HNCO
Comparison of various black box optimization algorithms

April 26, 2017

Contents

1 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
# ea_lambda = 100
# ea_mu = 10
# exhaustive_neighborhood = 0
# fun_num_traps = 10
# fun_threshold = 10
# function = 0
# ga_crossover_probability = 0.5
# ga_tournament_size = 10
# hea_binary_dynamics = 0
# hea_delay = 10000
# hea_num_par_updates = 1
# hea_num_seq_updates = 100
# hea_rate_strategy = 0
# hea_reset_period = 0
# hea_sampling_method = 0
# hea_time_constant = 1000
# hea_weight = 1
# learning_rate = 0.001
# map = 0
# map_input_size = 100
# map_path = nopath
# neighborhood = 0
# noise_stddev = 1
# num_iterations = 0
# path = nopath
# patience = 50
# plugin_function_name = nofunction
# population_size = 10
# radius = 2
# sa_initial_acceptance_probability = 0.6
# sa_num_transitions = 50
# sa_num_trials = 100
# sa_rate = 1.2
# scaled_mutation_probability = 1
# seed = 0
# selection_size = 1
# print_default_parameters
# last_parameter
# exec_name = hnco
# version = 1.13
# Generated from hnco.json
```

2 Plan

```
{
    "exec": "hnco",
    "opt": "--no-header --print-performance --map 1 --map-random -s 100 -i 0 -b 300000",
    "num_runs": 20,
    "results": "results",
    "graphics": "graphics",
    "report": "report",
    "functions": [
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            "id": "one-max",
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    "opt": "-F 0 --stop-on-maximum",
    "col": ">{{\\nprounddigits{0}}}N{3}{0}"
},
{
    "id": "lin",
    "opt": "-F 1 -p instances/lin.100",
    "col": ">{{\\nprounddigits{2}}}N{2}{2}"
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{
    "id": "leading-ones",
    "opt": "-F 10 --stop-on-maximum",
    "col": ">{{\\nprounddigits{0}}}N{3}{0}"
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{
    "id": "ridge",
    "opt": "-F 11 --stop-on-maximum",
    "col": ">{{\\nprounddigits{0}}}N{3}{0}"
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    "opt": "-F 30 --stop-on-maximum -t 5",
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    "opt": "-F 31 --stop-on-maximum -t 5",
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"algorithms": [
    {
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    {
        "id": "hc",
        "opt": "-A 150 --restart"
    },
    {
        "id": "sa",
        "opt": "-A 200 --sa-rate 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"
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    {
        "id": "ea-1c10",
        "opt": "-A 320 --ea-mu 1 --ea-lambda 10"
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```

```
        {
            "id": "ga",
            "opt": "-A 400 --ea-mu 100"
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        {
            "id": "pbil",
            "opt": "-A 500 -r 5e-3"
        },
        {
            "id": "umda",
            "opt": "-A 600 -x 100 -y 10"
        }
    ]
}
```

3 Rankings

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

4 Function one-max

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	100	100	100	100	100	1	0.006	0.002
`hc`	100	100	100	100	100	1	0.004	0.000
`sa`	100	100	100	100	100	1	0.007	0.001
`ea-1p1`	100	100	100	100	100	1	0.004	0.000
`ea-1p10`	100	100	100	100	100	1	0.005	0.001
`ea-10p1`	100	100	100	100	100	1	0.018	0.004
`ea-1c10`	100	100	100	100	100	1	0.006	0.001
`ga`	100	100	100	100	100	1	0.011	0.002
`pbil`	100	100	100	100	100	1	0.041	0.006
`umda`	100	100	100	100	100	1	0.006	0.002

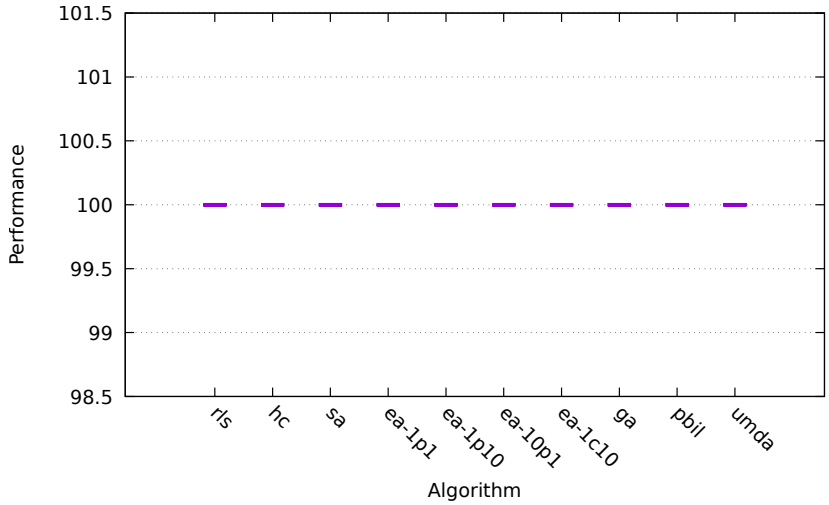

Figure 1: one-max

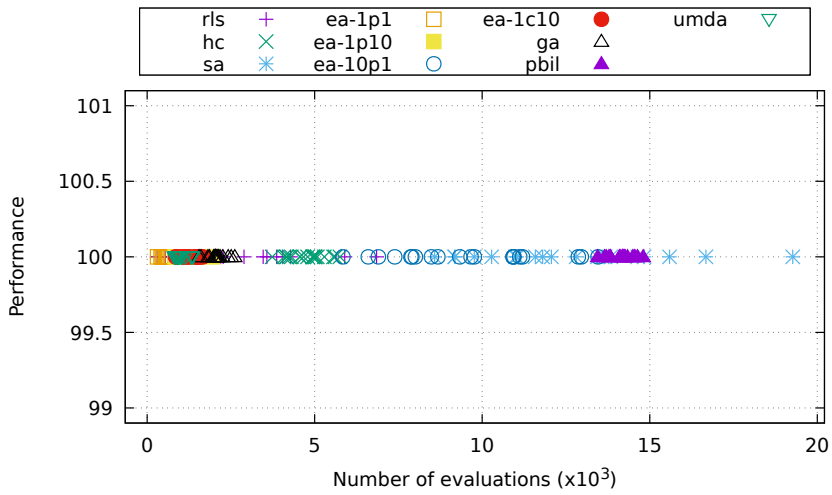

Figure 2: one-max

5 Function lin

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	50.65	50.65	50.65	50.65	50.65	1	0.117	0.019
`hc`	50.65	50.65	50.65	50.65	50.65	1	0.092	0.008
`sa`	50.65	50.65	50.65	50.65	50.65	1	0.158	0.040
`ea-1p1`	50.65	50.65	50.65	50.65	50.65	1	0.775	0.056
`ea-1p10`	50.65	50.65	50.65	50.65	50.65	1	0.534	0.059
`ea-10p1`	50.65	50.65	50.65	50.65	50.65	1	0.528	0.042
`ea-1c10`	50.65	50.65	50.65	50.65	50.65	1	0.545	0.046
`ga`	50.65	50.65	50.65	50.65	50.65	1	1.047	0.042
`pbil`	50.65	50.65	50.65	50.65	50.65	1	0.604	0.055
`umda`	50.65	50.65	50.65	50.65	50.65	1	0.578	0.043

