HNCO
Comparison of various black box optimization algorithms

May 18, 2020

Contents

1 Ranking

algorithm	rank distribution									
	1	2	3	4	5	6	7	8	9	10
pbil	10	0	0	1	3	0	4	0	0	1
sa	8	4	1	3	0	1	0	1	0	1
umda	7	2	0	1	0	1	2	1	2	3
hc	6	2	1	5	0	1	0	0	2	2
ga	5	3	4	3	1	0	0	0	0	3
ea-10p1	5	3	3	3	3	0	2	0	0	0
ea-1p1	5	3	1	4	0	0	3	1	2	0
ea-1p10	5	3	0	2	0	1	1	4	3	0
rls	4	6	0	4	0	2	0	1	1	1
ea-1c10	4	3	1	6	1	2	1	1	0	0

Per function rankings (ex-eaquo are grouped in parentheses):

one-max (rls, ea-1p10, ga, ea-1p1, ea-1c10, sa, pbil, ea-10p1, umda, hc)

lin (rls, sa, ea-1c10, ea-1p1, ga, ea-1p10, pbil, hc, umda, ea-10p1)

leading-ones (hc, umda, ea-10p1, pbil, ea-1c10, sa, ea-1p1, ea-1p10, rls), ga

ridge (umda, hc, ea-10p1, ea-1p1, sa, ea-1p10), pbil, ea-1c10, rls, ga

jmp-5 (pbil, umda), ga, (rls, ea-1p1, ea-1c10, sa, ea-1p10, hc, ea-10p1)

jmp-10 pbil, (ea-1p10, ga, ea-1p1, ea-1c10, sa, rls, ea-10p1, umda, hc)

djmp-5 (umda, pbil), ga, (hc, ea-10p1, ea-1c10, sa, ea-1p1, ea-1p10, rls)

djmp-10 pbil, (ea-1p10, sa, ea-1c10, ga, ea-1p1, rls, ea-10p1, hc, umda)

fp-5 (pbil, umda, ea-10p1, rls, ea-1p1, sa, ea-1c10, ea-1p10), hc, ga

fp-10 pbil, rls, ea-10p1, ea-1c10, ga, umda, ea-1p1, sa, ea-1p10, hc

nk sa, ga, ea-1c10, hc, pbil, rls, ea-10p1, ea-1p10, ea-1p1, umda

max-sat sa, rls, ga, ea-1p1, ea-10p1, ea-1c10, pbil, ea-1p10, umda, hc

labs ga, ea-1c10, sa, hc, ea-10p1, rls, ea-1p1, ea-1p10, umda, pbil

ep ga, rls, hc, ea-1c10, pbil, sa, ea-10p1, ea-1p1, ea-1p10, umda

cancel pbil, ea-10p1, ea-1p1, ga, ea-1c10, ea-1p10, umda, rls, hc, sa

trap hc, rls, ea-10p1, (ea-1p1, ga, sa), (ea-1c10, ea-1p10, pbil, umda)

hiff ga, sa, ea-10p1, ea-1c10, pbil, hc, ea-1p1, umda, ea-1p10, rls

plateau sa, (ea-1p1, ea-1p10), (ea-1c10, ga, rls, hc, umda, ea-10p1, pbil)

walsh2 hc, sa, ga, rls, ea-10p1, ea-1c10, pbil, ea-1p10, ea-1p1, umda

2 Function one-max

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	100	100	100	100	100	1
hc	100	100	100	100	100	1
sa	100	100	100	100	100	1
ea-1p1	100	100	100	100	100	1
ea-1p10	100	100	100	100	100	1
ea-10p1	100	100	100	100	100	1
ea-1c10	100	100	100	100	100	1
ga	100	100	100	100	100	1
pbil	100	100	100	100	100	1
umda	100	100	100	100	100	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.00	0.00	0.00	0.00	0.01	0.01
hc	0.00	0.00	0.01	0.00	0.01	0.00
sa	0.01	0.00	0.01	0.00	0.03	0.00
ea-1p1	0.00	0.00	0.00	0.00	0.00	0.00
ea-1p10	0.00	0.00	0.00	0.00	0.00	0.00
ea-10p1	0.01	0.00	0.01	0.00	0.02	0.01
ea-1c10	0.00	0.00	0.00	0.00	0.00	0.00
ga	0.01	0.00	0.00	0.00	0.02	0.00
pbil	0.07	0.00	0.02	0.00	0.09	0.00
umda	0.00	0.00	0.00	0.00	0.01	0.00

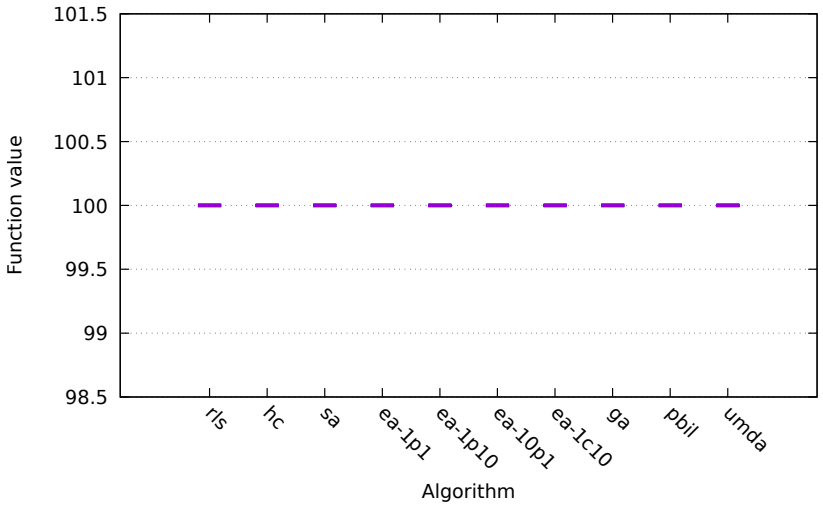

Figure 1: one-max

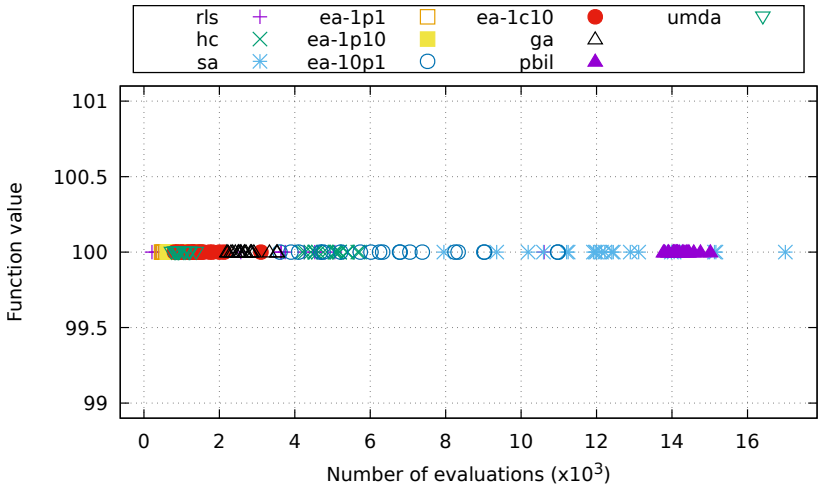

Figure 2: one-max

3 Function lin

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	45.03	45.03	45.03	45.03	45.03	1
hc	45.03	45.03	45.03	45.03	45.03	1
sa	45.03	45.03	45.03	45.03	45.03	1
ea-1p1	45.03	45.03	45.03	45.03	45.03	1
ea-1p10	45.03	45.03	45.03	45.03	45.03	1
ea-10p1	45.03	45.03	45.03	45.03	45.03	1
ea-1c10	45.03	45.03	45.03	45.03	45.03	1
ga	45.03	45.03	45.03	45.03	45.03	1
pbil	45.03	45.03	45.03	45.03	45.03	1
umda	45.03	45.03	45.03	45.03	45.03	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.00	0.00	0.00	0.00	0.00	0.00
hc	0.00	0.00	0.01	0.00	0.01	0.00
sa	0.02	0.01	0.03	0.01	0.05	0.01
ea-1p1	0.00	0.00	0.00	0.00	0.00	0.00
ea-1p10	0.00	0.00	0.00	0.00	0.00	0.00
ea-10p1	0.01	0.00	0.01	0.00	0.01	0.00
ea-1c10	0.00	0.00	0.00	0.00	0.00	0.00
ga	0.07	0.05	0.02	0.01	0.08	0.06
pbil	0.10	0.00	0.03	0.00	0.12	0.01
umda	0.01	0.00	0.00	0.00	0.01	0.00

