A Benchmark Suite for Designing Combinational Logic Circuits via Metaheuristics

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This supplementary material presents the tables with detailed results obtained from the experiments presented on the paper, allowing benchmark users to compare their algorithms with the proposed approaches.

Table 1: Experiment 1 – Information about the number of function evaluations used by CGP to find the first feasible circuit and the Success Rate (SR) obtained by each mutation.

Problem	**Method**	**Objective Function Evaluations**							**SR (%)**	**p-value**
		Best	**Q1**	**Median**	**Q3**	**Worst**	**Mean**	**Stdev**		
C17	SAM	541.0	1889.0	2373.0	3733.0	15385.0	3302.76	3.08E+03	100.0	1.00E-00
	SAMGAM	1221.0	2029.0	3005.0	3665.0	15833.0	3680.04	2.94E+03	100.0	
cm42a	SAM	14977.0	31761.0	43229.0	53877.0	94449.0	45702.76	2.02E+04	100.0	2.88E-01
	SAMGAM	15237.0	23301.0	31013.0	39785.0	74321.0	34081.00	1.33E+04	100.0	
cm82a	SAM	4213.0	11377.0	20085.0	32933.0	111697.0	28149.16	2.46E+04	100.0	1.00E-00
	SAMGAM	3345.0	13125.0	21253.0	32485.0	132805.0	30386.28	2.94E+04	100.0	
cm138a	SAM	91677.0	210009.0	265941.0	405473.0	798257.0	333323.40	1.86E+05	100.0	9.17E-01
	SAMGAM	47021.0	161609.0	234853.0	324709.0	444297.0	237318.12	1.15E+05	100.0	
decod	SAM	393377.0	572217.0	683077.0	952613.0	1300929.0	779161.48	2.58E+05	100.0	4.79E-02
	SAMGAM	174473.0	403597.0	550285.0	669189.0	880637.0	535477.16	1.77E+05	100.0	
f51m	SAM	436065.0	2314637.0	3343513.0	5421109.0	11605525.0	4127082.60	2.94E+06	100.0	1.00E-00
	SAMGAM	869073.0	1347501.0	2047477.0	3715721.0	13699469.0	2990684.68	2.69E+06	100.0	
majority	SAM	557.0	3137.0	5457.0	9129.0	24053.0	6174.12	4.90E+03	100.0	1.00E-00
	SAMGAM	885.0	3853.0	5661.0	12557.0	19377.0	7605.96	5.36E+03	100.0	
z4ml	SAM	21129.0	122533.0	200429.0	303501.0	482493.0	221805.32	1.23E+05	100.0	1.00E-00
	SAMGAM	37181.0	70309.0	163353.0	258665.0	463189.0	172815.08	1.12E+05	100.0	
9symml	SAM	260965.0	555709.0	1274929.0	2861877.0	9904525.0	1894035.72	2.07E+06	100.0	1.00E-00
	SAMGAM	287257.0	700026.0	1028541.0	2511969.0	4211033.0	1624326.17	1.23E+06	96.0	
alu2	SAM	7789925.0	9587184.0	11384443.0	13181702.0	14978961.0	11384443.00	3.59E+06	8.0	1.00E-00
	SAMGAM	14686325.0	14686325.0	14686325.0	14686325.0	14686325.0	14686325.00	0.00E+00	4.0	
alu4	SAM	4586621.0	9375589.0	11991005.0	18784375.0	29996997.0	13909170.74	6.81E+06	92.0	1.00E-00
	SAMGAM	3992309.0	11196071.0	15097929.0	17484821.0	29470241.0	15349400.37	6.46E+06	76.0	
cm85a	SAM	243661.0	377333.0	541665.0	1117569.0	1692469.0	717483.08	4.52E+05	100.0	8.99E-01
	SAMGAM	115893.0	280477.0	431705.0	574533.0	948761.0	451483.40	2.04E+05	100.0	
cm151a	SAM	37385.0	79497.0	101497.0	151505.0	226145.0	112819.88	5.15E+04	100.0	5.13E-01
	SAMGAM	27673.0	64197.0	81129.0	93809.0	313189.0	86299.08	5.39E+04	100.0	
cm162a	SAM	107533.0	313641.0	553757.0	855689.0	2164481.0	685180.68	4.95E+05	100.0	1.00E-00
	SAMGAM	108257.0	432441.0	551581.0	877985.0	1610085.0	668600.52	3.73E+05	100.0	
cu	SAM	1370425.0	2865457.0	3867989.0	7267673.0	16369765.0	5455837.48	3.73E+06	100.0	2.67E-03
	SAMGAM	669965.0	1366277.0	2297385.0	2626785.0	8138933.0	2352364.52	1.57E+06	100.0	
x2	SAM	576325.0	1407977.0	2473437.0	3398381.0	4854321.0	2445051.72	1.19E+06	100.0	2.41E-01
	SAMGAM	296413.0	879709.0	1617541.0	2099813.0	3526977.0	1610590.28	8.64E+05	100.0	
cmb	SAM	-	-	-	-	-	-	-	0.0	-
	SAMGAM	-	-	-	-	-	-	-	0.0	
cc	SAM	1882389.0	2284765.0	3380073.0	5839385.0	8951901.0	4112475.24	2.11E+06	100.0	1.00E-00
	SAMGAM	1298045.0	2126313.0	2933933.0	4230937.0	7358309.0	3279860.84	1.51E+06	100.0	
cordic	SAM	-	-	-	-	-	-	-	0.0	-
	SAMGAM	-	-	-	-	-	-	-	0.0	
frg1	SAM	1853877.0	4076977.0	5990665.0	7069533.0	17084045.0	6354018.44	3.48E+06	100.0	1.00E-00
	SAMGAM	1775573.0	4489533.0	5703125.0	8200213.0	15155957.0	6231536.20	3.01E+06	100.0	
pm1	SAM	1791037.0	4032489.0	9084849.0	11387865.0	14881761.0	8185932.84	4.06E+06	100.0	1.00E-00
	SAMGAM	4663713.0	7030979.0	8821889.0	12244145.0	33652349.0	10811699.67	6.46E+06	96.0	
sct	SAM	10387637.0	13780521.0	21271377.0	32387513.0	43430237.0	23233395.44	1.00E+07	72.0	1.00E-00
	SAMGAM	4950309.0	11930974.0	17676179.0	27486698.0	36316169.0	19439902.45	1.00E+07	88.0	
t481	SAM	50925.0	123813.0	215753.0	607685.0	1782545.0	423432.36	4.33E+05	100.0	1.00E-00
	SAMGAM	32785.0	138909.0	223365.0	422949.0	1439421.0	341220.52	2.94E+05	100.0	
tcon	SAM	86449.0	190485.0	287345.0	370529.0	652245.0	298886.12	1.49E+05	100.0	3.18E-04
	SAMGAM	47813.0	90365.0	122233.0	168149.0	270469.0	135175.88	6.06E+04	100.0	
vda	SAM	-	-	-	-	-	-	-	0.0	-
	SAMGAM	-	-	-	-	-	-	-	0.0	

