabling C Verifiers to Analyze MoXI Models [4]



There are **26 verifiers for C available** for *ReachSafety-Hardware* tasks (see SV-COMP 2024 [17]). $\Rightarrow$ 26 new MoXI model checkers via translation

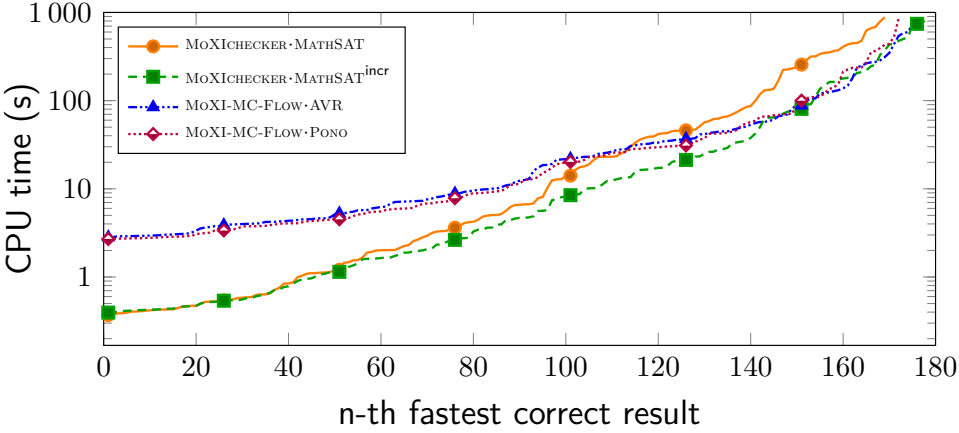
(ii) MoXIchecker: An Extensible Model Checker for MoXI [22]



- verifies MoXI models directly (no translation step involved)
- implemented in Python, based on PySMT [21]
- extensible, easy to add new algorithms and theories

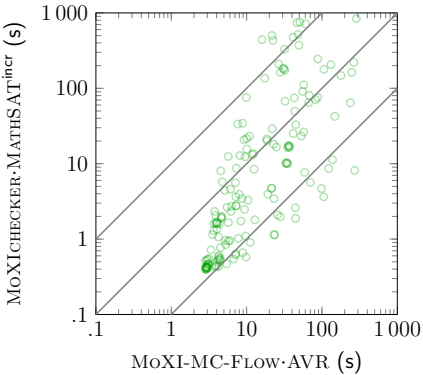
MoXIchecker: Performance

Comparison with MoXI-MC-Flow on 382 QF_BV tasks (also incremental solving)

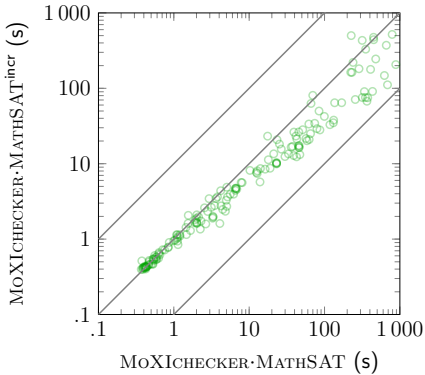


⇒ Direct implementation can be faster (think of CI [23])

MoXIchecker: Response Time and Extensibility



Efficiency of
MoXIchecker vs. MoXI-MC-Flow
⇒ Response Time



Effect of incremental SMT solving in
MoXIchecker
⇒ Extensibility

MoXIchecker: Effectiveness and Extensibility (Solvers, Algs)

Evaluation on 382 QF_BV tasks:

Tool	MoXIchecker				MoXI-MC-Flow	
Backend	MathSAT	MathSAT$^{\text{incr}}$	Z3	Z3$^{\text{incr}}$	AVR	Pono
Correct results	169	**178**	169	174	175	172
Proofs	44	46	**47**	**47**	45	45
Alarms	125	**132**	122	127	130	127

$\Rightarrow$ competitive to MoXI-MC-Flow
$\Rightarrow$ can serve as a base line
$\Rightarrow$ ideal for teaching due to slim architecture

MoXIchecker: Extensibility (Theories of integers, 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

$\Rightarrow$ extensible compared to MoXI-MC-Flow

$\Rightarrow$ sound compared to MoXI-MC-Flow's approximation

(iii) MoXI Competition

Should we create a competition of MoXI model checkers?
There are already ≥ 2 model checkers for MoXI.

$\Rightarrow$ drives standardization

$\Rightarrow$ maintains benchmark sets

Conclusion

- BTOR2C [4]: enables transformation MoXI → C
  ⇒ we can use 26 C verifiers for MoXI
  Status: not yet evaluated
- MoXIchecker [22]
  ⇒ extensible framework for direct MoXI model checking
  Status: software released and paper published
- MoXI-Comp
  ⇒ annual comparative evaluation of the MoXI state of the art
  Status: just proposed

MoXIchecker @GitLab

MoXIchecker @arXiv

https://gitlab.com/sosy-lab/software/moxichecker

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