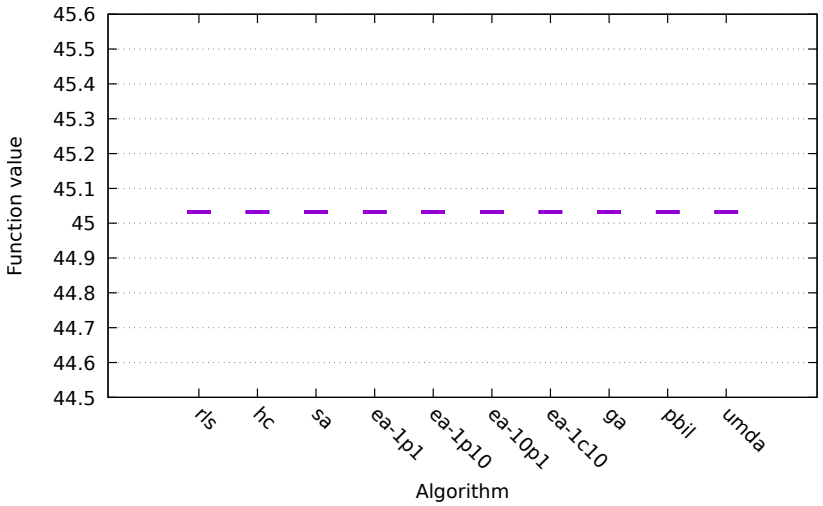

Figure 3: lin

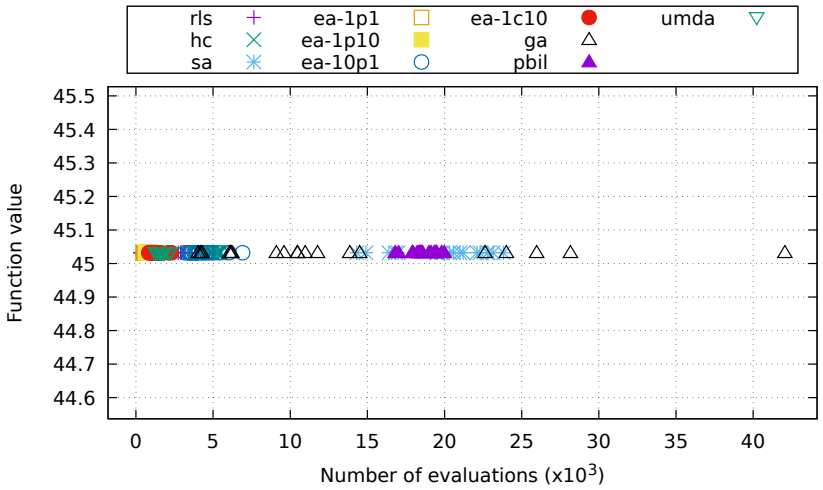

Figure 4: lin

4 Function leading-ones

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	100	100	100	100	100	1
hc	100	100	100	100	100	1
sa	100	100	100	100	100	1
ea-1p1	100	100	100	100	100	1
ea-1p10	100	100	100	100	100	1
ea-10p1	100	100	100	100	100	1
ea-1c10	100	100	100	100	100	1
ga	93	95	96	97	100	10
pbil	100	100	100	100	100	1
umda	100	100	100	100	100	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.01	0.01	0.02	0.01	0.03	0.02
hc	0.00	0.00	0.01	0.00	0.01	0.00
sa	0.01	0.02	0.01	0.03	0.02	0.05
ea-1p1	0.01	0.00	0.01	0.00	0.01	0.00
ea-1p10	0.01	0.00	0.01	0.00	0.01	0.00
ea-10p1	0.07	0.01	0.05	0.01	0.12	0.02
ea-1c10	0.01	0.00	0.01	0.00	0.02	0.00
ga	1.27	0.28	0.32	0.07	1.58	0.35
pbil	0.36	0.03	0.08	0.01	0.44	0.03
umda	0.05	0.01	0.01	0.00	0.07	0.01

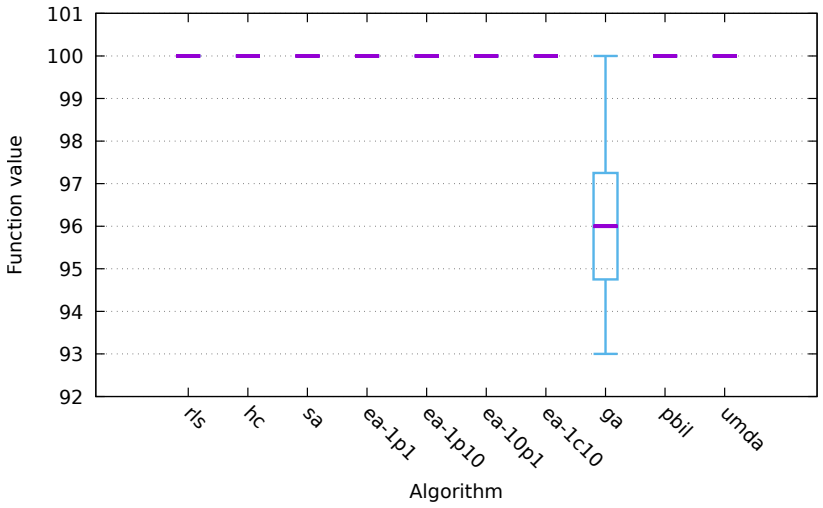

Figure 5: leading-ones

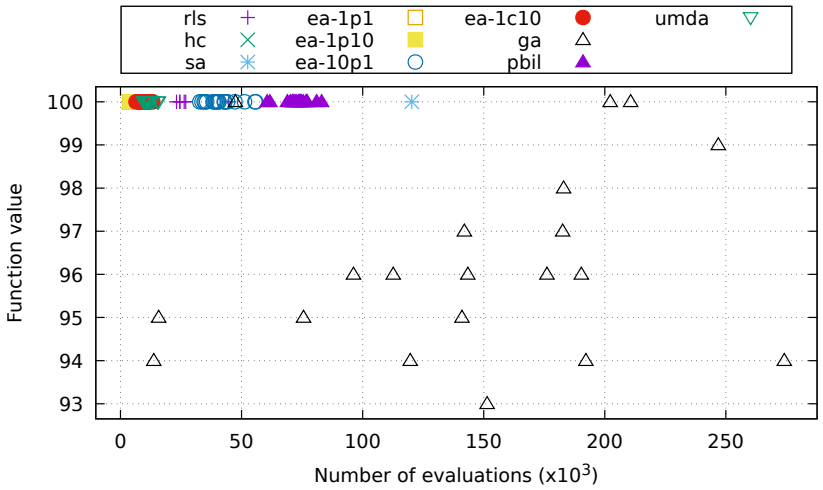

Figure 6: leading-ones

5 Function ridge

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	103	105	106	107	109	9
hc	200	200	200	200	200	1
sa	200	200	200	200	200	1
ea-1p1	200	200	200	200	200	1
ea-1p10	200	200	200	200	200	1
ea-10p1	200	200	200	200	200	1
ea-1c10	118	124	126	132	139	8
ga	102	103	103	103	104	10
pbil	154	155	155	156	157	7
umda	200	200	200	200	200	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.31	0.00	0.37	0.00	0.69	0.00
hc	0.01	0.00	0.02	0.00	0.03	0.00
sa	0.03	0.00	0.03	0.00	0.06	0.01
ea-1p1	0.02	0.00	0.02	0.00	0.04	0.00
ea-1p10	0.02	0.00	0.02	0.00	0.05	0.00
ea-10p1	0.28	0.03	0.22	0.02	0.50	0.05
ea-1c10	0.39	0.00	0.37	0.01	0.76	0.01
ga	1.36	0.01	0.35	0.00	1.72	0.01
pbil	1.37	0.01	0.36	0.01	1.73	0.01
umda	0.22	0.01	0.06	0.00	0.28	0.01

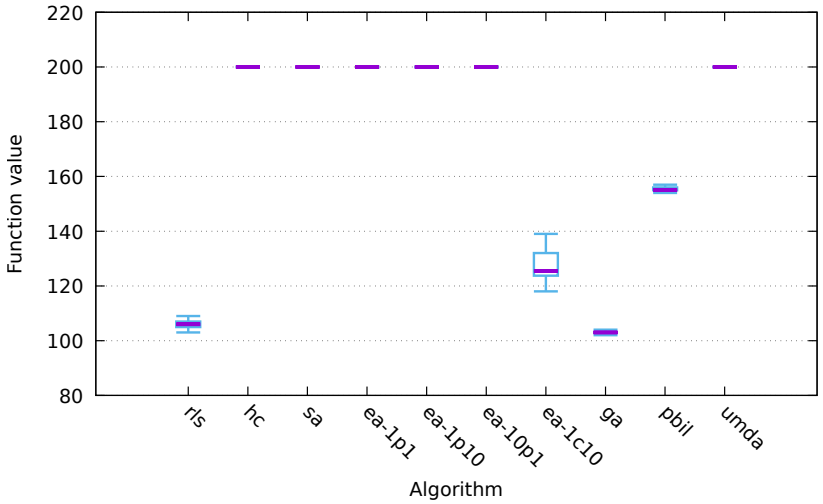

Figure 7: ridge

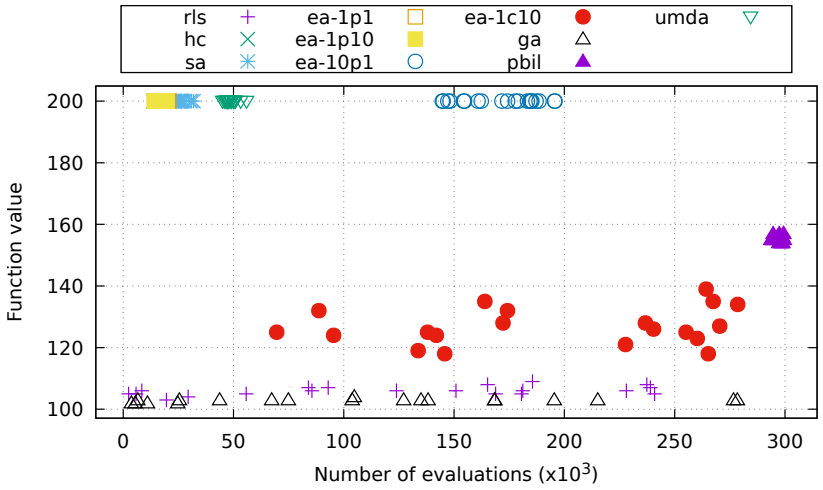

Figure 8: ridge

6 Function jmp-5

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	95	95	95	95	95	4
hc	95	95	95	95	95	4
sa	95	95	95	95	95	4
ea-1p1	95	95	95	95	95	4
ea-1p10	95	95	95	95	95	4
ea-10p1	95	95	95	95	95	4
ea-1c10	95	95	95	95	95	4
ga	95	100	100	100	100	3
pbil	100	100	100	100	100	1
umda	100	100	100	100	100	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.31	0.00	0.37	0.01	0.68	0.01
hc	0.28	0.00	0.36	0.00	0.65	0.00
sa	0.31	0.00	0.37	0.00	0.68	0.01
ea-1p1	0.41	0.00	0.36	0.00	0.77	0.01
ea-1p10	0.43	0.01	0.36	0.01	0.79	0.02
ea-10p1	0.50	0.01	0.37	0.01	0.87	0.02
ea-1c10	0.39	0.01	0.36	0.01	0.76	0.02
ga	0.42	0.36	0.10	0.09	0.52	0.44
pbil	0.08	0.00	0.02	0.00	0.10	0.00
umda	0.18	0.15	0.04	0.04	0.22	0.18