Table 2: Experiment 1 – The mean of total time spent by each algorithm.

Problem	**Method**	**Execution time (s)**	
		Mean	**Stdev**
C17	SAM	46.13	7.16E+00
	SAMGAM	40.23	6.88E+00
cm42a	SAM	120.40	3.78E+01
	SAMGAM	124.56	3.33E+01
cm82a	SAM	45.46	1.26E+01
	SAMGAM	42.46	1.35E+01
cm138a	SAM	229.93	5.10E+01
	SAMGAM	224.74	5.47E+01
decod	SAM	299.94	7.74E+01
	SAMGAM	365.16	1.51E+02
f51m	SAM	354.14	1.03E+02
	SAMGAM	377.63	9.92E+01
majority	SAM	24.71	4.87E+00
	SAMGAM	20.87	4.22E+00
z4ml	SAM	171.72	4.40E+01
	SAMGAM	165.93	6.29E+01
9symml	SAM	2309.80	1.03E+03
	SAMGAM	2462.72	1.15E+03
alu2	SAM	7264.68	2.20E+03
	SAMGAM	7940.65	2.23E+03
alu4	SAM	31333.04	1.25E+04
	SAMGAM	38968.91	1.31E+04
cm85a	SAM	751.98	9.54E+01
	SAMGAM	730.57	1.80E+02
cm151a	SAM	3506.51	6.27E+02
	SAMGAM	3203.77	7.71E+02
cm162a	SAM	2199.23	3.46E+02
	SAMGAM	2115.61	3.76E+02
cu	SAM	2782.84	5.34E+02
	SAMGAM	2309.90	6.18E+02
x2	SAM	1100.20	1.82E+02
	SAMGAM	1022.47	1.64E+02
cmb	SAM	5960.31	1.26E+03
	SAMGAM	9117.83	2.27E+03
cc	SAM	11878.37	2.76E+03
	SAMGAM	14096.77	3.14E+03
cordic	SAM	9334.73	2.01E+03
	SAMGAM	8176.20	2.06E+03
frg1	SAM	13431.62	3.62E+03
	SAMGAM	13090.45	3.01E+03
pm1	SAM	4543.29	8.74E+02
	SAMGAM	5076.47	1.76E+03
sct	SAM	8224.75	2.20E+03
	SAMGAM	10982.86	3.44E+03
t481	SAM	1761.05	5.36E+02
	SAMGAM	1571.19	7.51E+02
tcon	SAM	6034.98	1.22E+03
	SAMGAM	6839.18	1.81E+03
vda	SAM	199463.62	8.67E+04
	SAMGAM	194848.54	6.77E+04

Table 3: Experiment 1 – Number of transistors obtained for the first feasible solution and the final solution for all problems.