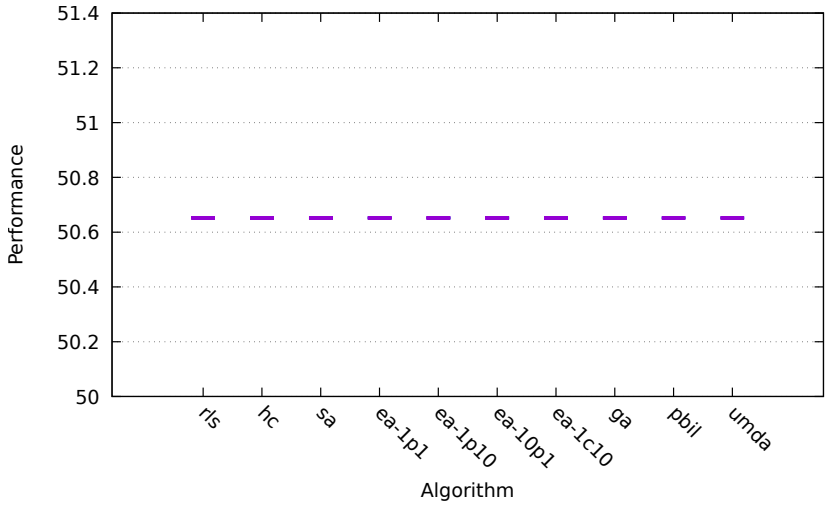

Figure 3: lin

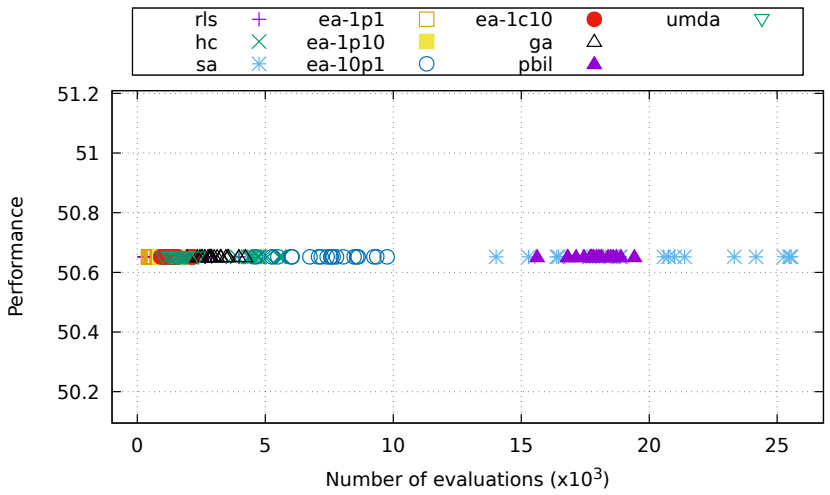

Figure 4: lin

6 Function leading-ones

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	100	100	100	100	100	1	0.014	0.008
hc	100	100	100	100	100	1	0.005	0.001
sa	3	100	100	100	100	10	0.027	0.040
ea-1p1	100	100	100	100	100	1	0.025	0.008
ea-1p10	100	100	100	100	100	1	0.019	0.004
ea-10p1	100	100	100	100	100	1	0.162	0.043
ea-1c10	100	100	100	100	100	1	0.022	0.005
ga	100	100	100	100	100	1	0.072	0.031
pbil	100	100	100	100	100	1	0.222	0.049
umda	100	100	100	100	100	1	0.027	0.007

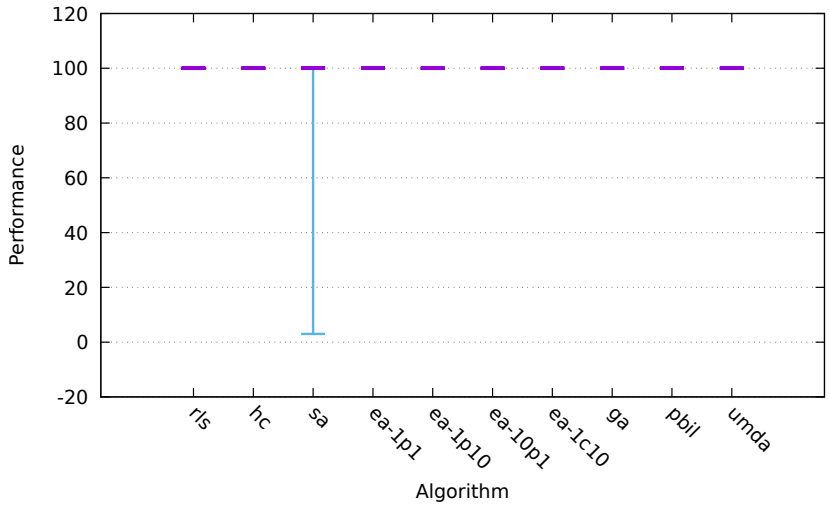

Figure 5: leading-ones

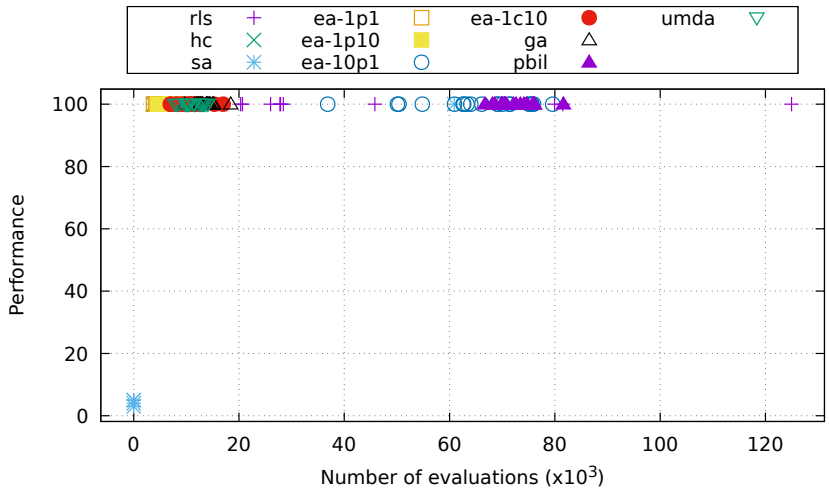

Figure 6: leading-ones

7 Function ridge

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	104	105	105	106	107	10	0.115	0.035
`hc`	200	200	200	200	200	1	0.008	0.001
`sa`	200	200	200	200	200	1	0.011	0.001
`ea-1p1`	200	200	200	200	200	1	0.065	0.027
`ea-1p10`	200	200	200	200	200	1	0.063	0.021
`ea-10p1`	187	200	200	200	200	7	0.514	0.065
`ea-1c10`	118	123	126	129	131	9	0.574	0.088
`ga`	200	200	200	200	200	1	0.195	0.029
`pbil`	153	154	155	156	157	8	0.588	0.054
`umda`	200	200	200	200	200	1	0.102	0.017