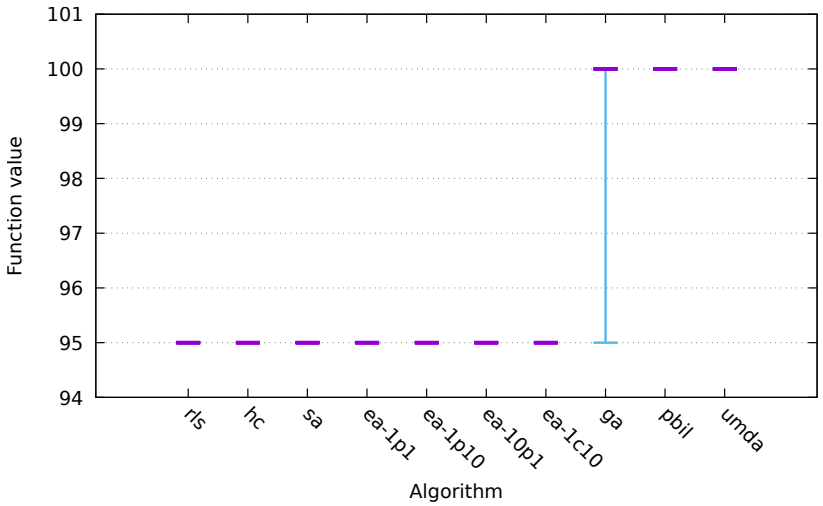

Figure 9: jmp-5

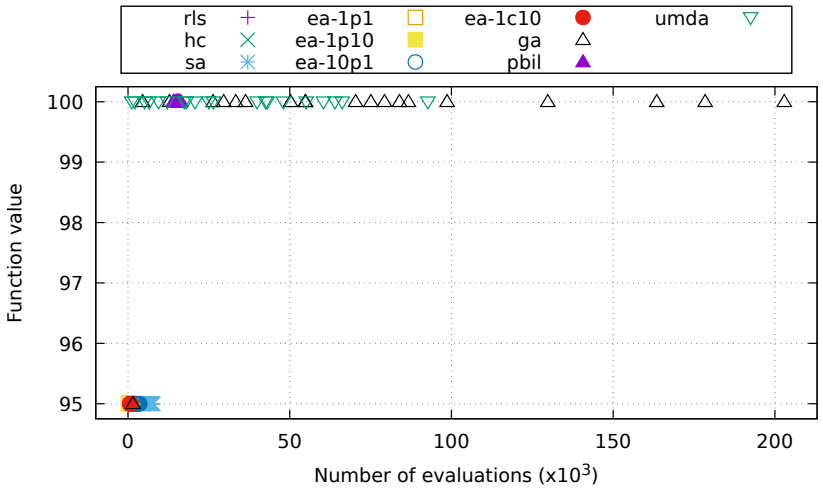

Figure 10: jmp-5

7 Function jmp-10

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	90	90	90	90	90	2
hc	90	90	90	90	90	2
sa	90	90	90	90	90	2
ea-1p1	90	90	90	90	90	2
ea-1p10	90	90	90	90	90	2
ea-10p1	90	90	90	90	90	2
ea-1c10	90	90	90	90	90	2
ga	90	90	90	90	90	2
pbil	90	90	90	100	100	1
umda	90	90	90	90	90	2

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.37	0.00	0.42	0.01	0.79	0.01
hc	0.33	0.01	0.42	0.00	0.75	0.00
sa	0.36	0.00	0.43	0.01	0.79	0.01
ea-1p1	0.47	0.01	0.42	0.01	0.89	0.01
ea-1p10	0.49	0.00	0.41	0.01	0.90	0.01
ea-10p1	0.57	0.01	0.42	0.01	0.99	0.02
ea-1c10	0.45	0.01	0.42	0.01	0.87	0.01
ga	1.58	0.01	0.39	0.01	1.97	0.01
pbil	1.04	0.76	0.25	0.18	1.29	0.94
umda	1.61	0.01	0.39	0.01	2.00	0.02

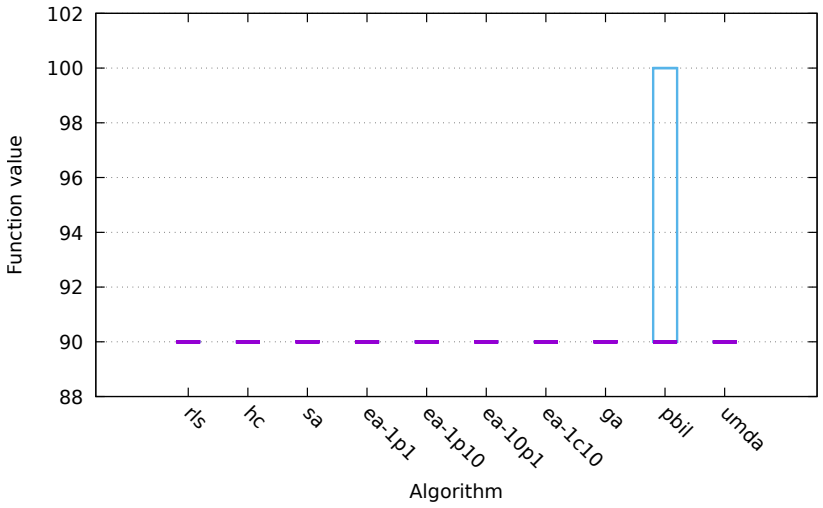

Figure 11: jmp-10

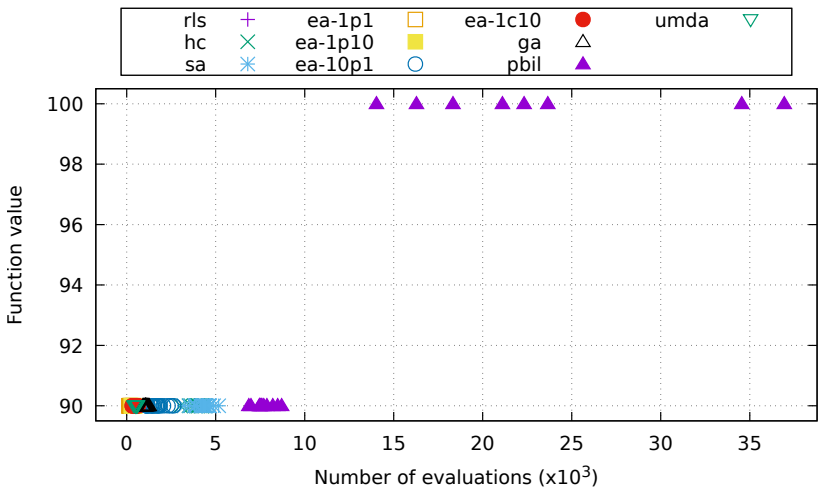

Figure 12: jmp-10

8 Function djmp-5

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	100	100	100	100	100	4
hc	100	100	100	100	100	4
sa	100	100	100	100	100	4
ea-1p1	100	100	100	100	100	4
ea-1p10	100	100	100	100	100	4
ea-10p1	100	100	100	100	100	4
ea-1c10	100	100	100	100	100	4
ga	100	105	105	105	105	3
pbil	105	105	105	105	105	1
umda	105	105	105	105	105	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.36	0.01	0.42	0.01	0.79	0.02
hc	0.33	0.00	0.42	0.01	0.75	0.00
sa	0.36	0.00	0.43	0.00	0.79	0.00
ea-1p1	0.47	0.01	0.42	0.01	0.88	0.01
ea-1p10	0.49	0.00	0.42	0.01	0.91	0.01
ea-10p1	0.57	0.01	0.42	0.01	0.99	0.02
ea-1c10	0.45	0.01	0.41	0.01	0.86	0.01
ga	0.47	0.41	0.12	0.10	0.59	0.52
pbil	0.09	0.00	0.02	0.00	0.11	0.01
umda	0.19	0.23	0.05	0.06	0.23	0.28

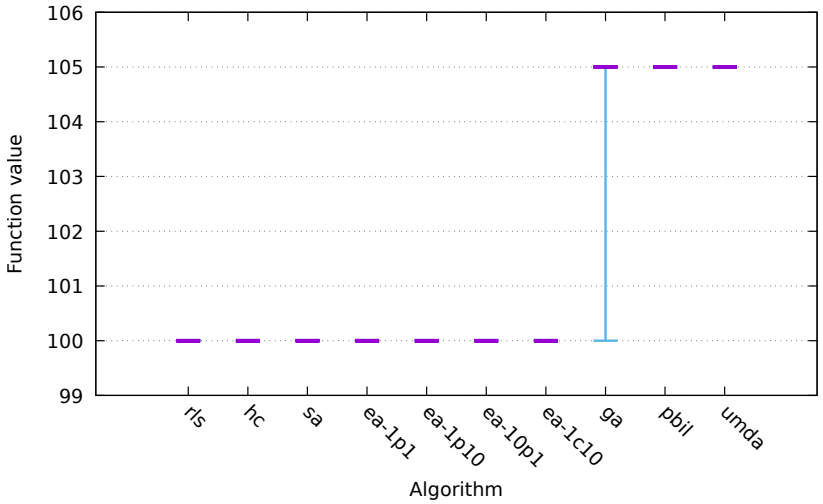

Figure 13: djmp-5

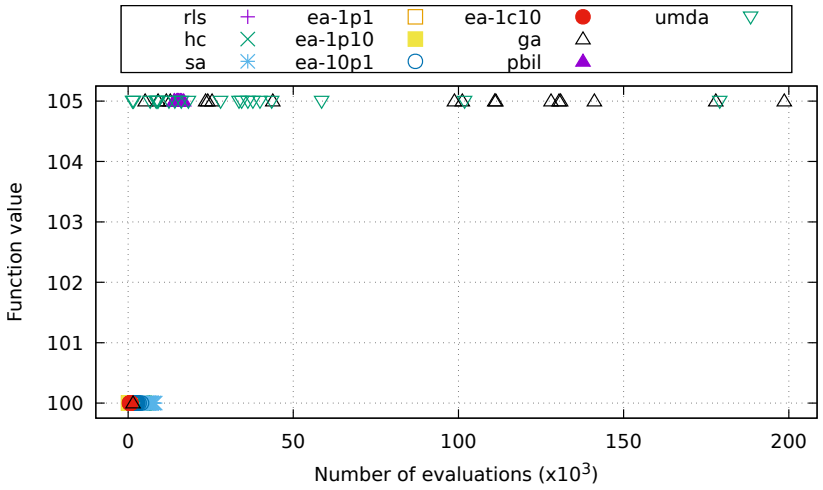

Figure 14: djmp-5

9 Function djmp-10

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	100	100	100	100	100	2
hc	100	100	100	100	100	2
sa	100	100	100	100	100	2
ea-1p1	100	100	100	100	100	2
ea-1p10	100	100	100	100	100	2
ea-10p1	100	100	100	100	100	2
ea-1c10	100	100	100	100	100	2
ga	100	100	100	100	100	2
pbil	100	100	100	110	110	1
umda	100	100	100	100	100	2

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.36	0.01	0.42	0.01	0.79	0.01
hc	0.33	0.00	0.42	0.01	0.75	0.01
sa	0.36	0.00	0.43	0.01	0.79	0.01
ea-1p1	0.47	0.01	0.42	0.01	0.89	0.01
ea-1p10	0.49	0.00	0.42	0.01	0.91	0.01
ea-10p1	0.57	0.01	0.42	0.01	0.99	0.01
ea-1c10	0.45	0.01	0.42	0.01	0.87	0.01
ga	1.57	0.01	0.39	0.01	1.97	0.01
pbil	0.98	0.76	0.23	0.18	1.21	0.94
umda	1.61	0.02	0.39	0.01	2.01	0.03