Problem	Method	First Feasible Solution (FFS)							Final Solution (FS)							RR (%)	p-value (FFS)	p-value (FS)
		Best	Q1	Median	Q3	Worst	Mean	Stdev	Best	Q1	Median	Q3	Worst	Mean	Stdev			
C17	SAM	22.0	36.0	54.0	66.0	77.0	51.96	1.63E+01	8.0	8.0	8.16	8.0	9.0	8.0	3.67E-01	84.30	1.00E-00	9.53E-01
	SAMGAM	23.0	44.0	55.0	62.0	109.0	56.60	1.79E+01	8.0	8.0	8.0	9.0	11.0	8.56	8.52E-01	84.88		
cm42a	SAM	104.0	112.0	122.0	129.0	150.0	121.52	1.07E+01	29.0	31.0	33.48	36.0	38.0	34.0	2.66E+00	72.45	1.00E-00	9.53E-01
	SAMGAM	94.0	109.0	115.0	127.0	149.0	117.84	1.22E+01	28.0	33.0	35.0	37.0	44.0	35.16	3.84E+00	70.16		
cm82a	SAM	48.0	64.0	69.0	75.0	89.0	69.84	9.76E+00	20.0	24.0	27.36	29.0	47.0	25.0	6.67E+00	60.82	8.74E-01	9.53E-01
	SAMGAM	46.0	68.0	76.0	87.0	116.0	76.84	1.61E+01	18.0	24.0	26.0	29.0	44.0	27.36	5.97E+00	64.39		
cm138a	SAM	76.0	88.0	102.0	113.0	129.0	102.52	1.48E+01	27.0	30.0	32.36	33.0	40.0	32.0	2.94E+00	68.44	8.14E-01	9.53E-01
	SAMGAM	79.0	100.0	113.0	120.0	133.0	110.08	1.32E+01	28.0	30.0	32.0	34.0	37.0	32.16	2.69E+00	70.78		
decod	SAM	113.0	132.0	139.0	144.0	163.0	139.40	1.25E+01	41.0	49.0	53.12	57.0	64.0	54.0	5.52E+00	61.89	1.00E-00	9.49E-01
	SAMGAM	125.0	132.0	146.0	151.0	170.0	143.68	1.16E+01	45.0	54.0	55.0	61.0	69.0	56.72	6.04E+00	60.52		
f51m	SAM	93.0	112.0	120.0	128.0	161.0	122.68	1.65E+01	74.0	80.0	89.60	93.0	128.0	89.0	1.22E+01	26.96	1.28E-01	2.43E-02
	SAMGAM	111.0	128.0	134.0	143.0	164.0	134.28	1.39E+01	78.0	94.0	98.0	111.0	130.0	101.00	1.28E+01	24.78		
majority	SAM	22.0	32.0	36.0	55.0	87.0	44.60	1.75E+01	11.0	12.0	12.92	13.0	23.0	12.0	2.56E+00	71.03	1.00E-00	9.53E-01
	SAMGAM	23.0	30.0	37.0	47.0	66.0	38.96	1.15E+01	11.0	12.0	12.0	13.0	21.0	13.16	2.41E+00	66.22		
z4ml	SAM	67.0	79.0	86.0	96.0	112.0	88.16	1.18E+01	35.0	42.0	48.08	51.0	76.0	48.0	8.86E+00	45.46	1.00E-00	9.53E-01
	SAMGAM	57.0	81.0	88.0	103.0	124.0	89.88	1.62E+01	35.0	42.0	46.0	51.0	76.0	48.12	9.07E+00	46.46		
9symml	SAM	95.0	154.0	175.0	251.0	332.0	202.24	6.96E+01	77.0	100.0	128.84	157.0	210.0	118.0	3.95E+01	36.29	1.00E-00	9.53E-01
	SAMGAM	118.0	170.5	207.0	240.2	341.0	210.50	5.17E+01	85.0	99.8	122.0	136.5	234.0	127.75	3.52E+01	39.31		
alu2	SAM	393.0	404.5	416.0	427.5	439.0	416.00	2.30E+01	306.0	316.8	327.50	338.2	349.0	327.5	2.15E+01	21.27	1.00E-00	9.53E-01
	SAMGAM	489.0	489.0	489.0	489.0	489.0	489.00	0.00E+00	392.0	392.0	392.0	392.0	392.0	392.00	0.00E+00	19.84		
alu4	SAM	222.0	294.0	345.0	390.0	469.0	341.22	6.97E+01	158.0	181.5	209.70	243.5	267.0	205.0	3.40E+01	38.54	6.83E-02	4.55E-01
	SAMGAM	268.0	375.0	408.0	477.5	549.0	416.11	7.89E+01	151.0	197.5	256.0	301.5	357.0	253.89	6.40E+01	38.98		
cm85a	SAM	70.0	119.0	141.0	176.0	298.0	151.96	5.15E+01	42.0	47.0	51.84	56.0	68.0	51.0	7.14E+00	65.89	2.66E-02	9.53E-01
