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Supplemental information

Optimization-based Eukaryotic Genetic Circuit Design (EuGeneCiD) and modeling (EuGeneCiM) tools: Computational approach to synthetic biology Wheaton L. Schroeder, Anna S. Baber, and Rajib Saha

A. Solut	ion Qu	antity	and Q	uality Results				EuGeneCiD Results			
NUMBER OF SOLUTIONS RETURNED				PERCENT OPTIMAL SOLUTIONS				CAUSE OF EUGENECID RUN ENDING			
	Cd/Cu	Cd/Zn	Cu/Zn		Cd/Cu	Cd/Zn	Cu/Zn		Cd/Cu	Cd/Zn	Cu/Zn
AND	1000	1000	1000	AND	75.50%	84.00%	82.20%	AND			
NIMPLY	1000	1000	1000	NIMPLY	55.10%	71.40%	60.60%	NIMPLY			
CNI	1000	1000	1000	CNI	70.50%	70.20%	57.80%	CNI			
HALF ADDER	328	595	335	HALF ADDER	8.23%	16.97%	12.54%	HALF ADDER			
NAND	1000	1000	1000	NAND	21.00%	31.70%	42.80%	NAND			
NOR	1000	1000	1000	NOR	80.40%	18.50%	13.00%	NOR			
OR	1000	1000	1000	OR	31.30%	39.30%	44.40%	OR			
XNOR	738	877	680	XNOR	25.47%	45.04%	53.38%	XNOR			
XOR	351	687	577	XOR	8.83%	6.11%	8.84%	XOR			
NUMBER OI		NS RETURN	ED	PERCENT OPTIMAL SOLUTIONS				CAUSE OF E	UGENECID	RUN ENDI	٧G
	Cd	Cu	Zn		Cd Ci	u Zi	n		Cd	Cu	Zn
BUFFER	1000	1000	1000	BUFFER	73.50%	71.10%	78.40%	BUFFER			
B. Solution Size Results								Completed Time Interrupted			
SOLUTION MI		Cd/7=	Cu/7=	INODE SOLU		Cd/7=	Cu /7~	SOLUTION M		Cd/7=	Cu /7~
		Cu/Zn	Cu/Zn			Cu/Zn	Cu/Zn			Cu/Zn	cu/2n
	2	2	2		5	4	4		5	5	5
	3	2	2		5	4	4		5	5	5
	2	2			4	4	4		5	5	5
HALF ADDER	5	5	5	HALF ADDER	6	6	6	HALF ADDER		6	/
NAND	3	2	2	NAND	5	4	4	NAND	5	5	5
NOR	1	1	2	INDR	5	4	4	NOR	5	5	5
UK	1	1	2	UNOR	4	4	4	UK	5	5	5
XNUK	3	2	2	XNOR	6	5	5	XNOR	6	5	6
XUR 4 3 4 XOR 5 5 5 XOR 6 5 6											0
SOLUTION N		SIZE		MODE SOLUTION SIZE				SOLUTION MAXIMUM SIZE			
	Cd	Cu	Zn		Cd	Cu	Zn		Cd	Cu	Zn
BUFFER	1	1	1	BUFFFR	5	5	5	BUEEER	5	6	6
		-	_	Dorran	5	•	5	DOTTER	5	Ũ	•
C. Soluti	ion Tim	ne Resu	ılts			-		DOTTER		Ū	
C. Soluti	On Tim		ılts		TION TIME (S)				IME (S)	
C. Soluti		ne Resu	Ilts Cu/Zn	MEAN SOLU	TION TIME (S) Cd/7n	Cu/7n	MAXIMUM SC	DLUTION TI	IME (S)	Cu/Zn
C. Soluti	LUTION TII Cd/Cu	NE (S) Cd/Zn	Cu/Zn	MEAN SOLU	TION TIME (S Cd/Cu 46.2) Cd/Zn 54.18	Cu/Zn 42.5		DLUTION TI Cd/Cu 193.33	IME (S) Cd/Zn 314.11	Cu/Zn 210.08
C. Soluti	Con Tim	NE (S) Cd/Zn 1.14 1.29	Cu/Zn 1.02 1.15	MEAN SOLU AND	TION TIME (S Cd/Cu 46.2 74.08) Cd/Zn 54.18 61.1	Cu/Zn 42.5 96.61		DLUTION TI Cd/Cu 193.33 414.64	IME (S) Cd/Zn 314.11 191.95	Cu/Zn 210.08 623.21
C. Soluti	LUTION TII Cd/Cu 1.22 2.02 1.11	ME (S) Cd/Zn 1.14 1.29 0.95	Cu/Zn 1.02 1.15 0.79	MEAN SOLU AND NIMPLY	TION TIME (S Cd/Cu 46.2 74.08 62.53) Cd/Zn 54.18 61.1 56.24	Cu/Zn 42.5 96.61 56.76	MAXIMUM SC AND NIMPLY CNI	DLUTION TI Cd/Cu 193.33 414.64 393.94	IME (S) Cd/Zn 314.11 191.95 269.48	Cu/Zn 210.08 623.21 335.72
C. Soluti	On Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51	ME (S) Cd/Zn 1.14 1.29 0.95 11.5	Cu/Zn 1.02 1.15 0.79 68,51	MEAN SOLU AND NIMPLY CNI	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87) Cd/Zn 54.18 61.1 56.24 1007.99	Cu/Zn 42.5 96.61 56.76 1776.34	AND NIMPLY CNI HALF ADDER	DLUTION TI Cd/Cu 193.33 414.64 393.94	IME (S) Cd/Zn 314.11 191.95 269.48 7069.24	Cu/Zn 210.08 623.21 335.72 10001 5
C. Soluti	On Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51 2.58	ME (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9	Cu/Zn 1.02 1.15 0.79 68.51 0.89	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33) Cd/Zn 54.18 61.1 56.24 1007.99 364.65	Cu/Zn 42.5 96.61 56.76 1776.34 258.09	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98	IME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR	On Tim LUTION TH Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78	ME (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53) Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66	IME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR	Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8	ME (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26) Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75	IME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR	On Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54) Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97	IME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR	ion Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR XNOR XNOR XOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97 10001.83	