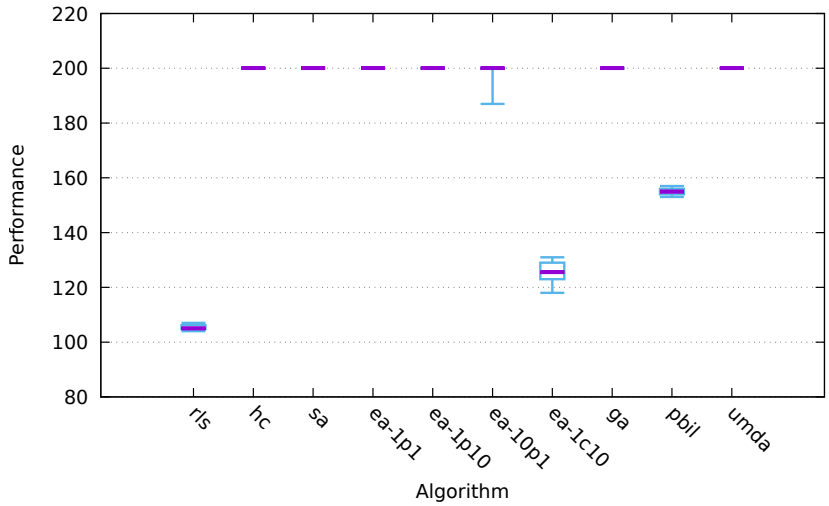

Figure 7: ridge

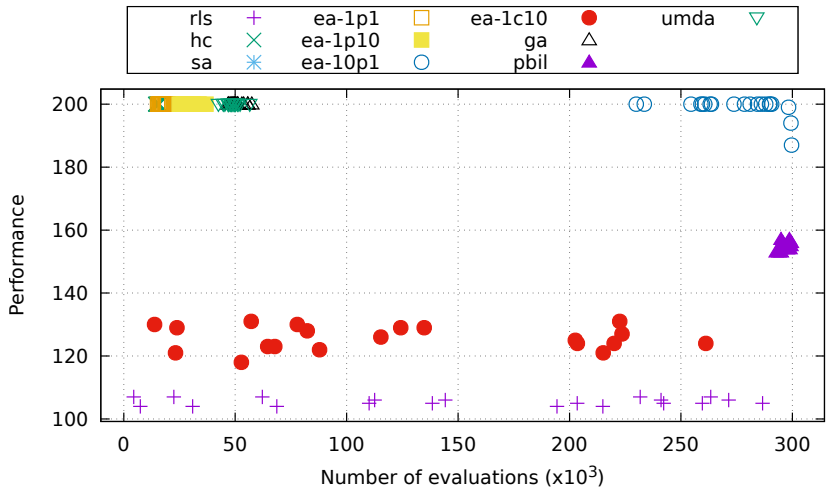

Figure 8: ridge

8 Function jmp-5

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	95	95	95	95	95	4	0.095	0.020
`hc`	95	95	95	95	95	4	0.076	0.019
`sa`	95	95	95	95	95	4	0.111	0.017
`ea-1p1`	95	95	95	95	95	4	0.736	0.035
`ea-1p10`	95	95	95	95	95	4	0.490	0.025
`ea-10p1`	95	95	95	95	95	4	0.503	0.024
`ea-1c10`	95	95	95	95	95	4	0.498	0.027
`ga`	100	100	100	100	100	1	0.273	0.203
`pbil`	100	100	100	100	100	1	0.043	0.008
`umda`	100	100	100	100	100	1	0.081	0.093

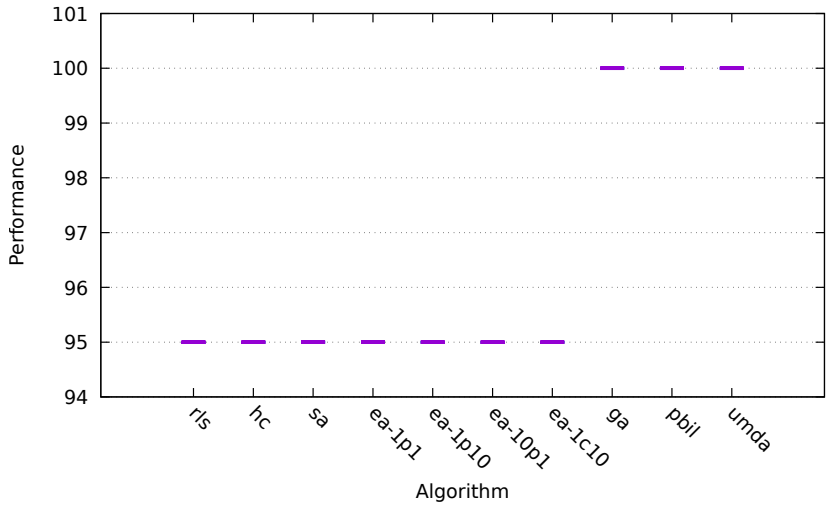

Figure 9: jmp-5

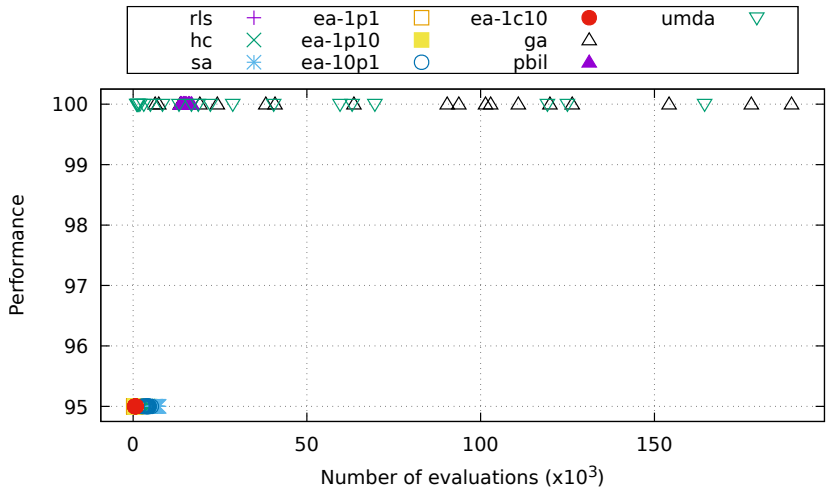

Figure 10: jmp-5

9 Function jmp-10

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	90	90	90	90	90	2	0.088	0.018
`hc`	90	90	90	90	90	2	0.068	0.014
`sa`	90	90	90	90	90	2	0.107	0.014
`ea-1p1`	90	90	90	90	90	2	0.743	0.023
`ea-1p10`	90	90	90	90	90	2	0.493	0.021
`ea-10p1`	90	90	90	90	90	2	0.539	0.044
`ea-1c10`	90	90	90	90	90	2	0.538	0.045
`ga`	90	90	90	90	90	2	1.043	0.041
`pbil`	90	90	100	100	100	1	0.310	0.260
`umda`	90	90	90	90	90	2	0.604	0.051

