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iRw: An Intelligent Rewriting

Haisheng Zheng¹, Haoyuan Wu², Zhuolun He², Yuzhe Ma³, Bei Yu²

¹Shanghai Artificial Intelligence Laboratory

²The Chinese University of Hong Kong

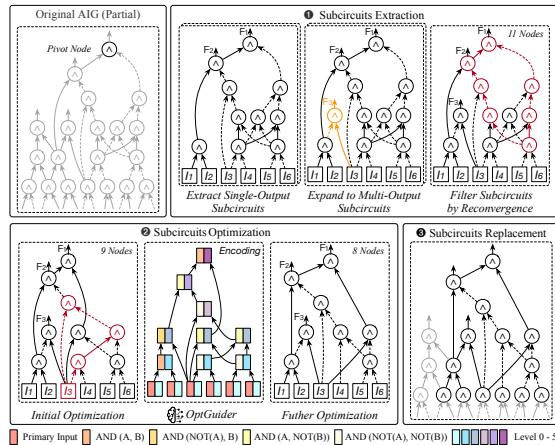
³The Hong Kong University of Science and Technology, Guangzhou

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上海人工智能实验室
Shanghai Artificial Intelligence Laboratory





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

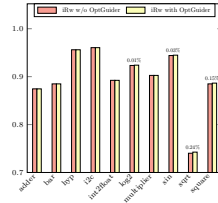
- Performance Comparison Between iRw & SOTA Rewriting.

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	-

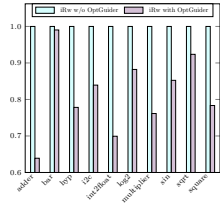
- Impact of Multi-Output Subcircuit Extraction.

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

- iRw with/without OptGuider Performance.



(a) Node Reduction Comparison.



(b) Runtime Comparison.

- iRw outperforms Window Rewriting¹ 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.

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

THANK YOU!