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3413.98	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR	on Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31	MAXIMUM SC AND NIMPLY CNI HALF ADDER NOR OR XNOR XNOR XOR	DLUTION TI Cd/Cu 193.33 414.64 393.94 2803.98 263.66 2651.75 4667.97 10001.83	ME (S) Cd/Zn 314.11 191.95 269.48 5293.96 81.39 1369.53 3413.98 3249.65	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XNOR XOR	on Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 SOLUTION	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S)	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME	Cd/Zn 54.18 61.1 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Citi	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31	MAXIMUM SC AND NIMPLY CNI HALF ADDER NOR OR XNOR XNOR XOR	DLUTION TI Cd/Cu 193.33 414.64 393.94 2803.98 263.66 2651.75 4667.97 10001.83	ME (S) Cd/Zn 314.11 191.95 269.48 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S)	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR XOR	on Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 SOLUTION Cd 0 547	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR XOR	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7 337	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 244.04 877.64 1030.31	MAXIMUM SC AND NIMPLY CNI HALF ADDER NOR OR XNOR XNOR XOR DI JECEP	DLUTION TI Cd/Cu 193.33 414.64 393.98 2803.98 263.66 2651.75 4667.97 10001.83 SOLUTION Cd 24.326	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86 Zn 63.041
C. Soluti	on Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 SOLUTION Cd 0.547	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 16.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR XOR BUFFER	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 7.0 9.188	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XNOR XNOR XOR BUFFER	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97 10001.83 SOLUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86 Zn 63.041
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR BUFFER D. Objet	ion Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 Cd 0.547 Ctive R	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578 ESULTS	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 16.8	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR MEAN SOL BUFFER	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 Zn 9.188	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR XOR BUFFER	CUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97 10001.83 SOLUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86 Zn 63.041
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR MINIMUM S BUFFER D. Objecti	on Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 50LUTION Cd 0.547 Ctive R VE VALUE	Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578 esults (SOLUTION	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 2n 0.581	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR BUFFER	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337) Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 030.31 7n 9.188	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XNOR XOR BUFFER	DLUTION TI Cd/Cu 193.33 414.64 393.98 2803.98 263.66 2651.75 4667.97 10001.83 30LUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86 Zn 63.041
C. Soluti	ion Tim LUTION TII Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 Cd 0.547 Cd Ctive R VE VALUE Cd/Cu	Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578 esults (SOLUTION Cd	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 16.8 Zn 0.581 XUMBER /Zn	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR BUFFER	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 7 0.3 2 7 9.188	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR MAXIMUM SC BUFFER	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97 10001.83 30LUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 10001.5 1950.73 231.61 3180.24 3210.01 7576.86 Zn 63.041