	SAMGAM	88.0	192.0	214.0	228.0	301.0	203.48	5.53E+01	42.0	49.0	53.0	57.0	79.0	53.84	8.00E+00	73.54		
cm151a	SAM	78.0	124.0	150.0	195.0	282.0	159.00	5.03E+01	36.0	42.0	46.00	46.0	78.0	44.0	8.11E+00	71.07	1.00E-02	9.53E-01
	SAMGAM	84.0	124.0	159.0	168.0	294.0	158.04	4.43E+01	36.0	40.0	45.0	49.0	57.0	44.72	5.75E+00	71.70		
cm162a	SAM	110.0	183.0	209.0	251.0	304.0	211.00	5.35E+01	54.0	63.0	66.00	69.0	78.0	65.0	5.97E+00	68.72	1.00E-00	9.53E-01
	SAMGAM	133.0	181.0	214.0	242.0	309.0	209.40	4.41E+01	57.0	63.0	65.0	70.0	74.0	65.56	5.03E+00	68.69		
cu	SAM	126.0	215.0	238.0	254.0	383.0	241.20	5.86E+01	58.0	62.0	66.28	68.0	79.0	67.0	5.12E+00	72.52	6.83E-02	9.53E-01
	SAMGAM	192.0	238.0	284.0	359.0	406.0	300.88	6.82E+01	59.0	65.0	67.0	71.0	77.0	67.64	4.44E+00	77.52		
x2	SAM	155.0	190.0	212.0	251.0	374.0	224.80	5.17E+01	51.0	56.0	62.80	67.0	99.0	61.0	9.51E+00	72.06	3.68E-01	9.53E-01
	SAMGAM	165.0	220.0	241.0	283.0	350.0	253.76	4.86E+01	55.0	58.0	62.0	65.0	68.0	61.80	3.59E+00	75.65		
cmb	SAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAMGAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
cc	SAM	375.0	463.0	513.0	554.0	665.0	519.04	7.42E+01	74.0	81.0	86.76	92.0	98.0	87.0	6.27E+00	83.28	1.20E-03	6.66E-01
	SAMGAM	410.0	553.0	644.0	705.0	827.0	637.72	9.79E+01	80.0	86.0	89.0	96.0	116.0	91.56	8.02E+00	85.64		
cordic	SAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAMGAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
frg1	SAM	107.0	139.0	158.0	176.0	242.0	160.36	3.05E+01	84.0	89.0	96.20	100.0	114.0	96.0	7.27E+00	40.01	1.00E-00	9.53E-01
	SAMGAM	108.0	131.0	154.0	175.0	242.0	157.60	3.37E+01	83.0	93.0	96.0	100.0	112.0	95.96	6.70E+00	39.11		
pm1	SAM	155.0	214.0	256.0	307.0	379.0	266.56	5.41E+01	53.0	57.0	57.84	59.0	62.0	58.0	2.09E+00	78.30	6.66E-02	6.23E-01
	SAMGAM	201.0	284.8	315.5	355.5	496.0	328.92	6.55E+01	53.0	58.0	59.0	61.2	64.0	59.33	2.59E+00	81.96		
sct	SAM	308.0	364.2	423.0	458.0	597.0	423.11	7.84E+01	83.0	93.5	97.72	103.0	112.0	97.5	6.93E+00	76.90	3.89E-02	9.53E-01
	SAMGAM	386.0	450.0	510.0	567.0	758.0	515.18	8.69E+01	91.0	98.0	100.0	104.8	113.0	101.41	5.72E+00	80.32		
t481	SAM	60.0	107.0	147.0	193.0	413.0	159.60	7.21E+01	43.0	48.0	63.60	68.0	144.0	55.0	2.40E+01	60.15	1.00E-00	9.53E-01
	SAMGAM	62.0	96.0	128.0	215.0	378.0	162.08	8.51E+01	42.0	49.0	57.0	68.0	95.0	62.00	1.61E+01	61.75		
tcon	SAM	345.0	450.0	478.0	545.0	660.0	501.40	7.71E+01	36.0	38.0	43.80	49.0	57.0	43.0	6.31E+00	91.26	1.10E-03	9.53E-01
	SAMGAM	469.0	555.0	613.0	643.0	761.0	603.36	6.65E+01	32.0	40.0	44.0	52.0	65.0	45.92	8.09E+00	92.39		
vda	SAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAMGAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Table 4: Experiment 1 – Mean number of each gate, total gates and circuit depth in the first feasible and optimized solution.