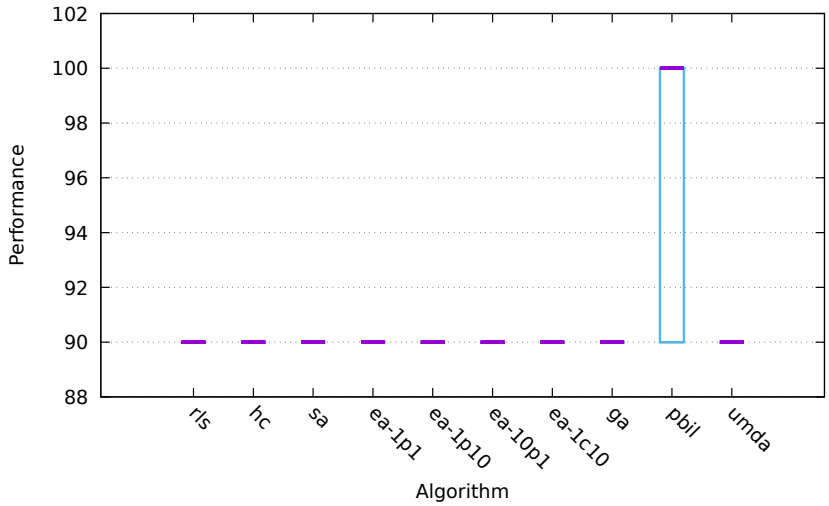

Figure 11: jmp-10

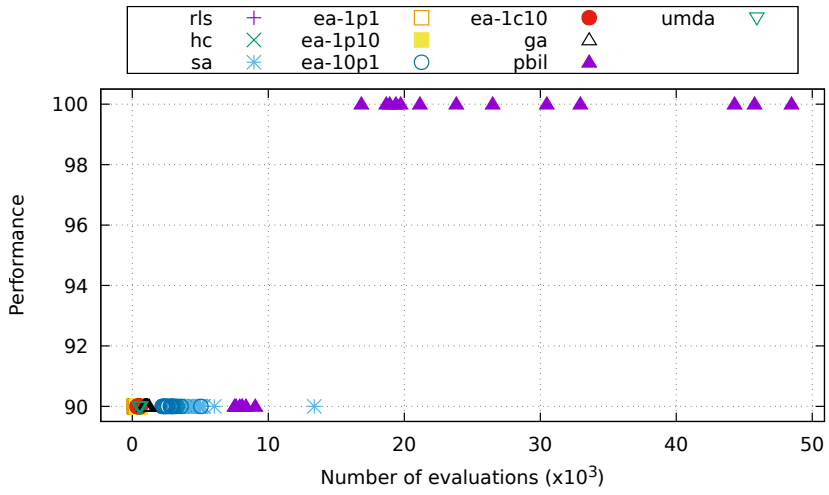

Figure 12: jmp-10

10 Function djmp-5

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	100	100	100	100	100	4	0.135	0.035
`hc`	100	100	100	100	100	4	0.103	0.031
`sa`	100	100	100	100	100	4	0.156	0.041
`ea-1p1`	100	100	100	100	100	4	0.745	0.052
`ea-1p10`	100	100	100	100	100	4	0.520	0.045
`ea-10p1`	100	100	100	100	100	4	0.526	0.047
`ea-1c10`	100	100	100	100	100	4	0.536	0.042
`ga`	105	105	105	105	105	1	0.203	0.131
`pbil`	105	105	105	105	105	1	0.060	0.025
`umda`	105	105	105	105	105	1	0.078	0.066