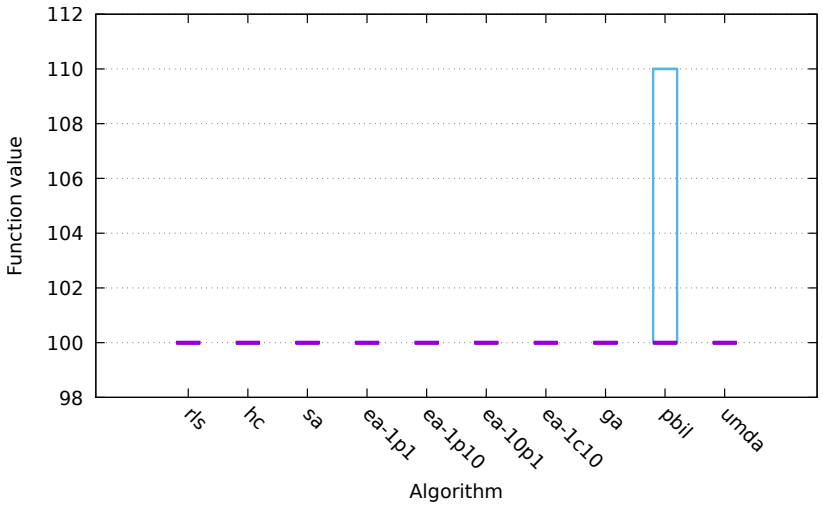

Figure 15: djmp-10

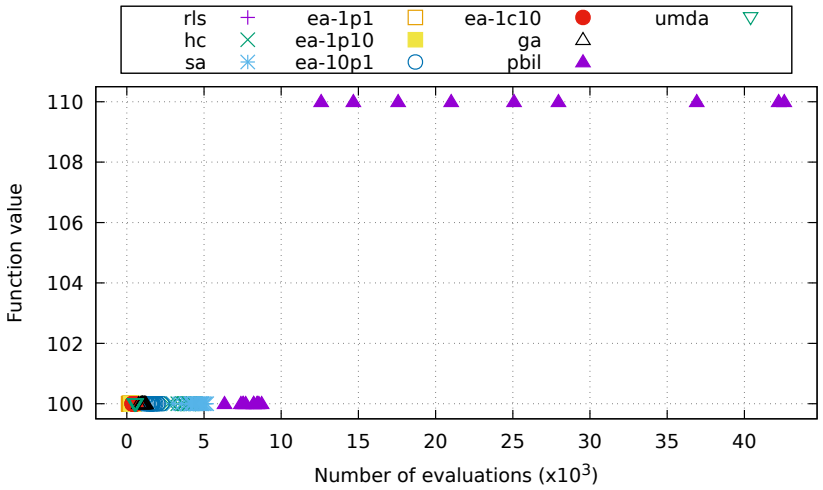

Figure 16: djmp-10

10 Function fp-5

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	194	194	194	194	194	1
hc	100	100	194	194	194	9
sa	194	194	194	194	194	1
ea-1p1	194	194	194	194	194	1
ea-1p10	194	194	194	194	194	1
ea-10p1	194	194	194	194	194	1
ea-1c10	194	194	194	194	194	1
ga	187	189	189	191	194	10
pbil	194	194	194	194	194	1
umda	194	194	194	194	194	1

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.04	0.04	0.05	0.04	0.09	0.08
hc	0.22	0.10	0.30	0.13	0.52	0.22
sa	0.02	0.04	0.03	0.05	0.05	0.10
ea-1p1	0.01	0.00	0.01	0.00	0.02	0.00
ea-1p10	0.01	0.00	0.01	0.00	0.02	0.00
ea-10p1	0.07	0.02	0.05	0.01	0.12	0.03
ea-1c10	0.02	0.01	0.02	0.01	0.03	0.01
ga	1.48	0.32	0.38	0.08	1.86	0.41
pbil	0.45	0.04	0.11	0.01	0.57	0.05
umda	0.06	0.01	0.02	0.00	0.08	0.01

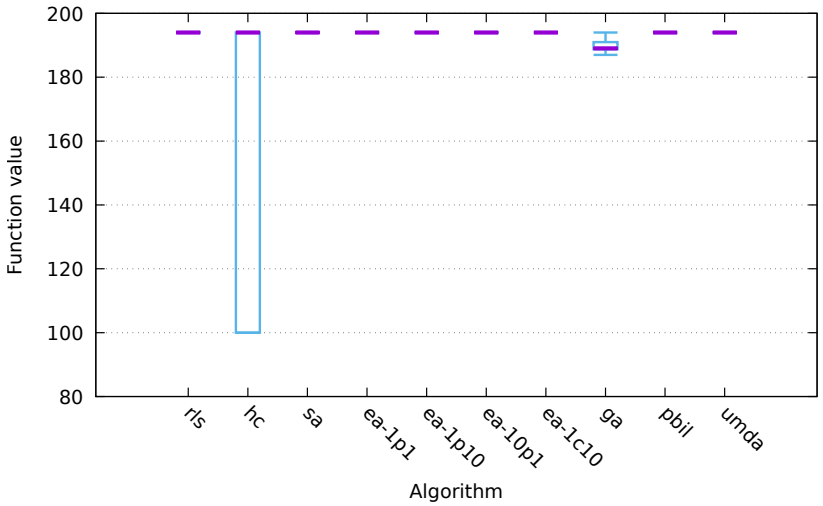

Figure 17: fp-5

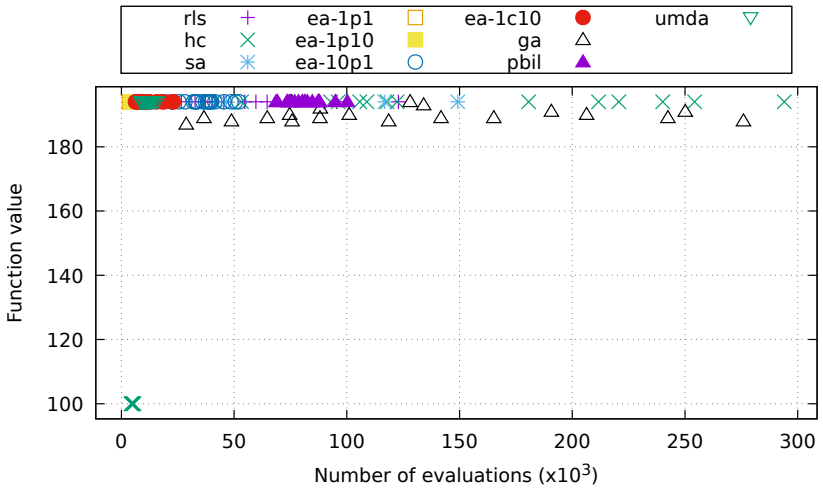

Figure 18: fp-5

11 Function fp-10

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	186	189	189	189	189	2
hc	100	100	100	100	100	10
sa	100	100	100	122	189	8
ea-1p1	100	100	100	189	189	7
ea-1p10	100	100	100	100	189	9
ea-10p1	100	189	189	189	189	3
ea-1c10	100	100	189	189	189	4
ga	183	185	187	188	189	5
pbil	189	189	189	189	189	1
umda	100	100	106	189	189	6

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.11	0.11	0.13	0.14	0.24	0.25
hc	0.32	0.00	0.43	0.01	0.75	0.01
sa	0.28	0.15	0.33	0.18	0.61	0.33
ea-1p1	0.33	0.22	0.31	0.20	0.64	0.42
ea-1p10	0.44	0.15	0.38	0.13	0.82	0.28
ea-10p1	0.15	0.19	0.12	0.14	0.27	0.32
ea-1c10	0.25	0.17	0.24	0.16	0.50	0.33
ga	1.47	0.35	0.38	0.09	1.86	0.44
pbil	0.40	0.03	0.10	0.01	0.50	0.04
umda	0.89	0.77	0.23	0.20	1.12	0.97

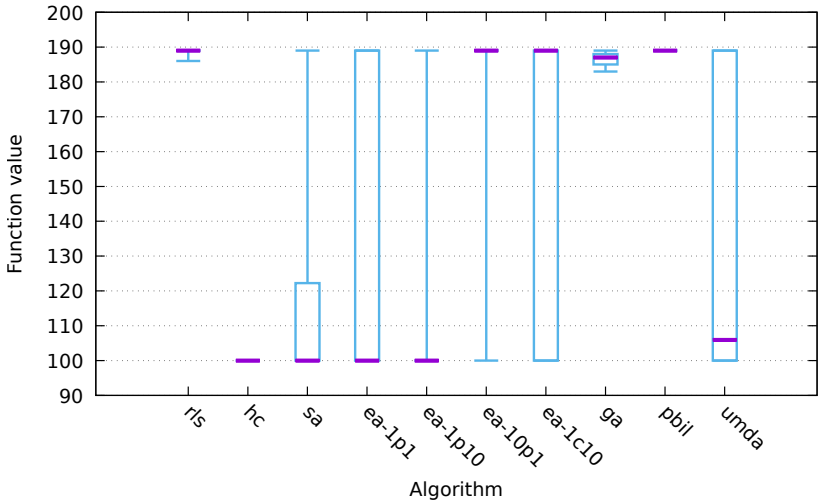

Figure 19: fp-10

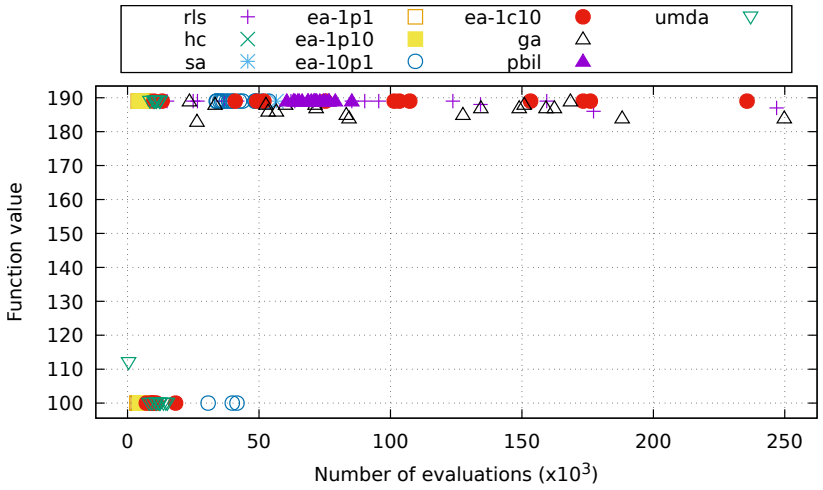

Figure 20: fp-10

12 Function nk

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	0.95	0.97	0.99	1.00	1.02	6
hc	0.96	0.99	0.99	1.01	1.03	4
sa	1.00	1.04	1.06	1.06	1.09	1
ea-1p1	0.85	0.92	0.96	0.99	1.04	9
ea-1p10	0.89	0.93	0.96	0.98	1.07	8
ea-10p1	0.89	0.96	0.98	1.03	1.09	7
ea-1c10	0.97	1.00	1.02	1.03	1.08	3
ga	1.00	1.03	1.04	1.05	1.10	2
pbil	0.95	0.97	0.99	1.01	1.04	5
umda	0.88	0.90	0.94	0.96	1.01	10

