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iRw: An Intelligent Rewriting

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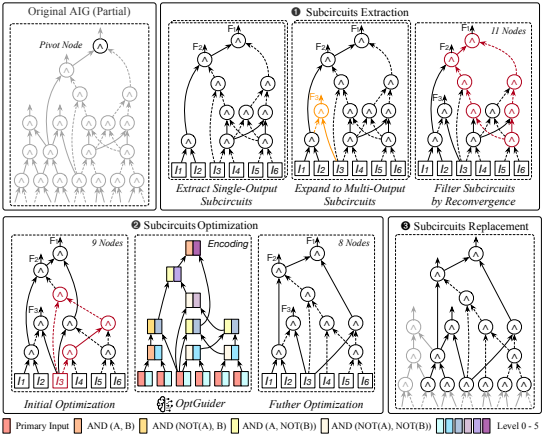
Methodology



Overview of the *iRw*.

1. **Subcircuit Extraction**
   Optimization Potential-Driven
2. **Subcircuit Optimization**
   - ***Initial Optimization***
     Balance, *Resubstitution*.
   - ***Further Optimization***
     Rewrite, *Refactor*.
   - ***OptGuider***
     A Lightweight GNN-Based Algorithm *minimizes runtime overhead* by determining whether a subcircuit should be further optimized.

Experimental Results

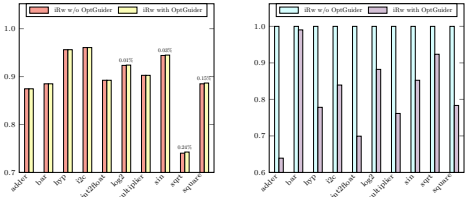
- Performance Comparison Between *iRw* & SOTA Rewriting.

Benchmark		Window Rewriting [1]		iRw			
		Until Convergence		First Iteration		Until Convergence	
Name	# Nodes	# Nodes	Time	# Nodes	Time	# Nodes	Time
adder	1,020	892	0.04	892	0.13	892	0.28
bar	3,336	2,952	3.76	2,952	0.62	2,952	1.17
hyp	214,335	204,926	20.28	204,926	19.90	204,926	40.38
i2c	1,342	1,291	0.10	1,289	0.14	1,273	0.58
int2float	260	239	0.02	232	0.09	226	0.36
log2	32,060	29,700	6.59	29,603	5.19	29,556	28.55
multiplier	27,062	24,566	3.89	24,426	3.93	24,426	8.80
sin	5,416	5,132	1.85	5,115	1.05	5,095	7.73
sqrt	24,618	18,325	2.95	18,279	2.42	18,236	16.17
square	18,484	16,606	2.72	16,386	2.04	16,316	6.47
Average	-	9.79%	-	10.32%	-	10.78%	-
Total	-	-	42.20		35.51	-	110.49

- Impact of *Multi-Output Subcircuit Extraction*.

Method	# Initial Nodes	# Optimized Nodes	Average Improvement
b; rs -K 6; rw; rf;	327,933	314,793	4.01%
iRw		304,100	10.32%

- *iRw* with/without *OptGuider* Performance.



(a) Node Reduction Comparison. (b) Runtime Comparison.

- *iRw* outperforms Window Rewriting [1] both in node reduction and runtime.
- *iRw* achieves better node reduction, demonstrating the effectiveness of multi-output subcircuit extraction.
- *iRw*, guided by OptGuider, significantly improves runtime with only a slight impact on node reduction.

[1] **Heinz Riener et al. (2022). "Boolean Rewriting Strikes Back: Reconvergence-Driven Windowing Meets Resynthesis".** In: *Proc. ASPDAC*.

THANK YOU!