

IWLS 2023

Programming Contest

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Overview

- Node minimization, continued from last year
 - Given a Boolean function as a truth table, find a minimal circuit
- Three tracks: AIG, XAIG, and cumulative
 - Cumulative means sum of AIG nodes and XAIG nodes
- Our plan for today
 - Introduce the participants
 - Review the problems
 - Show the results
 - Congratulate the winners!

Participants

- **Team EPFL:**
 - Hanyu Wang, Alessandro Tempia Calvino, Siang-Yun Lee
- **Google DeepMind:**
 - Adam Hillier, Georges Rotival, Ivan Lobov, Kshiteej Mahajan, Marco Gelmi, Ngan Vu, Olivier Temam, Sergio Guadarrama, Vinod Nair
- **TU Wien:**
 - Franz-Xaver Reichl, Friedrich Slivovsky, Stefan Szeider
- **NBU-Giga:**
 - Chengyu Ma, Hongyang Pan, Ruibing Zhang, Yong Xiao, Yun Shao, Zhufei Chu

Problems

- We converted/renumbered the last year benchmark in such a way that the minimum number of nodes stays the same
- The following table explains the function of each benchmark with the last year numbering

Examples	Description
ex00 - ex01	Known random-looking functions
ex02 - ex07	Random and modified random functions
ex08 - ex09	s-box and inverse s-box from AES [1]
ex10 - ex15	5-input through 15-input majority functions
ex16 - ex27	N-input N-output binary sorters
ex28 - ex49	Selected Espresso benchmarks with permuted inputs
ex50 - ex67	Arithmetic functions with permuted inputs / dropped outputs
ex68 - ex99	Three-output neurons from the LogicNets project [2]

[1] https://en.wikipedia.org/wiki/Rijndael_S-box

[2] Y. Umuroglu et al., "LogicNets: Co-designed neural networks and circuits for extreme-throughput applications," Proceedings of FPL 2020, pp. 291–297. <https://github.com/Xilinx/logicnets>

Mapping from 2022 to 2023

last year	this year
ex00	ex32
ex01	ex99
ex02	ex19
ex03	ex35
ex04	ex86
ex05	ex55
ex06	ex08
ex07	ex25
ex08	ex22
ex09	ex78
ex10	ex12
ex11	ex23
ex12	ex57
ex13	ex49
ex14	ex03
ex15	ex98
ex16	ex41
ex17	ex79
ex18	ex95
ex19	ex10

last year	this year
ex20	ex83
ex21	ex63
ex22	ex45
ex23	ex38
ex24	ex69
ex25	ex36
ex26	ex56
ex27	ex59
ex28	ex71
ex29	ex53
ex30	ex82
ex31	ex48
ex32	ex93
ex33	ex65
ex34	ex97
ex35	ex17
ex36	ex15
ex37	ex24
ex38	ex04
ex39	ex26

last year	this year
ex40	ex31
ex41	ex07
ex42	ex13
ex43	ex39
ex44	ex68
ex45	ex94
ex46	ex14
ex47	ex62
ex48	ex09
ex49	ex52
ex50	ex96
ex51	ex90
ex52	ex30
ex53	ex44
ex54	ex89
ex55	ex47
ex56	ex81
ex57	ex74
ex58	ex85
ex59	ex01

last year	this year
ex60	ex00
ex61	ex34
ex62	ex84
ex63	ex51
ex64	ex02
ex65	ex66
ex66	ex50
ex67	ex18
ex68	ex75
ex69	ex37
ex70	ex43
ex71	ex33
ex72	ex16
ex73	ex72
ex74	ex70
ex75	ex11
ex76	ex20
ex77	ex80
ex78	ex58
ex79	ex67

last year	this year
ex80	ex54
ex81	ex87
ex82	ex05
ex83	ex29
ex84	ex76
ex85	ex77
ex86	ex92
ex87	ex27
ex88	ex64
ex89	ex60
ex90	ex28
ex91	ex88
ex92	ex21
ex93	ex06
ex94	ex46
ex95	ex40
ex96	ex61
ex97	ex91
ex98	ex73
ex99	ex42

AIG Track

	team1	team2	team3	team4
total nodes	40071	23815	33802	37851
wins	19	82	42	15
uniq. wins	2	56	16	0
score	7827.49	9902.15	8625.29	7615.11

XAIG Track

	team1	team2	team3	team4
total nodes	34823	22507	32304	-
wins	9	65	45	-
uniq. wins	3	52	31	-
score	7685.89	9779.55	8536.00	no submission

Cumulative Track

	team1	team2	team3	team4
total nodes	74894	46322	66106	-
wins	7	70	41	-
uniq. wins	2	57	28	-
score	7766.16	9859.56	8591.57	no submission

Winners

- 1st place
 - Google DeepMind:
 - Adam Hillier, Georges Rotival, Ivan Lobov, Kshiteej Mahajan, Marco Gelmi, Ngan Vu, Olivier Temam, Sergio Guadarrama, Vinod Nair
- 2nd place
 - TU Wien:
 - Franz-Xaver Reichl, Friedrich Slivovsky, Stefan Szeider
- 3rd place
 - Team EPFL:
 - Hanyu Wang, Alessandro Tempia Calvino, Siang-Yun Lee

AIG Track with Our Results

	Team EPFL	Google DeepMind	TU Wien	ours
total nodes	40071	23815	33802	24847
wins	17	63	33	56
uniq. wins	1	36	6	28
score	7694.87	9737.37	8487.98	9291.43

Our method (transduction) won most of small cases, while it lost most of large cases probably because we couldn't restart enough for those cases

Improvement over Last Year

	last year best	this year best	this year best (with ours)	best ever
total nodes	27727	23439	22622	22469
geomean of ratios	1.0000	0.8178	0.8036	0.8032