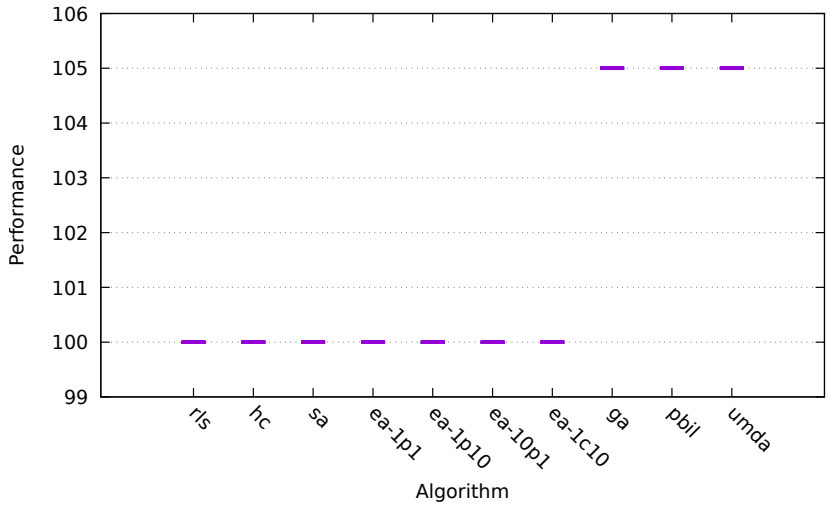

Figure 13: djmp-5

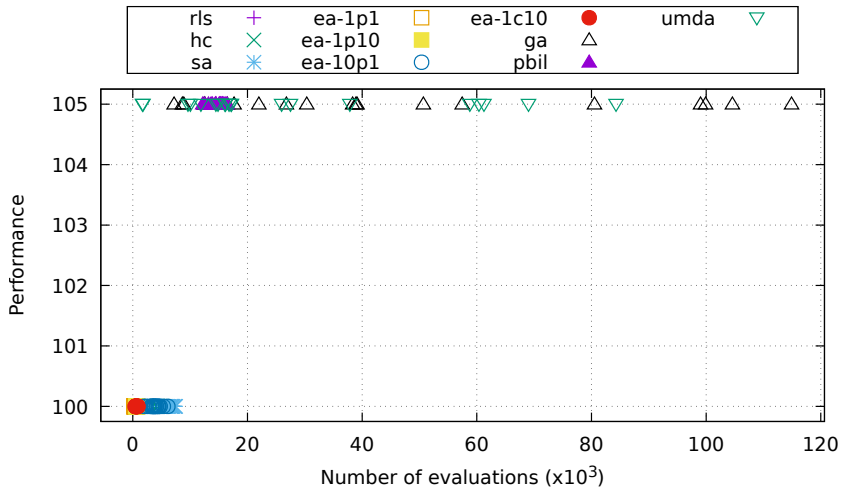

Figure 14: djmp-5

11 Function djmp-10

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	100	100	100	100	100	2	0.134	0.031
`hc`	100	100	100	100	100	2	0.124	0.023
`sa`	100	100	100	100	100	2	0.164	0.039
`ea-1p1`	100	100	100	100	100	2	0.784	0.050
`ea-1p10`	100	100	100	100	100	2	0.520	0.050
`ea-10p1`	100	100	100	100	100	2	0.522	0.055
`ea-1c10`	100	100	100	100	100	2	0.529	0.043
`ga`	100	100	100	100	100	2	1.056	0.035
`pbil`	100	100	105	110	110	1	0.407	0.260
`umda`	100	100	100	100	100	2	0.602	0.050

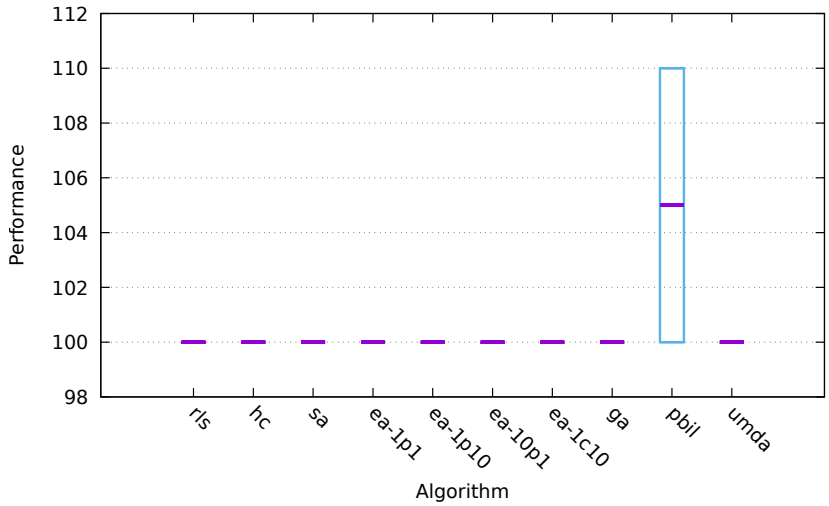

Figure 15: djmp-10

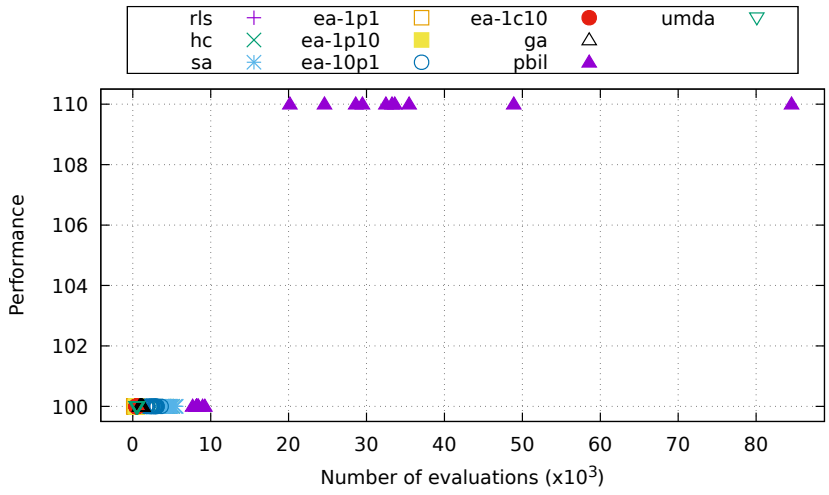

Figure 16: djmp-10

12 Function fp-5

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	194	194	194	194	194	1	0.018	0.015
`hc`	100	100	100	194	194	10	0.109	0.042
`sa`	3	194	194	194	194	9	0.027	0.047
`ea-1p1`	194	194	194	194	194	1	0.024	0.008
`ea-1p10`	100	194	194	194	194	7	0.080	0.145
`ea-10p1`	194	194	194	194	194	1	0.167	0.048
`ea-1c10`	194	194	194	194	194	1	0.032	0.018
`ga`	100	194	194	194	194	7	0.150	0.296
`pbil`	194	194	194	194	194	1	0.257	0.039
`umda`	194	194	194	194	194	1	0.047	0.016