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.34	0.00	1.02	0.01	1.36	0.02
hc	0.30	0.00	0.98	0.01	1.27	0.01
sa	0.34	0.00	0.96	0.01	1.30	0.01
ea-1p1	0.44	0.01	1.00	0.01	1.45	0.01
ea-1p10	0.46	0.00	0.99	0.01	1.46	0.01
ea-10p1	0.55	0.01	1.01	0.02	1.56	0.03
ea-1c10	0.42	0.00	0.93	0.02	1.35	0.02
ga	1.56	0.01	1.11	0.01	2.67	0.02
pbil	1.57	0.01	1.00	0.01	2.57	0.02
umda	1.54	0.01	0.94	0.02	2.48	0.03

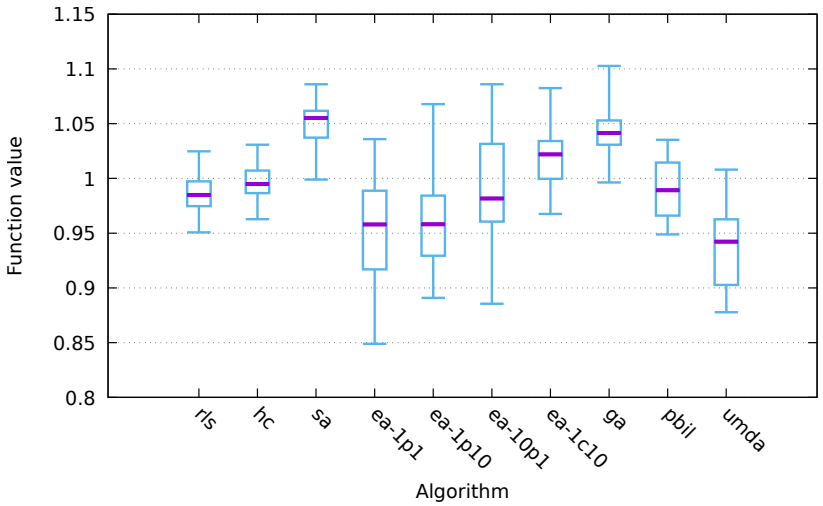

Figure 21: nk

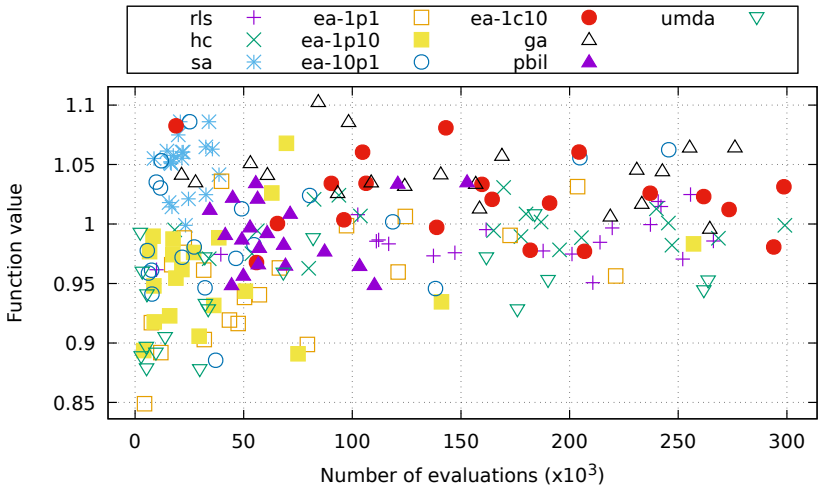

Figure 22: nk

13 Function max-sat

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	971	971	972	972	972	2
hc	963	965	966	967	971	10
sa	971	972	972	972	972	1
ea-1p1	962	967	968	970	972	4
ea-1p10	957	965	967	968	972	8
ea-10p1	964	966	968	971	972	5
ea-1c10	964	965	968	971	972	6
ga	964	968	969	971	972	3
pbil	964	967	967	967	968	7
umda	959	965	967	968	972	9

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.32	0.00	4.46	0.13	4.78	0.13
hc	0.29	0.00	4.03	0.09	4.32	0.09
sa	0.34	0.01	3.73	0.11	4.07	0.10
ea-1p1	0.46	0.01	4.06	0.12	4.52	0.12
ea-1p10	0.46	0.00	4.04	0.12	4.50	0.12
ea-10p1	0.54	0.01	4.92	0.08	5.46	0.08
ea-1c10	0.42	0.00	3.62	0.06	4.03	0.06
ga	1.53	0.00	5.26	0.10	6.79	0.09
pbil	1.59	0.01	4.08	0.12	5.66	0.13
umda	1.52	0.00	3.87	0.06	5.39	0.06

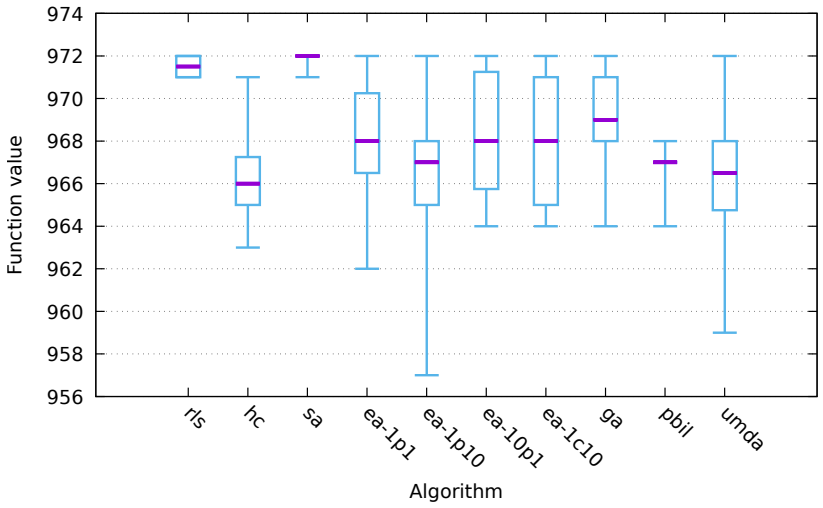

Figure 23: max-sat

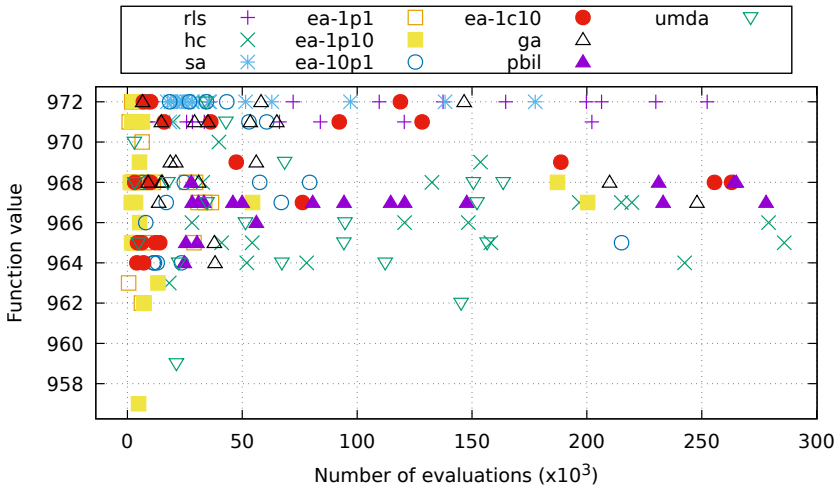

Figure 24: max-sat

14 Function labs

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	4.20	4.50	4.58	4.64	4.82	6
hc	4.47	4.61	4.73	4.83	5.35	4
sa	4.47	4.67	4.75	4.92	5.07	3
ea-1p1	3.67	3.86	4.17	4.43	4.66	7
ea-1p10	3.53	3.94	4.12	4.35	4.64	8
ea-10p1	4.22	4.41	4.62	4.73	5.20	5
ea-1c10	4.57	4.67	4.86	5.00	5.18	2
ga	4.69	4.91	4.97	5.23	5.45	1
pbil	3.55	3.86	3.96	4.14	5.01	10
umda	3.53	3.70	3.98	4.19	4.46	9

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.34	0.01	3.90	0.01	4.24	0.01
hc	0.31	0.01	3.92	0.01	4.23	0.01
sa	0.33	0.00	3.90	0.01	4.23	0.01
ea-1p1	0.43	0.01	3.90	0.01	4.32	0.01
ea-1p10	0.44	0.00	3.89	0.01	4.33	0.01
ea-10p1	0.51	0.01	3.89	0.01	4.40	0.01
ea-1c10	0.40	0.01	3.89	0.01	4.29	0.01
ga	1.52	0.01	3.85	0.01	5.37	0.02
pbil	1.56	0.01	3.87	0.02	5.44	0.03
umda	1.50	0.02	3.88	0.01	5.38	0.03