Problem	Method	First Feasible Solution									Optimized Solution								
		AND	**OR**	**NOT**	**NAND**	**NOR**	**XOR**	**XNOR**	**Total**	**Depth**	**AND**	**OR**	**NOT**	**NAND**	**NOR**	**XOR**	**XNOR**	**Total**	**Depth**
C17	SAM	5.24	3.60	3.16	3.56	3.44	2.48	3.28	24.76	9.28	2.60	0.08	0.72	0.64	0.80	0.00	0.00	4.84	3.96
	SAMGAM	4.84	3.60	3.68	4.20	4.08	3.00	3.64	27.04	10.28	1.96	0.16	0.96	0.96	1.32	0.04	0.00	5.40	4.08
cm42a	SAM	6.24	12.72	5.68	10.08	7.00	7.32	7.20	56.24	11.72	0.76	3.88	0.84	8.12	6.36	0.20	0.04	20.20	6.28
	SAMGAM	6.52	10.24	6.36	11.52	7.88	7.20	6.36	56.08	12.16	1.32	3.56	0.72	8.20	5.96	0.40	0.28	20.44	6.68
cm82a	SAM	3.12	3.20	3.56	3.76	3.04	5.72	6.48	28.88	10.28	0.92	0.56	1.00	1.16	3.48	4.32	1.16	12.60	7.88
	SAMGAM	3.44	3.84	4.60	3.80	3.52	6.56	6.72	32.48	10.48	1.08	1.00	1.08	1.24	3.60	4.12	0.92	13.04	7.68
cm138a	SAM	6.52	10.48	4.80	10.12	8.48	4.84	5.12	50.36	12.32	1.48	3.36	2.00	6.88	5.68	0.20	0.16	19.76	8.20
	SAMGAM	7.00	10.28	5.48	11.12	7.48	5.44	6.00	52.80	12.20	1.48	3.36	1.68	6.84	6.04	0.20	0.12	19.72	7.88
decod	SAM	14.72	7.56	5.56	9.60	15.68	7.84	7.72	68.68	12.12	5.68	2.56	3.12	4.16	18.88	0.72	1.04	36.16	8.36
	SAMGAM	15.80	7.96	6.84	9.68	14.56	7.64	8.12	70.60	12.52	7.68	2.84	2.68	3.84	18.44	0.80	1.12	37.40	9.60
f51m	SAM	3.84	4.20	5.80	5.04	3.84	12.80	12.12	47.64	12.52	2.80	2.96	3.72	3.68	4.36	14.00	5.16	36.68	11.60
	SAMGAM	6.04	5.88	6.24	4.48	4.68	12.96	12.92	53.20	12.80	4.24	4.28	3.92	3.24	5.48	13.52	6.88	41.56	12.00
majority	SAM	3.12	3.28	2.36	3.48	2.92	2.52	3.00	20.68	9.80	0.76	1.20	0.08	1.72	4.48	0.28	0.04	8.56	5.76
	SAMGAM	3.08	3.40	1.72	2.64	3.20	1.96	2.48	18.48	9.20	1.28	1.16	0.32	1.20	4.80	0.20	0.04	9.00	6.12
z4ml	SAM	4.36	3.84	5.16	3.60	4.24	8.36	7.52	37.08	11.24	1.80	1.36	1.84	1.84	4.32	7.28	2.52	20.96	9.76
	SAMGAM	3.52	4.40	4.88	3.60	3.20	9.08	7.88	36.56	10.92	1.72	1.56	1.60	1.52	4.04	8.08	2.16	20.68	10.12
9symml	SAM	12.88	12.32	9.20	12.44	12.40	15.76	14.52	89.52	17.72	8.00	7.92	3.96	7.96	12.68	11.88	7.20	59.60	16.12
	SAMGAM	12.29	13.62	9.38	14.29	11.29	15.58	15.67	92.12	18.33	7.79	8.71	4.25	8.79	11.42	10.33	7.62	58.92	16.17
alu2	SAM	28.50	20.00	17.50	31.50	31.50	31.00	28.50	188.50	20.50	21.00	21.00	15.00	24.00	31.00	24.50	19.00	155.50	20.50
	SAMGAM	36.00	27.00	23.00	35.00	28.00	38.00	32.00	219.00	21.00	29.00	30.00	21.00	34.00	25.00	24.00	22.00	185.00	19.00
alu4	SAM	22.13	21.61	24.09	24.00	22.26	23.22	22.43	159.74	18.65	15.17	13.96	16.04	15.13	20.74	14.39	10.30	105.74	16.65
	SAMGAM	26.42	26.42	28.53	29.58	28.32	28.32	27.37	194.95	20.37	17.47	15.95	19.11	17.79	26.53	16.26	14.26	127.37	18.05
cm85a	SAM	11.16	11.04	11.36	10.24	9.20	9.32	9.64	71.96	15.96	4.24	3.88	3.24	4.04	9.96	2.80	1.48	29.64	12.32
	SAMGAM	13.56	15.84	14.36	15.52	14.16	12.00	12.28	97.72	16.96	3.16	4.56	3.80	5.20	9.76	2.68	1.60	30.76	12.44