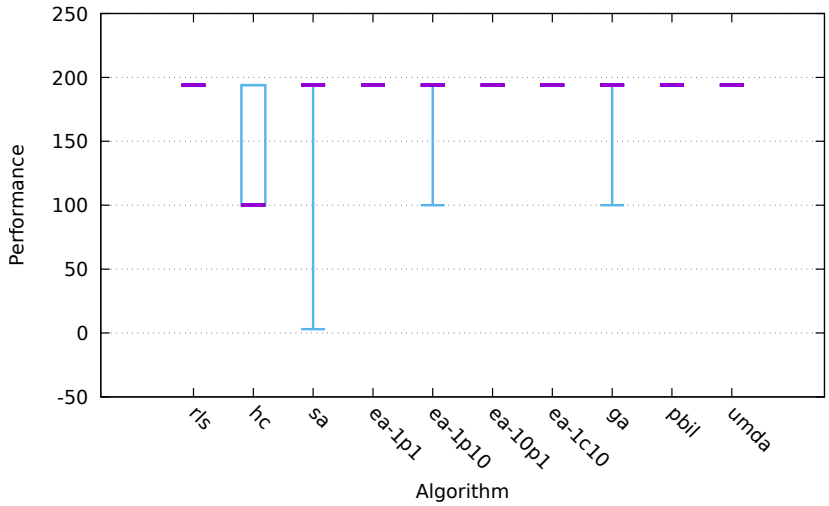

Figure 17: fp-5

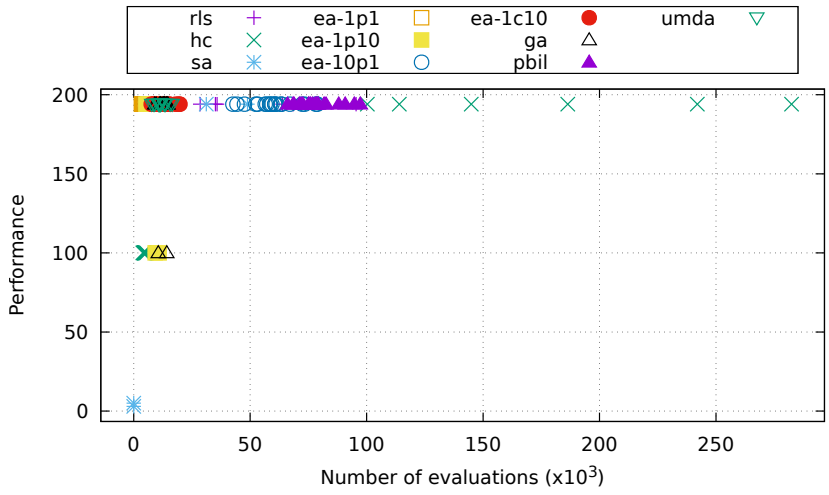

Figure 18: fp-5

13 Function fp-10

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	189	189	189	189	189	1	0.050	0.036
`hc`	100	100	100	100	189	7	0.119	0.030
`sa`	100	100	100	122	189	6	0.136	0.071
`ea-1p1`	100	100	100	100	189	7	0.669	0.271
`ea-1p10`	100	100	100	100	189	7	0.451	0.210
`ea-10p1`	100	189	189	189	189	3	0.217	0.138
`ea-1c10`	100	167	189	189	189	4	0.319	0.190
`ga`	100	100	100	100	100	10	1.051	0.042
`pbil`	189	189	189	189	189	1	0.215	0.048
`umda`	100	100	189	189	189	5	0.257	0.262

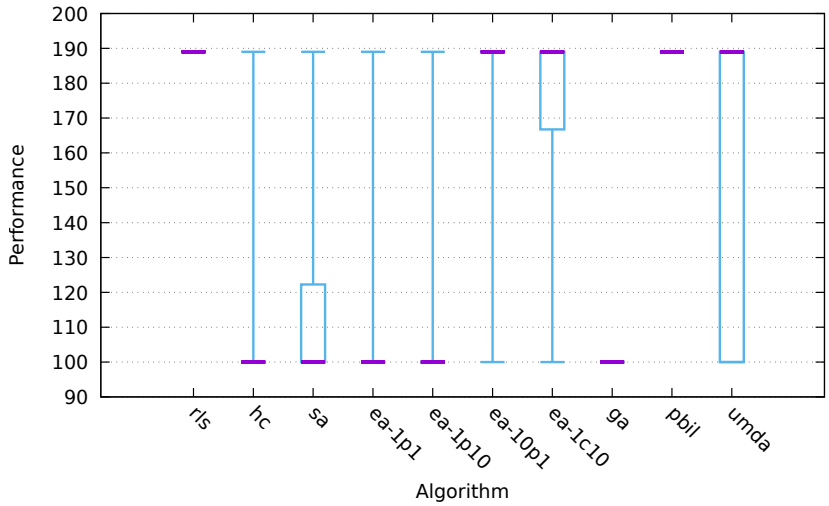

Figure 19: fp-10

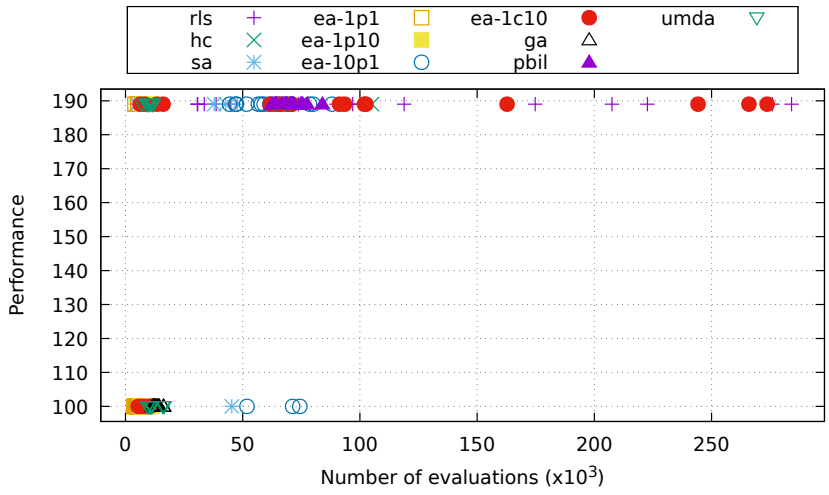

Figure 20: fp-10

14 Function quad

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	689.03	700.12	701.83	707.22	714.27	3	4.500	0.075
`hc`	700.61	704.75	708.35	711.19	716.37	2	4.802	0.074
`sa`	701.74	710.59	711.68	718.76	718.76	1	0.877	0.078
`ea-1p1`	555.68	644.59	661.79	687.15	709.29	8	1.643	0.082
`ea-1p10`	552.46	635.70	659.75	673.93	716.37	9	1.174	0.073
`ea-10p1`	615.44	667.24	677.92	693.79	703.39	6	1.763	0.067
`ea-1c10`	652.39	686.45	698.10	709.73	718.76	4	1.796	0.173
`ga`	583.84	629.32	662.47	677.36	709.29	7	1.733	0.066
`pbil`	639.43	666.70	694.94	701.78	716.37	5	1.943	0.088
`umda`	570.61	621.14	637.48	658.06	700.74	10	1.246	0.070