C. Soluti MINIMUM SO AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XNOR XOR BUFFER D. Objeu MIN. OBJECTI	ion Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 Cd 0.547 Cd Cd Cd Cd Cd Cd Cd Cd Cd Cd	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578 ESULTS (SOLUTION Cd 650 -19.0	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 16.8 2 0.581 VUMBER /Zn 29 (7) - 2	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR XOR XOR ZUZN I.7.68 (699)	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094 IVE VALUE Cd/Cu 5.61 (4	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 7 9.188 2 (SOLUTIO 4 2 (SOLUTIO 4 2 5.6 2 4 5.6 2 4 5 5.3 2 4 4.04 8 77.64 1030.31	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND OR XNOR XOR XOR BUFFER MAXIMUM SC MAXIMUM SC MAXIMUM SC MAXIMUM SC MAXIMUM SC SC SC SC SC SC SC SC SC SC SC SC SC S	CLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97 10001.83 CUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 1950.73 231.61 3180.24 3210.01 7576.86
C. Soluti	ion Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 Cd 0.547 Cd 0.547 Cd Cd Cd/Cu -15.56 (30 -4.95 (28	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578 ESULTS (SOLUTION Cd 660 - 19.0 (0) -5.66	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 16.8 2 7 0.581 NUMBER /Zn 29 (7) - 1 (691) -	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR XOR EUFFER MEAN SOL BUFFER	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337 MAX. OBJECT	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094 IVE VALUE Cd/Cu 5.61 (4 13.47 (2	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 7 9.188 c(SOLUTIO 4 5.62 2) 5.62 20 13.22 20 20 20 20 20 20 20 20 20 20 20 20 2	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR BUFFER MAXIMUM SC MAXIMUM SC MAXIMUM SC MAXIMUM SC MAXIMUM SC 07 XOR XOR XOR XOR XOR XOR XOR XOR XOR XOR	CLUTION TI Cd/Cu 193.33 414.64 2803.98 263.66 2651.75 4667.97 10001.83 CUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 1950.73 231.61 3180.24 3210.01 7576.86
C. Soluti	ion Tim Cd/Cu 1.22 2.02 1.11 10.51 2.58 0.78 0.8 5.55 24.73 Cd Cd Cd Cd Cd Cd Cd Cd Cd Cd	NE (S) Cd/Zn 1.14 1.29 0.95 11.5 0.9 0.82 0.79 1.39 3.4 TIME (S) Cu 0.578 TIME (S) Cu 0.578 C	Cu/Zn 1.02 1.15 0.79 68.51 0.89 0.82 0.84 18.8 16.8 16.8 Zn 0.581 VUMBER /Zn 0.581	MEAN SOLU AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR XOR BUFFER BUFFER N CU/Zn IZ.68 (699) 5.66 (560) N 4.24 (589)	TION TIME (S Cd/Cu 46.2 74.08 62.53 1836.87 382.33 37.53 283.26 809.54 1701.5 UTION TIME Cd 7.337 UTION TIME Cd 7.337	Cd/Zn 54.18 61.1 56.24 1007.99 364.65 20.25 248.57 681.9 871.15 (S) Cu 17.094 IVE VALUE Cd/Cu 5.61 (4 13.47 (2 13.47 (2	Cu/Zn 42.5 96.61 56.76 1776.34 258.09 55.3 244.04 877.64 1030.31 7 9.188 c(SOLUTIO 4 5.6 2) 5.6 20 13.9 13.	MAXIMUM SC AND NIMPLY CNI HALF ADDER NAND NOR OR XNOR XOR BUFFER MAXIMUM S MAXIMUM S BUFFER 3/Zn Cu S1 (8) 5.6 47 (6) 13.4	DLUTION TI Cd/Cu 193.33 414.64 393.94 10002.08 2803.98 263.66 2651.75 4667.97 10001.83 30LUTION Cd 24.236	ME (S) Cd/Zn 314.11 191.95 269.48 7069.24 5293.96 81.39 1369.53 3413.98 3249.65 TIME (S) Cu 154.033	Cu/Zn 210.08 623.21 335.72 1950.73 231.61 3180.24 3210.01 7576.86
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Figure S1: Results Tables. Contains the data presented in Figure 5, but in a more compact and tabular form, allowing precise data points to been seen. Also contains new data tables which report on the minimum and maximum objectives values of EuGeneCiD for each conceptualization as well as the solution number associated with that value A. Shows data relate to overall quality and quantity of the EuGeneCiD/EuGeneCiM runs, including number of solutions, percent of solutions which are optimal, and cause of the end of the run. B. Shows result tables related to solution size (in number of design triads) including minimum, mode, and maximum. C. Shows result tables related to solution time including minimum, mean, and maximum times. D. Shows results tables related to the minimum and maximum objective values of EuGeneCiD for a given design, as well as the design number associated with that value.



Figure S2: Specific Example BUFFER Solution Results. Shown in this image are three examples of successful BUFFER gate designs created by EuGeneCiD, presented in a similar manner to Figure 6. These successful examples include solutions for Cadmium, Copper, and Zinc signals using solutions of size one, three, and four respectively. This figure is included to show the applicability of the EuGeneCiD and EuGeneCiM workflow to circuits which have other than two inputs.