cm151a	SAM	11.96	12.96	9.88	11.92	12.88	8.48	9.28	77.36	16.64	3.48	2.92	2.84	4.28	13.96	1.60	0.76	29.84	11.88
	SAMGAM	11.04	12.72	9.40	11.80	13.16	9.24	9.16	76.52	16.60	4.52	2.88	2.32	3.76	13.72	1.32	0.60	29.12	11.68
cm162a	SAM	16.84	13.64	14.96	16.80	12.84	12.80	12.56	100.44	15.20	6.76	3.88	4.60	5.84	11.76	3.48	1.56	37.88	11.12
	SAMGAM	16.84	13.76	16.48	15.80	14.52	12.48	12.04	101.92	16.20	6.28	4.96	4.80	6.16	11.04	3.48	1.12	37.84	11.60
cu	SAM	19.80	18.48	19.48	17.24	19.88	13.04	12.92	120.84	16.68	7.20	4.84	4.92	4.44	17.00	2.36	1.08	41.84	10.96
	SAMGAM	24.84	21.88	21.40	20.12	23.48	17.20	17.68	146.60	17.48	8.52	4.12	5.12	5.68	15.76	2.36	0.76	42.32	11.48
x2	SAM	16.44	18.56	15.84	17.20	15.52	13.36	12.24	109.16	17.32	4.44	6.44	4.36	6.72	11.28	1.96	1.52	36.72	11.80
	SAMGAM	18.96	18.48	17.80	19.96	16.56	15.40	14.60	121.76	16.80	6.04	5.04	4.72	6.72	12.12	2.00	0.84	37.48	11.64
cmb	SAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAMGAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cc	SAM	39.68	32.28	39.92	36.56	37.96	31.24	32.60	250.24	19.08	10.40	5.84	9.96	5.48	16.88	2.40	2.32	53.28	9.44
	SAMGAM	48.92	41.68	48.60	41.40	43.52	41.28	39.44	304.84	21.04	11.40	6.40	12.32	5.32	16.16	2.36	2.44	56.40	9.80
cordic	SAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAMGAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
frg1	SAM	20.80	13.20	12.16	17.68	13.56	4.56	4.40	86.36	16.32	17.08	7.52	4.48	12.44	13.32	0.80	0.48	56.12	13.76
	SAMGAM	20.36	13.80	11.64	16.96	12.00	4.28	4.72	83.76	15.84	17.16	8.28	4.36	12.56	12.48	0.72	0.24	55.80	13.20
pm1	SAM	21.92	18.28	24.64	21.68	18.48	14.88	13.76	133.64	16.52	7.64	3.20	8.96	6.16	8.64	1.60	0.36	36.56	9.36
	SAMGAM	24.75	22.88	27.00	26.46	24.21	16.96	19.67	161.92	17.12	7.58	4.29	10.25	5.38	9.67	1.25	0.29	38.71	10.00
sct	SAM	30.17	29.44	33.61	30.00	28.50	25.11	26.61	203.44	19.94	7.72	6.39	11.50	7.00	13.44	5.44	3.56	55.06	14.44
	SAMGAM	33.82	35.59	41.73	35.77	33.73	33.91	31.91	246.45	21.45	7.45	7.73	14.09	5.82	13.68	5.45	3.82	58.05	15.14
t481	SAM	9.36	8.48	12.88	10.56	9.88	12.12	10.92	74.20	15.20	2.76	2.96	7.96	3.16	6.48	6.68	2.84	32.84	10.00
	SAMGAM	9.96	10.08	13.60	9.80	10.00	11.92	10.76	76.12	14.96	2.20	2.76	7.40	3.48	7.04	5.96	3.20	32.04	10.28
tcon	SAM	33.80	32.60	37.24	34.68	34.32	32.48	32.56	237.68	19.28	3.08	2.20	4.12	2.40	13.80	2.12	1.04	28.76	5.04
	SAMGAM	43.40	39.20	46.52	42.36	39.96	38.16	38.12	287.72	20.56	3.60	3.24	4.60	2.96	11.88	1.84	1.08	29.20	5.00
vda	SAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAMGAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5: Experiment 1 – Algorithm Counting: for each problem, the number of times that each method obtained statistically better results. For the cases where there is no statistical difference, both algorithms are counted.