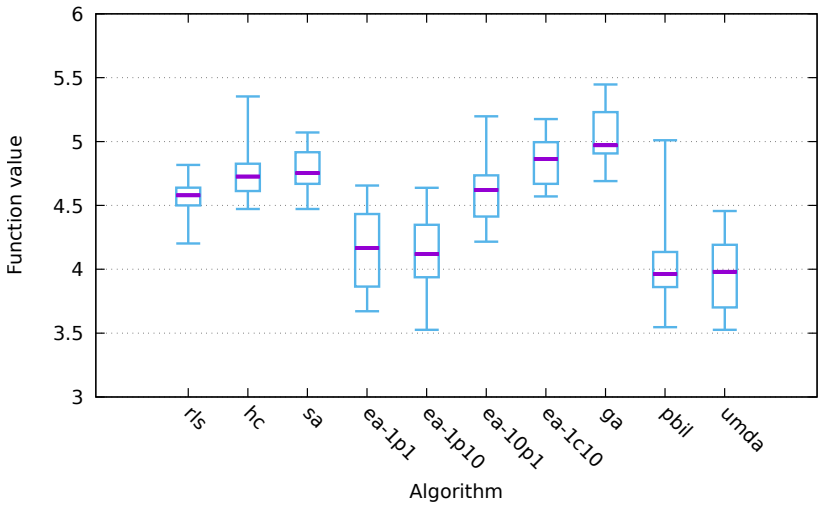

Figure 25: labs

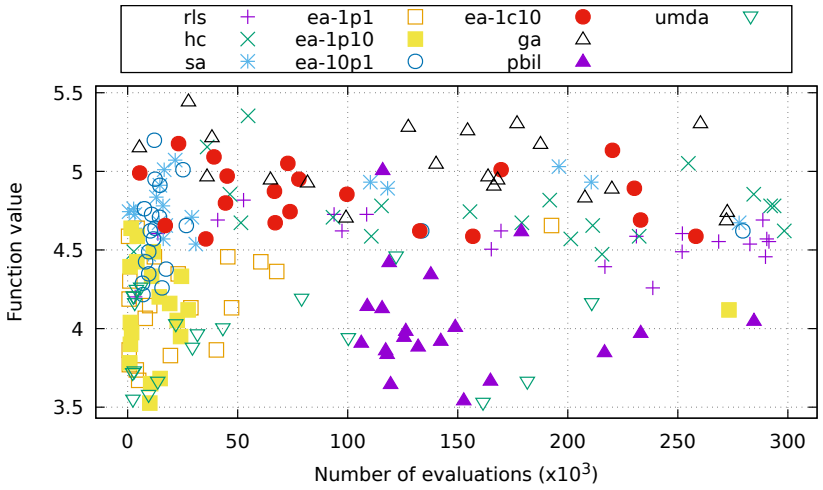

Figure 26: labs

15 Function ep

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	4.6×10^{-32}	1.0×10^{-30}	2.4×10^{-30}	3.8×10^{-30}	8.8×10^{-30}	2
hc	1.3×10^{-31}	9.3×10^{-31}	2.8×10^{-30}	5.4×10^{-30}	1.4×10^{-29}	3
sa	1.6×10^{-31}	3.1×10^{-30}	5.4×10^{-30}	1.1×10^{-29}	1.7×10^{-29}	6
ea-1p1	1.3×10^{-30}	9.3×10^{-30}	1.3×10^{-29}	2.5×10^{-29}	1.0×10^{-28}	8
ea-1p10	2.0×10^{-30}	9.7×10^{-30}	1.4×10^{-29}	4.6×10^{-29}	7.4×10^{-29}	9
ea-10p1	1.1×10^{-31}	2.8×10^{-30}	6.2×10^{-30}	1.0×10^{-29}	2.2×10^{-29}	7
ea-1c10	2.1×10^{-31}	3.2×10^{-30}	4.4×10^{-30}	1.3×10^{-29}	2.0×10^{-29}	4
ga	2.1×10^{-31}	7.9×10^{-31}	1.8×10^{-30}	3.0×10^{-30}	7.2×10^{-30}	1
pbil	1.1×10^{-30}	2.5×10^{-30}	5.1×10^{-30}	7.4×10^{-30}	1.2×10^{-29}	5
umda	5.6×10^{-31}	1.6×10^{-29}	3.5×10^{-29}	5.3×10^{-29}	1.4×10^{-28}	10

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.36	0.02	0.49	0.03	0.85	0.05
hc	0.31	0.00	0.51	0.01	0.82	0.00
sa	0.35	0.00	0.50	0.01	0.85	0.01
ea-1p1	0.45	0.01	0.50	0.01	0.95	0.01
ea-1p10	0.47	0.00	0.49	0.01	0.96	0.01
ea-10p1	0.55	0.01	0.51	0.01	1.06	0.02
ea-1c10	0.43	0.01	0.49	0.00	0.92	0.01
ga	1.57	0.02	0.54	0.01	2.11	0.02
pbil	1.71	0.01	0.55	0.01	2.25	0.02
umda	1.56	0.01	0.46	0.01	2.02	0.01

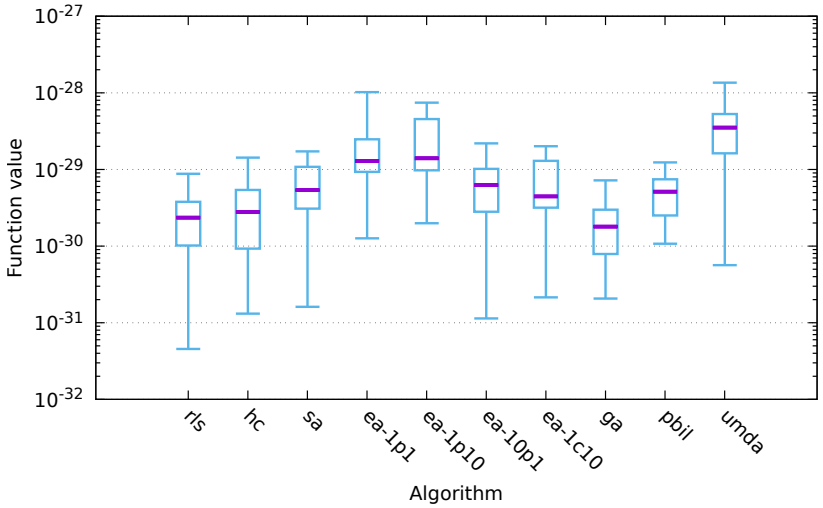

Figure 27: ep

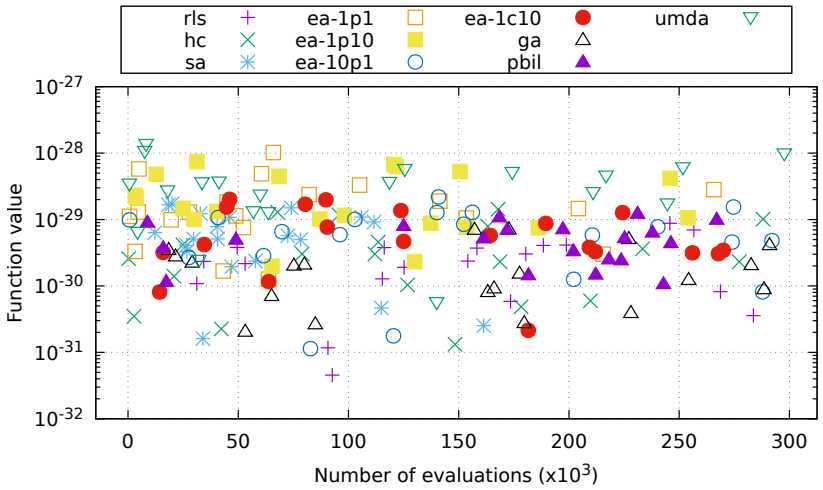

Figure 28: ep

16 Function cancel

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	0.16	1.20	1.62	1.90	2.26	8
hc	0.93	1.68	1.90	2.12	2.37	9
sa	0.85	1.98	2.09	2.84	4.75	10
ea-1p1	0.08	0.15	0.61	0.95	2.61	3
ea-1p10	0.11	0.33	0.72	1.31	1.96	6
ea-10p1	0.04	0.24	0.51	0.71	1.67	2
ea-1c10	0.10	0.33	0.71	1.41	1.97	5
ga	0.04	0.07	0.70	0.74	1.47	4
pbil	0.04	0.07	0.08	0.09	1.31	1
umda	0.13	0.76	0.92	1.78	2.48	7

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.33	0.01	0.50	0.01	0.83	0.01
hc	0.30	0.01	0.50	0.01	0.80	0.01
sa	0.35	0.00	0.48	0.01	0.83	0.01
ea-1p1	0.45	0.01	0.49	0.01	0.93	0.01
ea-1p10	0.47	0.00	0.48	0.01	0.95	0.01
ea-10p1	0.55	0.01	0.48	0.01	1.02	0.02
ea-1c10	0.43	0.01	0.48	0.01	0.91	0.01
ga	1.56	0.01	0.47	0.01	2.03	0.01
pbil	1.59	0.00	0.48	0.01	2.07	0.01
umda	1.54	0.02	0.46	0.01	2.00	0.03

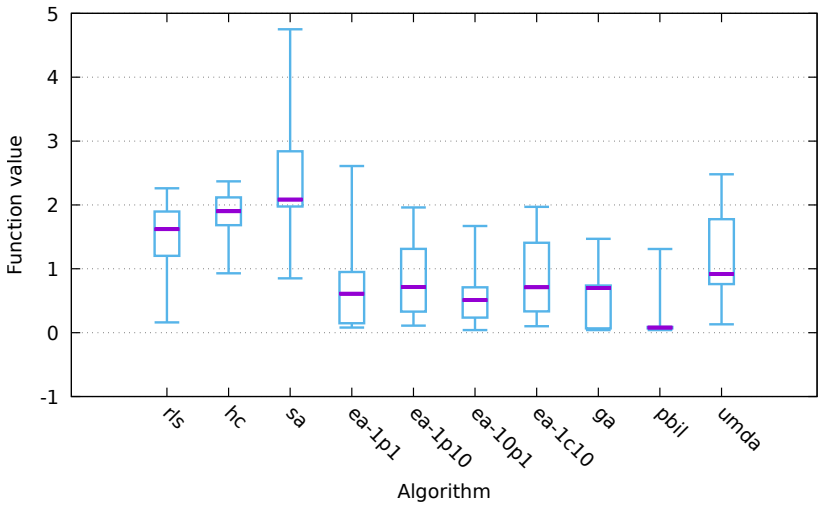

Figure 29: cancel

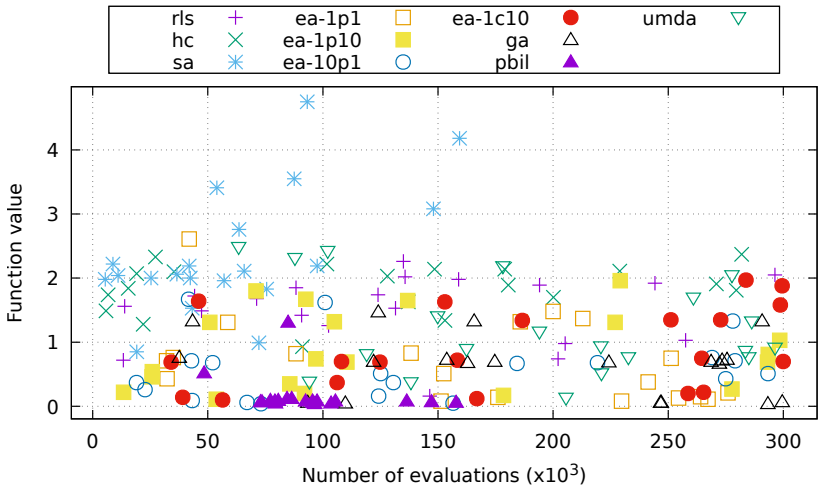

Figure 30: cancel

17 Function trap

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	91	91	91	91	92	2
hc	91	91	91	91	92	1
sa	90	90	90	90	91	4
ea-1p1	90	90	90	90	91	4
ea-1p10	90	90	90	90	90	7
ea-10p1	90	90	90	90	92	3
ea-1c10	90	90	90	90	90	7
ga	90	90	90	90	91	4
pbil	90	90	90	90	90	7
umda	90	90	90	90	90	7