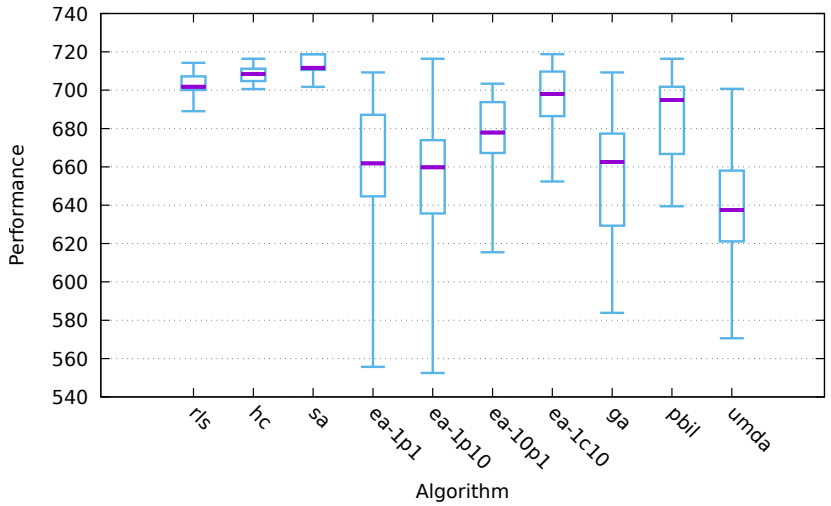

Figure 21: quad

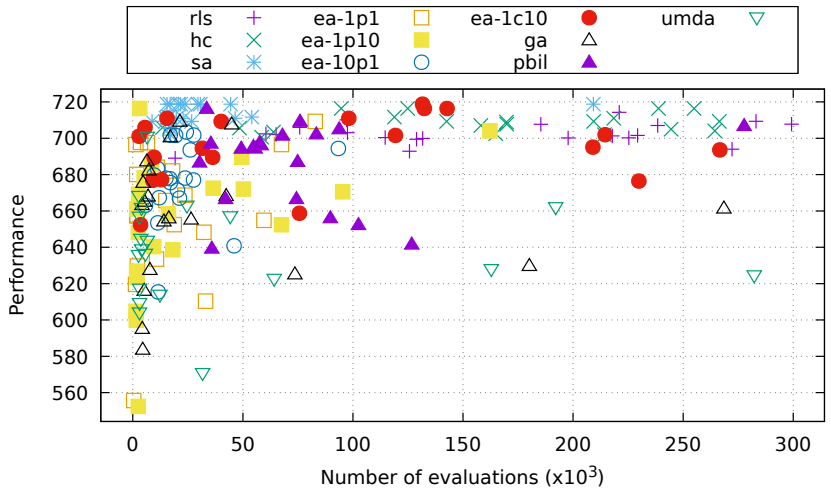

Figure 22: quad

15 Function nk

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	0.85	0.86	0.87	0.87	0.91	6	0.345	0.041
hc	0.85	0.88	0.89	0.90	0.95	5	0.318	0.048
sa	0.87	0.92	0.95	0.97	0.99	1	0.372	0.045
ea-1p1	0.72	0.77	0.82	0.87	0.91	10	0.936	0.051
ea-1p10	0.71	0.79	0.82	0.86	0.90	9	0.714	0.046
ea-10p1	0.78	0.85	0.89	0.93	0.97	3	0.711	0.049
ea-1c10	0.79	0.90	0.93	0.95	0.99	2	0.723	0.047
ga	0.74	0.78	0.84	0.87	0.90	7	1.256	0.046
pbil	0.86	0.88	0.89	0.91	0.96	4	0.789	0.051
umda	0.79	0.82	0.84	0.88	0.94	8	0.776	0.044

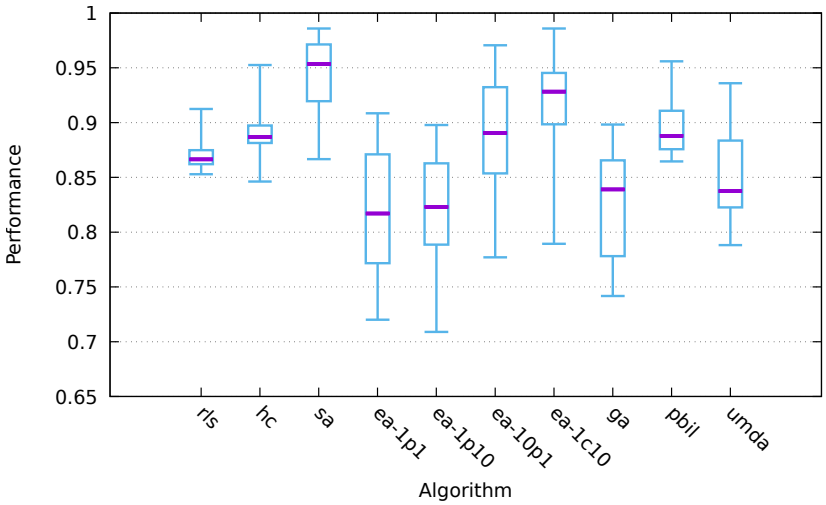

Figure 23: nk

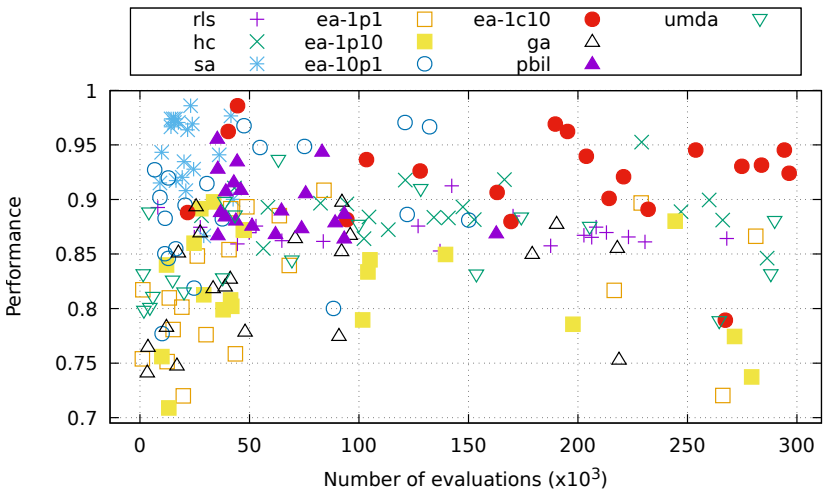

Figure 24: nk

16 Function max-sat

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	964	964	964	965	965	2	2.075	0.060
`hc`	951	957	961	962	964	8	0.319	0.045
`sa`	964	965	965	965	965	1	0.866	0.127
`ea-1p1`	955	961	962	963	965	5	1.398	0.144
`ea-1p10`	954	960	962	964	965	7	1.080	0.116
`ea-10p1`	957	961	962	964	965	4	2.021	0.088
`ea-1c10`	959	962	964	965	965	3	1.285	0.110
`ga`	955	960	962	963	965	6	1.678	0.126
`pbil`	957	959	959	960	962	10	1.522	0.081
`umda`	955	959	960	961	965	9	1.162	0.081

