Unified Solver Strategy for Floating-Point based on Proxy Theories

FMCAD 2017 Student Forum

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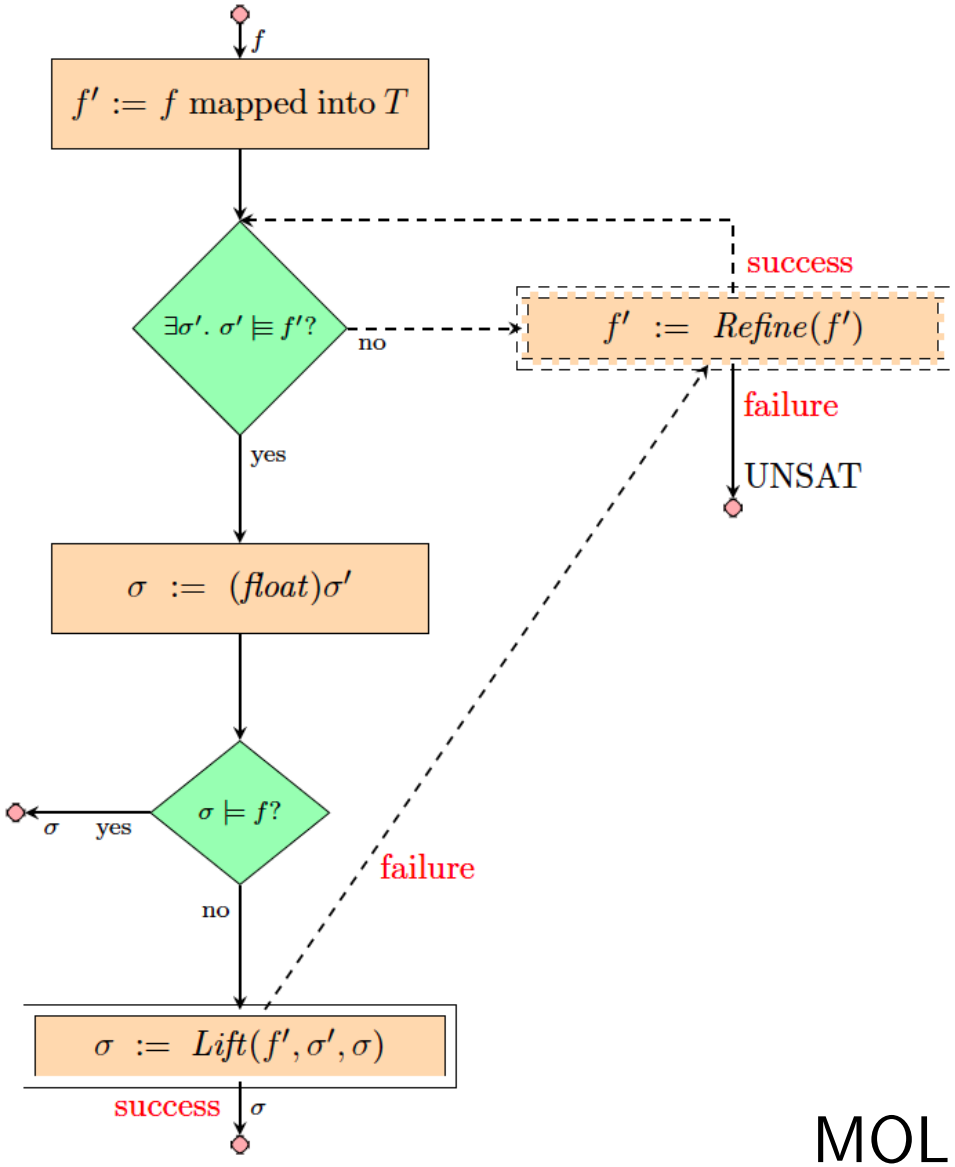
Oct 4, 2017

Model Lifting Architecture [FMCAD16]*



MOLLY = Model Lifting tool

*joint work with Thomas Wahl

Molly Configurations

Spec \ Name	Molly^{RA}	Lazy Realizer	Molly^{MRFPA}	Molly^{dReal}	Molly^{RPFPA}	Approx
Proxy theory	RA	RA	RA	Reals + δ-sat	RPFPA	RPFPA
Proxy solver	Z3	Realizer++	Realizer++	dReal	MathSAT	MathSAT
Lifting?	✓	×	✓	✓	✓	×
Refinement?	×	✓	✓	×	✓	✓

Molly = Model Lifting tool
RA = Real Arithmetic
Realizer = Tool doing eager & exact encoding to Real+Int [DATE14]
MRFPA = Mixed Real–Floating-Point Arithmetic
dReal = Numerical solving tool from CMU
RPFPA = Reduced Precision Floating-Point Arithmetic

Illustration

- Non-linear polynomials
  $10.25 \leq x^2 + y^2 \leq 10.50$ RA
- Non-linear complex
  $-0.5 \leq e^x + sin(x) \leq 0.5$ dReal
- Non-linear with operators reordered
  $|(x + y)^2 - ((x^2 + (2 * x) * y) + y^2)| > \epsilon$ dReal, RPFPA
- Linear with operators reordered
  $|(x + (y + z)) - ((x + y) + z)| > \epsilon$ MRFPA

May need different strategies to solve!

Unified Strategy

Input: f: FPA formula

1: **if** *Linear*(f) **then**
2: **return** $\textsc{Molly}^{\mathsf{MRFPA}}(f)$ ▷ mixed real-float reasoning
3: **end if**
4: *result* := $\textsc{Molly}^{\mathsf{RA}}(f)$ ▷ pure real abstraction
5: **if** *result* $\neq$ `failed` **then**
6: **return** *result*
7: **end if**
8: *result* := $\textsc{Molly}^{\mathsf{dReal}}(f)$ ▷ numerical solving
9: **if** *result* $\neq$ `failed` **then**
10: **return** *result*
11: **end if**
12: **return** $\textsc{Molly}^{\mathsf{RPFPA}}$ ▷ reduced precision abstraction

Thank You!