Method	**#Evaluations**	**#Transistors First Solution**	**#Transistors Final Solution**
SAM	19	22	22
SAMGAM	22	18	22

Table 6: Experiment 2 – Information about the number of transistors, number of gates, depth, relative reduction (RR), time and p-value for each problem.

Problem	Method	FFS Value	Optimized Solution									p-value
			Min	Median	Mean	Stdev	Max	Gates	Depth	RR (%)	Time (s)	
C17	PM	12	12.00	12.00	12.00	0.00	12.00	6.00	4.00	0.00	14.10	5.30E-22
	SAM		8.00	8.00	8.00	0.00	8.00	4.00	4.00	33.33	20.15	
cm42a	PM	156	30.00	36.00	35.76	2.52	42.00	21.70	6.50	77.08	158.63	8.00E-01
	SAM		31.00	36.00	35.56	2.65	41.00	21.56	6.42	77.21	160.05	
cm82a	PM	159	18.00	22.00	22.04	2.04	28.00	11.54	8.04	86.14	66.10	8.00E-01
	SAM		19.00	21.00	22.76	3.67	36.00	13.38	8.60	85.69	84.19	
cm138a	PM	148	33.00	39.00	38.52	2.44	42.00	23.64	8.04	73.97	296.15	8.00E-01
	SAM		32.00	38.00	38.78	3.05	46.00	23.80	8.30	73.80	323.55	
decod	PM	132	59.00	69.00	68.46	5.23	80.00	37.96	7.52	48.14	233.24	8.00E-01
	SAM		56.00	67.00	67.90	8.20	90.00	38.56	7.68	48.56	270.71	
f51m	PM	638	638.00	638.00	638.00	0.00	638.00	323.00	29.00	0.00	3317.60	5.10E-19
	SAM		344.00	421.50	415.02	23.64	449.00	215.20	23.54	34.95	1995.98	
majority	PM	24	13.00	16.00	16.92	2.12	22.00	9.20	6.48	29.50	14.31	5.44E-09
	SAM		11.00	14.00	14.00	1.67	18.00	8.52	6.16	41.67	16.30	
z4ml	PM	503	499.00	503.00	502.92	0.56	503.00	254.96	33.00	0.02	1773.45	7.30E-19
	SAM		33.00	87.00	89.88	40.12	223.00	49.36	15.16	82.13	1054.02	
9symml	PM	1039	1039.00	1039.00	1039.00	0.00	1039.00	524.00	92.00	0.00	5625.68	1.09E-09
	SAM		197.00	257.00	262.92	50.34	367.00	142.24	22.60	74.69	4684.54	
alu2	PM	1790	1790.00	1790.00	1790.00	0.00	1790.00	900.00	74.00	0.00	10414.20	5.11E-19
	SAM		497.00	623.50	626.26	53.35	746.00	325.10	61.66	65.01	106322.62	
alu4	PM	-	-	-	-	-	-	-	-	-	-	-
	SAM		-	-	-	-	-	-	-	-	-	
cm85a	PM	610	610.00	610.00	610.00	0.00	610.00	309.00	25.00	0.00	2334.73	5.04E-19
	SAM		43.00	62.00	69.14	20.76	106.00	40.12	17.96	88.67	1652.11	
cm151a	PM	154	43.00	54.00	53.22	4.06	58.00	31.36	12.14	65.44	3317.33	1.78E-01
	SAM		45.00	52.00	51.68	3.67	59.00	31.78	12.02	66.44	1892.28	
cm162a	PM	200	57.00	67.00	66.98	4.52	78.00	40.58	12.14	66.51	1924.53	5.48E-01
	SAM		59.00	65.00	65.56	3.64	79.00	40.18	12.26	67.22	1388.39	
cu	PM	261	64.00	75.00	75.36	5.54	87.00	46.88	12.84	71.13	2369.41	2.00E-01
	SAM		63.00	72.00	71.88	4.48	82.00	46.20	12.36	72.46	1774.73	
x2	PM	174	56.00	63.00	63.40	2.37	67.00	38.18	13.18	63.56	827.97	8.00E-01
	SAM		55.00	65.00	63.94	3.35	73.00	38.86	12.74	63.25	630.05	
cmb	PM	144	44.00	58.50	59.18	10.51	75.00	34.50	10.48	58.90	721.09	6.20E-02
	SAM		46.00	65.50	64.64	8.22	77.00	38.30	12.26	55.11	664.53	
cc	PM	256	86.00	102.00	101.96	7.96	130.00	55.68	8.82	60.17	3058.44	4.23E-10
	SAM		75.00	90.00	89.20	7.79	105.00	50.70	8.94	65.16	1925.81	
cordic	PM	-	-	-	-	-	-	-	-	-	-	-
	SAM		-	-	-	-	-	-	-	-	-	
frg1	PM	1605	1605.00	1605.00	1605.00	0.00	1605.00	816.00	116.00	0.00	191578.47	1.09E-09
	SAM		238.00	356.00	354.32	53.40	441.00	193.16	25.00	77.92	37334.75	
pm1	PM	2084	2084.00	2084.00	2084.00	0.00	2084.00	1050.00	45.00	0.00	26939.52	4.68E-19
	SAM		74.00	84.00	84.58	5.23	97.00	51.26	10.98	95.90	6579.89	
sct	PM	466	438.00	466.00	461.96	6.42	466.00	238.92	25.58	0.87	9090.86	3.18E-17
	SAM		92.00	106.00	106.64	8.62	129.00	64.74	16.24	77.12	5168.36	
t481	PM	-	-	-	-	-	-	-	-	-	-	-
	SAM		-	-	-	-	-	-	-	-	-	
tcon	PM	49	43.00	49.00	47.92	1.67	49.00	26.36	4.52	2.20	380.79	6.18E-02
	SAM		43.00	46.00	46.60	1.70	49.00	26.24	4.36	4.90	361.93	
vda	PM	-	-	-	-	-	-	-	-	-	-	-
	SAM		-	-	-	-	-	-	-	-	-	

Table 7: Experiment 2 – Mean number of each gate, total gates and circuit depth in the optimized solution.