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.36	0.01	0.46	0.01	0.82	0.01
hc	0.32	0.01	0.47	0.00	0.79	0.01
sa	0.36	0.01	0.46	0.01	0.82	0.00
ea-1p1	0.47	0.02	0.47	0.01	0.94	0.03
ea-1p10	0.48	0.00	0.46	0.00	0.95	0.01
ea-10p1	0.57	0.01	0.47	0.01	1.04	0.02
ea-1c10	0.44	0.00	0.47	0.01	0.91	0.01
ga	1.57	0.01	0.44	0.01	2.01	0.01
pbil	1.58	0.00	0.44	0.01	2.02	0.01
umda	1.55	0.01	0.44	0.01	1.99	0.00

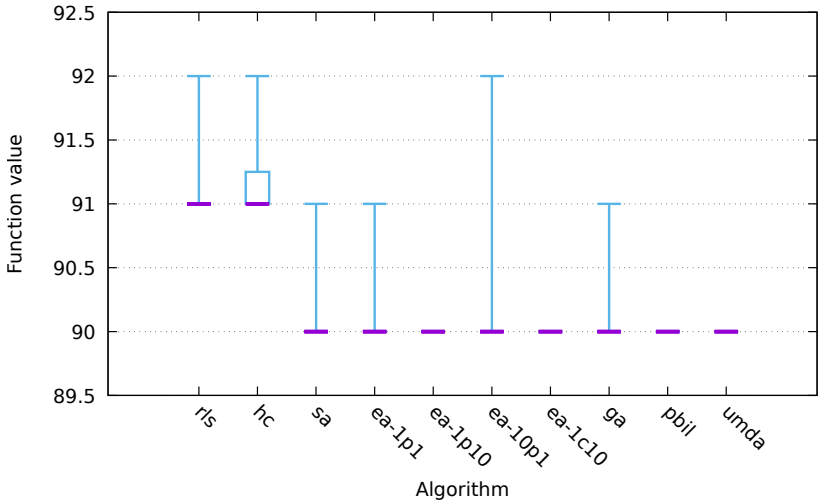

Figure 31: trap

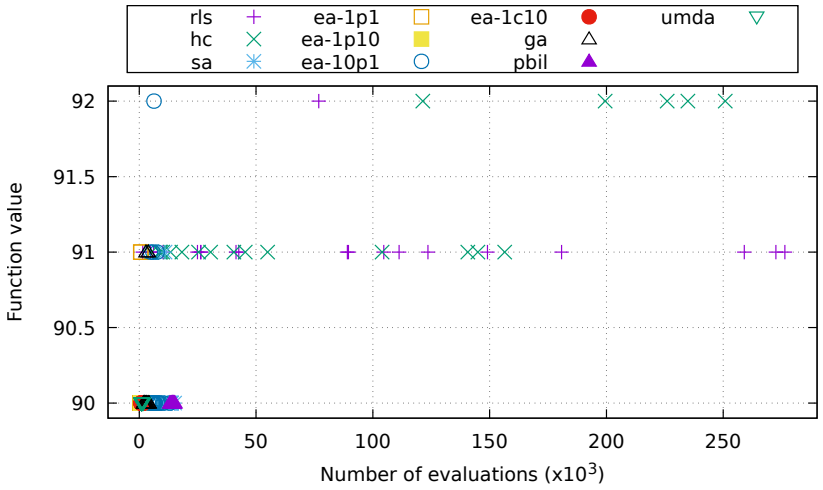

Figure 32: trap

18 Function hiff

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	408	418	423	432	448	10
hc	492	508	518	526	552	6
sa	640	672	720	800	832	2
ea-1p1	456	478	500	514	600	7
ea-1p10	440	472	484	498	544	9
ea-10p1	608	672	704	736	800	3
ea-1c10	564	627	660	682	800	4
ga	640	732	772	776	832	1
pbil	480	502	548	570	624	5
umda	456	487	496	509	572	8

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.35	0.00	0.89	0.01	1.24	0.01
hc	0.30	0.00	0.89	0.01	1.20	0.01
sa	0.34	0.01	0.99	0.02	1.33	0.02
ea-1p1	0.45	0.01	0.93	0.02	1.38	0.02
ea-1p10	0.47	0.00	0.91	0.02	1.38	0.02
ea-10p1	0.55	0.01	1.00	0.02	1.55	0.03
ea-1c10	0.43	0.00	0.94	0.02	1.36	0.02
ga	1.76	0.01	0.99	0.02	2.75	0.02
pbil	1.91	0.01	0.91	0.02	2.82	0.02
umda	1.87	0.01	0.88	0.02	2.75	0.02

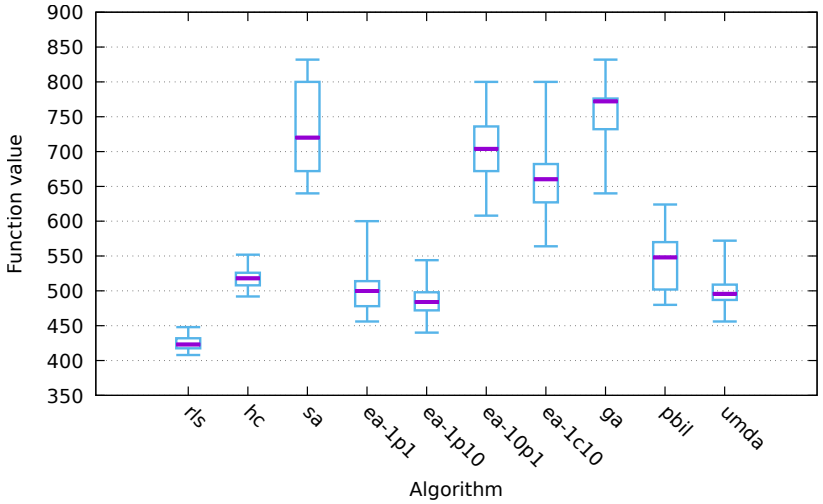

Figure 33: hiff

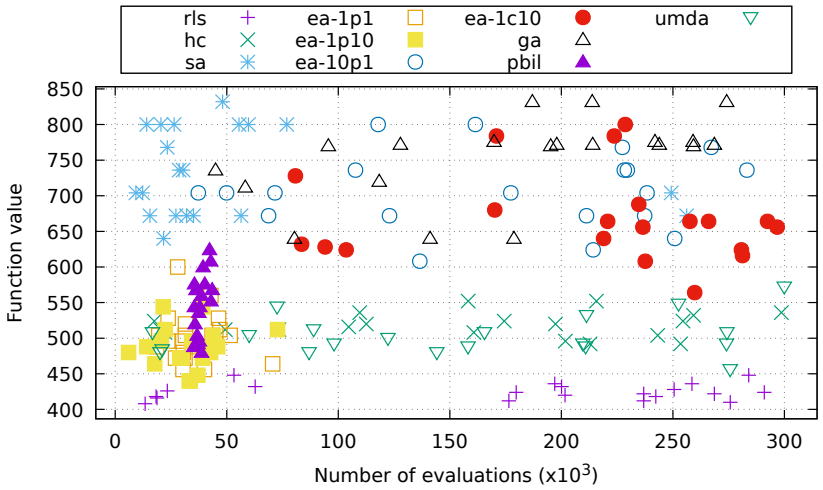

Figure 34: hiff

19 Function plateau

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	101	101	101	101	101	4
hc	101	101	101	101	101	4
sa	101	101	101	102	102	1
ea-1p1	101	101	101	101	102	2
ea-1p10	101	101	101	101	102	2
ea-10p1	101	101	101	101	101	4
ea-1c10	101	101	101	101	101	4
ga	101	101	101	101	101	4
pbil	101	101	101	101	101	4
umda	101	101	101	101	101	4

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.36	0.01	0.43	0.01	0.79	0.01
hc	0.32	0.00	0.43	0.01	0.76	0.00
sa	0.32	0.07	0.39	0.09	0.71	0.16
ea-1p1	0.44	0.06	0.42	0.06	0.86	0.12
ea-1p10	0.47	0.06	0.42	0.06	0.89	0.12
ea-10p1	0.57	0.01	0.44	0.01	1.01	0.02
ea-1c10	0.45	0.01	0.43	0.01	0.88	0.01
ga	1.57	0.01	0.41	0.00	1.98	0.01
pbil	1.58	0.01	0.41	0.01	2.00	0.01
umda	1.56	0.01	0.41	0.01	1.97	0.01