Problem	Method	Optimized Solution								
		AND	**OR**	**NOT**	**NAND**	**NOR**	**XOR**	**XNOR**	**Total**	**Depth**
C17	PM	6.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	4.00
	SAM	4.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00
cm42a	PM	0.68	8.82	2.34	4.56	5.30	0.00	0.00	21.70	6.50
	SAM	0.40	8.38	1.80	5.22	5.76	0.00	0.00	21.56	6.42
cm82a	PM	1.88	1.18	0.58	0.00	4.40	3.06	0.44	11.54	8.04
	SAM	1.82	1.38	0.82	0.04	6.50	2.32	0.50	13.38	8.60
cm138a	PM	0.24	11.54	3.06	3.10	5.70	0.00	0.00	23.64	8.04
	SAM	0.30	11.74	2.82	2.86	6.04	0.04	0.00	23.80	8.30
decod	PM	29.84	0.22	3.44	0.16	4.16	0.14	0.00	37.96	7.52
	SAM	28.76	0.16	3.12	0.42	6.10	0.00	0.00	38.56	7.68
f51m	PM	246.00	69.00	8.00	0.00	0.00	0.00	0.00	323.00	29.00
	SAM	132.26	64.52	8.48	0.12	8.64	0.62	0.56	215.20	23.54
majority	PM	4.28	3.04	0.12	0.40	1.36	0.00	0.00	9.20	6.48
	SAM	2.92	1.96	0.10	0.60	2.94	0.00	0.00	8.52	6.16
z4ml	PM	192.96	55.00	7.00	0.00	0.00	0.00	0.00	254.96	33.00
	SAM	22.18	13.64	3.34	0.20	8.04	1.38	0.58	49.36	15.16
9symml	PM	430.00	85.00	9.00	0.00	0.00	0.00	0.00	524.00	92.00
	SAM	73.64	46.20	8.20	0.32	13.64	0.20	0.04	142.24	22.60
alu2	PM	750.00	140.00	10.00	0.00	0.00	0.00	0.00	900.00	74.00
	SAM	206.22	94.50	13.58	0.20	10.50	0.06	0.04	325.10	61.66
alu4	PM	-	-	-	-	-	-	-	-	-
	SAM	-	-	-	-	-	-	-	-	-
cm85a	PM	256.00	45.00	8.00	0.00	0.00	0.00	0.00	309.00	25.00
	SAM	18.94	10.04	3.12	0.04	7.98	0.00	0.00	40.12	17.96
cm151a	PM	15.86	4.78	1.44	1.22	8.06	0.00	0.00	31.36	12.14
	SAM	14.54	5.00	1.60	0.36	10.28	0.00	0.00	31.78	12.02
cm162a	PM	12.28	11.76	4.12	1.04	10.72	0.66	0.00	40.58	12.14
	SAM	11.70	11.88	4.02	0.56	11.42	0.56	0.04	40.18	12.26
cu	PM	21.60	6.04	4.00	0.84	14.40	0.00	0.00	46.88	12.84
	SAM	19.72	5.80	3.76	0.08	16.80	0.04	0.00	46.20	12.36
x2	PM	8.42	13.36	4.18	2.04	9.50	0.64	0.04	38.18	13.18
	SAM	8.98	13.54	3.86	1.92	10.26	0.26	0.04	38.86	12.74
cmb	PM	11.22	11.12	3.14	1.98	6.86	0.18	0.00	34.50	10.48
	SAM	10.52	13.16	3.82	2.30	8.32	0.18	0.00	38.30	12.26
cc	PM	32.44	12.14	6.44	1.18	3.22	0.26	0.00	55.68	8.82
	SAM	27.50	10.72	6.90	0.28	5.30	0.00	0.00	50.70	8.94
cordic	PM	-	-	-	-	-	-	-	-	-
	SAM	-	-	-	-	-	-	-	-	-
frg1	PM	673.00	116.00	27.00	0.00	0.00	0.00	0.00	816.00	116.00
	SAM	107.88	53.00	15.84	0.28	16.16	0.00	0.00	193.16	25.00
pm1	PM	876.00	158.00	16.00	0.00	0.00	0.00	0.00	1050.00	45.00
	SAM	17.40	14.20	14.60	1.56	3.42	0.08	0.00	51.26	10.98
sct	PM	163.66	59.06	15.96	0.06	0.08	0.04	0.06	238.92	25.58
	SAM	21.16	18.54	7.50	0.14	16.52	0.58	0.30	64.74	16.24
t481	PM	-	-	-	-	-	-	-	-	-
	SAM	-	-	-	-	-	-	-	-	-
tcon	PM	13.68	7.04	2.08	0.84	2.72	0.00	0.00	26.36	4.52
	SAM	13.36	7.00	1.92	0.00	3.96	0.00	0.00	26.24	4.36
vda	PM	-	-	-	-	-	-	-	-	-
	SAM	-	-	-	-	-	-	-	-	-

Table 8: Experiment 2 – Algorithm Counting: for each problem, the number of times that each method obtained statistically better results. For the cases where there is no statistical difference, both algorithms are counted.

Method	**#Transistors Final Solution**
PM	10
SAM	21