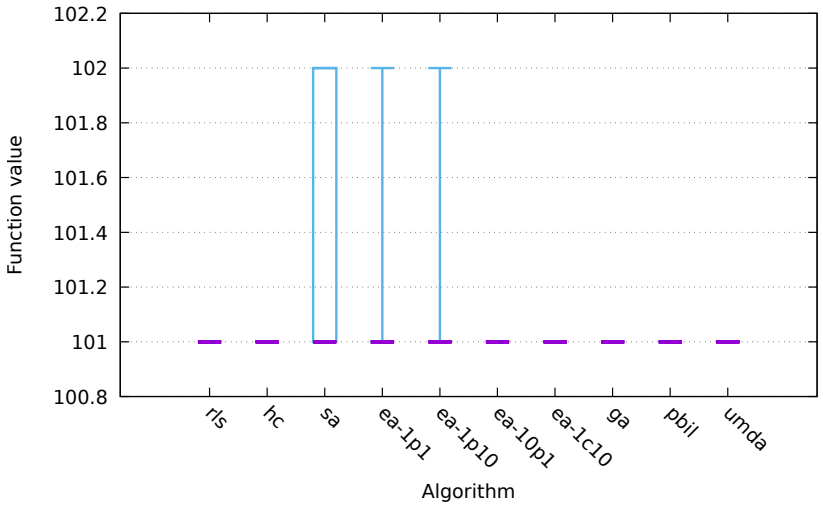

Figure 35: plateau

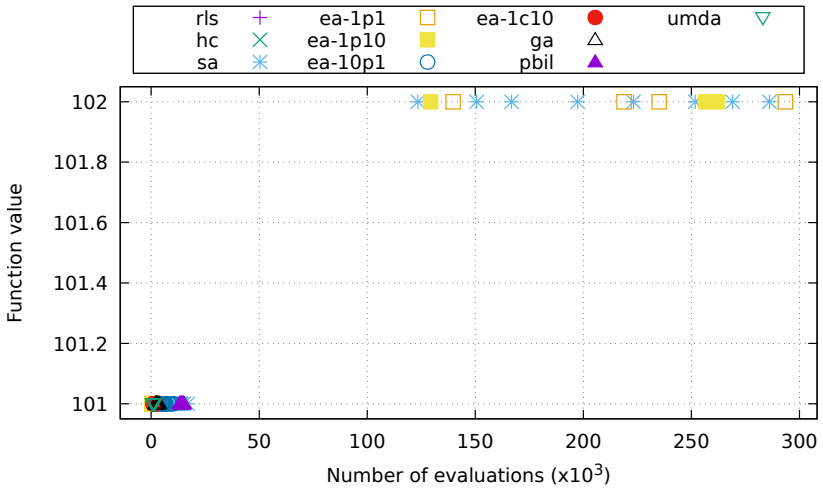

Figure 36: plateau

20 Function walsh2

algorithm	function value					
	min	Q_1	med.	Q_3	max	rk
rls	695.07	701.97	704.42	710.42	721.22	4
hc	704.95	709.56	714.49	720.04	721.22	1
sa	698.75	708.91	713.69	720.24	721.22	2
ea-1p1	638.39	657.98	663.67	688.12	720.85	9
ea-1p10	603.89	651.15	669.69	678.14	707.56	8
ea-10p1	649.21	686.45	700.26	720.39	721.22	5
ea-1c10	672.51	688.12	699.75	706.82	721.22	6
ga	685.02	700.29	707.77	715.33	721.22	3
pbil	641.42	658.39	672.19	682.02	720.24	7
umda	635.25	648.65	663.40	681.04	702.96	10

algorithm	algo. time (s)		eval. time (s)		total time (s)	
	mean	dev.	mean	dev.	mean	dev.
rls	0.32	0.00	3.67	0.04	3.99	0.04
hc	0.29	0.00	3.56	0.03	3.85	0.03
sa	0.33	0.00	3.55	0.04	3.88	0.04
ea-1p1	0.44	0.01	3.81	0.05	4.25	0.05
ea-1p10	0.46	0.01	3.81	0.06	4.27	0.06
ea-10p1	0.53	0.01	4.37	0.15	4.91	0.15
ea-1c10	0.41	0.00	3.45	0.03	3.86	0.03
ga	1.53	0.02	4.93	0.18	6.47	0.18
pbil	1.53	0.01	3.86	0.06	5.39	0.07
umda	1.46	0.11	3.41	0.28	4.88	0.39

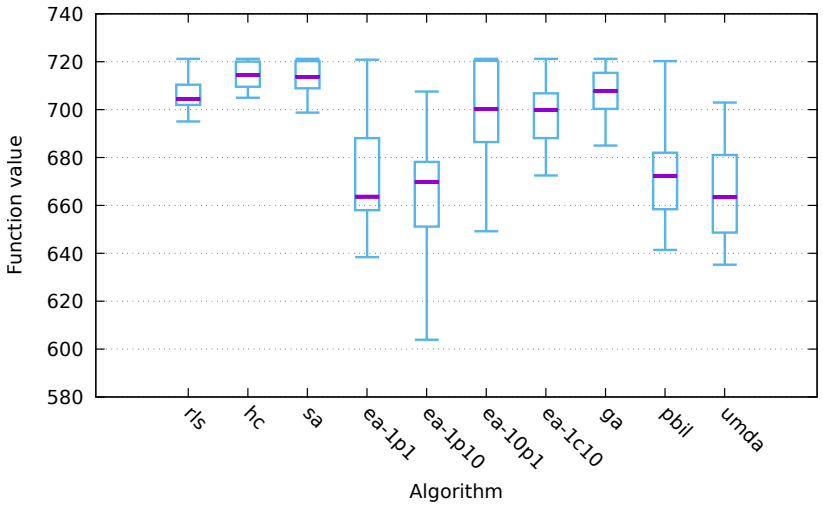

Figure 37: walsh2

A Plan

```
{
    "exec": "hnco",
    "opt": "--print-results --map 1 --map-random -s 100",
    "budget": 300000,
    "num_runs": 20,
    "parallel": true,
    "functions": [
        {
            "id": "one-max",
            "opt": "-F 0 --stop-on-maximum",
```

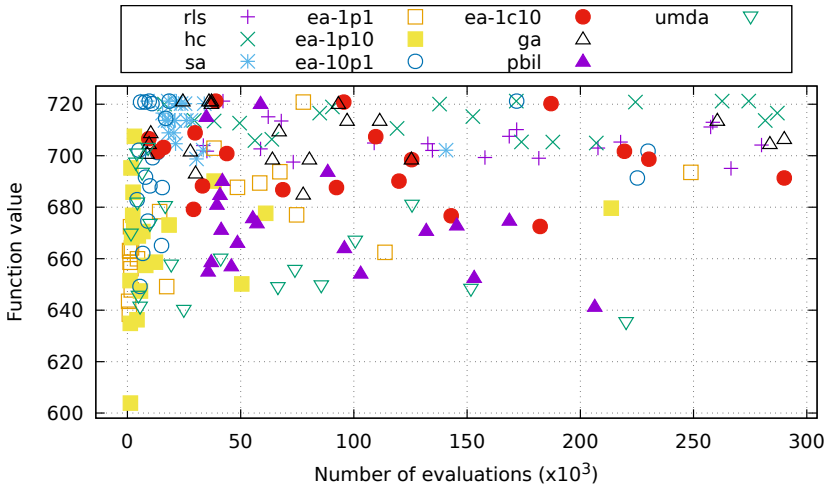

Figure 38: walsh2

```
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "lin",
    "opt": "-F 1 --stop-on-maximum -p instances/lin.100",
    "rounding": {
        "value": { "before": 2, "after": 2 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "leading-ones",
    "opt": "-F 10 --stop-on-maximum",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "ridge",
    "opt": "-F 11 --stop-on-maximum",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "jmp-5",
    "opt": "-F 30 --stop-on-maximum -t 5",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "jmp-10",
    "opt": "-F 30 --stop-on-maximum -t 10",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "djmp-5",
    "opt": "-F 31 --stop-on-maximum -t 5",
    "rounding": {
```

```
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "djmp-10",
    "opt": "-F 31 --stop-on-maximum -t 10",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "fp-5",
    "opt": "-F 40 --stop-on-maximum -t 5",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "fp-10",
    "opt": "-F 40 --stop-on-maximum -t 10",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "nk",
    "opt": "-F 60 -p instances/nk.100.4",
    "rounding": {
        "value": { "before": 1, "after": 2 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "max-sat",
    "opt": "-F 70 -p instances/ms.100.3.1000",
    "rounding": {
        "value": { "before": 3, "after": 0 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "labs",
    "opt": "-F 81",
    "rounding": {
        "value": { "before": 1, "after": 2 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "ep",
    "opt": "-F 90 -p instances/ep.100",
    "reverse": true,
    "logscale": true,
    "rounding": {
        "value": { "before": 1, "after": 1 },
        "time": { "before": 1, "after": 2 } }
},
{
    "id": "cancel",
    "opt": "-F 100 -s 99",
    "reverse": true,
    "rounding": {
        "value": { "before": 1, "after": 2 },
        "time": { "before": 1, "after": 2 } }
},
{
```

```
        "id": "trap",
        "opt": "-F 110 --stop-on-maximum --fn-num-traps 10",
        "rounding": {
            "value": { "before": 3, "after": 0 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "hiff",
        "opt": "-F 120 --stop-on-maximum -s 128",
        "rounding": {
            "value": { "before": 4, "after": 0 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "plateau",
        "opt": "-F 130 --stop-on-maximum",
        "rounding": {
            "value": { "before": 3, "after": 0 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "walsh2",
        "opt": "-F 162 -p instances/walsh2.100",
        "rounding": {
            "value": { "before": 3, "after": 2 },
            "time": { "before": 1, "after": 2 } }
    }
],
"algorithms": [
    {
        "id": "rls",
        "opt": "-A 100 --restart"
    },
    {
        "id": "hc",
        "opt": "-A 150 --restart"
    },
    {
        "id": "sa",
        "opt": "-A 200 --sa-beta-ratio 1.05 --sa-num-trials 10"
    },
    {
        "id": "ea-1p1",
        "opt": "-A 300"
    },
    {
        "id": "ea-1p10",
        "opt": "-A 310 --ea-mu 1 --ea-lambda 10"
    },
    {
        "id": "ea-10p1",
        "opt": "-A 310 --ea-mu 10 --ea-lambda 1"
    },
    {
        "id": "ea-1c10",
        "opt": "-A 320 --ea-mu 1 --ea-lambda 10 --allow-stay"
    },
    {
        "id": "ga",
        "opt": "-A 400 --ea-mu 100"
    },
    {
        "id": "pbil",
```

```
            "opt": "-A 500 -r 5e-3"
        },
        {
            "id": "umda",
            "opt": "-A 600 -x 100 -y 10"
        }
    ]
}
```

B Default parameters

```
# algorithm = 100
# bm_mc_reset_strategy = 1
# bm_num_gs_cycles = 1
# bm_num_gs_steps = 100
# bm_sampling = 1
# budget = 10000
# bv_size = 100
# description_path = description.txt
# ea_lambda = 100
# ea_mu = 10
# expression = x
# fn_name = noname
# fn_num_traps = 10
# fn_prefix_length = 2
# fn_threshold = 10
# function = 0
# ga_crossover_bias = 0.5
# ga_crossover_probability = 0.5
# ga_tournament_size = 10
# hea_bit_herding = 0
# hea_num_seq_updates = 100
# hea_reset_period = 0
# hea_sampling_method = 0
# hea_weight = 1
# learning_rate = 0.001
# map = 0
# map_input_size = 100
# map_path = map.txt
# map_ts_length = 10
# map_ts_sampling_mode = 0
# mutation_probability = 1
# neighborhood = 0
# neighborhood_iterator = 0
# noise_stddev = 1
# num_iterations = 0
# num_threads = 1
# path = function.txt
# pn_mutation_probability = 1
# pn_neighborhood = 0
# pn_radius = 2
# population_size = 10
# pv_log_num_components = 5
# radius = 2
# real_expression = (1-x)^2+100*(y-x^2)^2
# real_lower_bound = -2
# real_num_bits = 8
# real_upper_bound = 2
# results_path = results.json
# rls_patience = 50
# sa_beta_ratio = 1.2
# sa_initial_acceptance_probability = 0.6
```

```
# sa_num_transitions = 50
# sa_num_trials = 100
# seed = 0
# selection_size = 1
# solution_path = solution.txt
# target = 100
# print_defaults
# last_parameter
# exec_name = hnco
# version = 0.14
# Generated from hnco.json
```