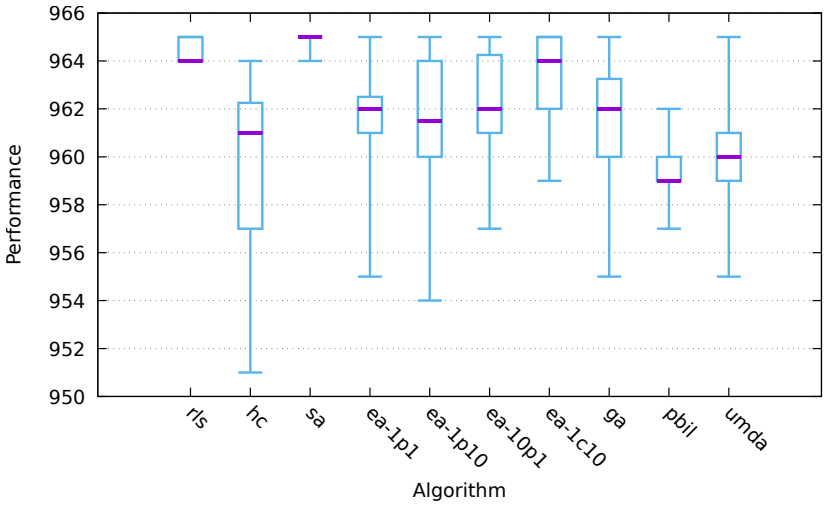

Figure 25: max-sat

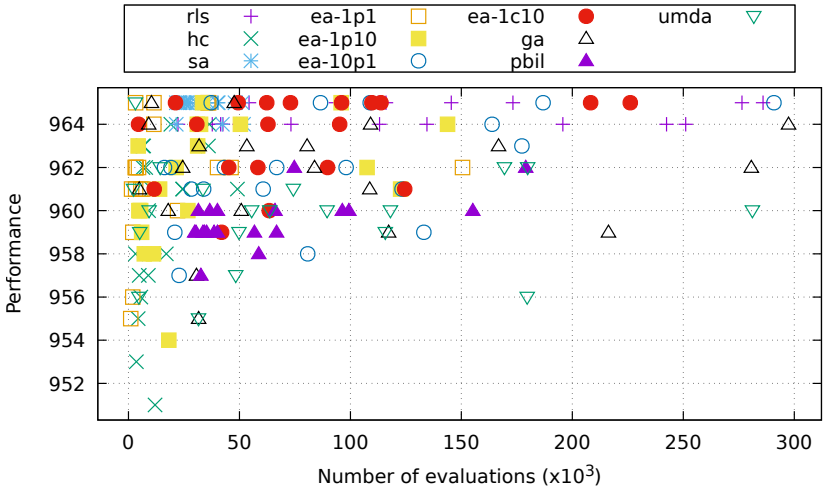

Figure 26: max-sat

17 Function labs

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	4.17	4.39	4.44	4.52	4.91	5	1.652	0.051
`hc`	4.46	4.59	4.81	4.88	5.31	2	1.662	0.052
`sa`	4.47	4.63	4.76	5.08	5.75	3	1.678	0.046
`ea-1p1`	3.54	3.81	4.03	4.28	4.87	8	2.270	0.064
`ea-1p10`	3.71	3.89	4.13	4.35	4.73	7	2.024	0.050
`ea-10p1`	4.16	4.49	4.60	4.69	4.80	4	2.041	0.050
`ea-1c10`	4.57	4.79	4.85	4.90	5.05	1	2.026	0.054
`ga`	3.64	4.05	4.33	4.48	5.11	6	2.554	0.044
`pbil`	3.50	3.68	3.89	4.07	4.60	10	2.157	0.040
`umda`	3.51	3.86	3.91	4.10	4.41	9	2.047	0.054

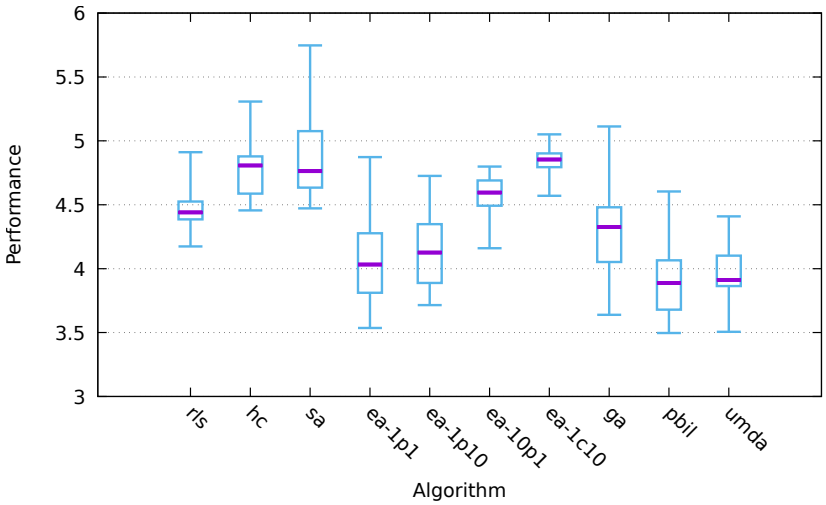

Figure 27: labs

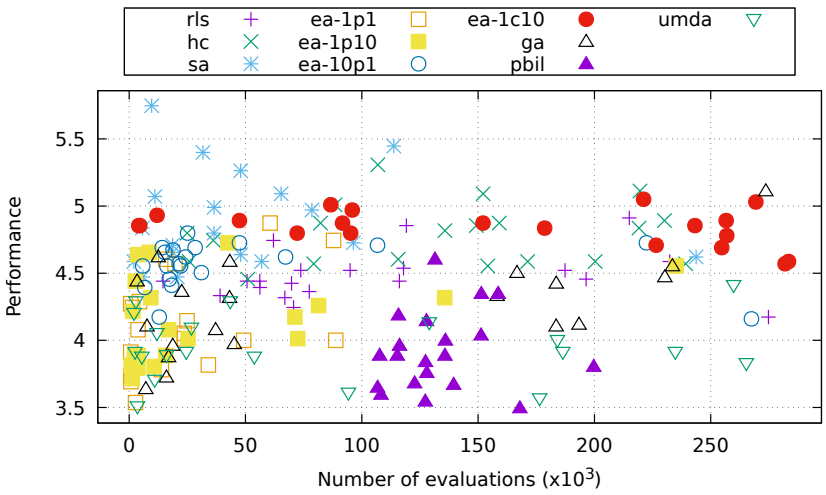

Figure 28: labs

18 Function ep

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	2.14×10^{-29}	8.84×10^{-29}	2.01×10^{-28}	4.54×10^{-28}	7.41×10^{-28}	1	0.166	0.043
`hc`	9.58×10^{-31}	2.22×10^{-28}	3.50×10^{-28}	7.36×10^{-28}	2.55×10^{-27}	2	0.156	0.036
`sa`	8.24×10^{-29}	3.30×10^{-28}	4.69×10^{-28}	1.94×10^{-27}	2.61×10^{-23}	3	0.190	0.045
`ea-1p1`	9.12×10^{-29}	1.24×10^{-27}	4.94×10^{-27}	8.94×10^{-27}	3.28×10^{-26}	8	0.780	0.051
`ea-1p10`	4.14×10^{-28}	3.56×10^{-27}	6.24×10^{-27}	1.21×10^{-26}	4.16×10^{-26}	10	0.546	0.051
`ea-10p1`	4.83×10^{-29}	8.57×10^{-28}	2.02×10^{-27}	6.48×10^{-27}	2.76×10^{-26}	6	0.552	0.049
`ea-1c10`	3.16×10^{-29}	3.36×10^{-28}	7.99×10^{-28}	1.55×10^{-27}	2.88×10^{-27}	4	0.565	0.042
`ga`	1.82×10^{-28}	1.68×10^{-27}	3.88×10^{-27}	1.78×10^{-26}	5.06×10^{-26}	7	1.051	0.047
`pbil`	3.24×10^{-29}	3.65×10^{-28}	8.47×10^{-28}	1.39×10^{-27}	3.48×10^{-27}	5	0.779	0.048
`umda`	7.56×10^{-29}	2.68×10^{-27}	4.96×10^{-27}	1.07×10^{-26}	3.72×10^{-26}	9	0.582	0.051

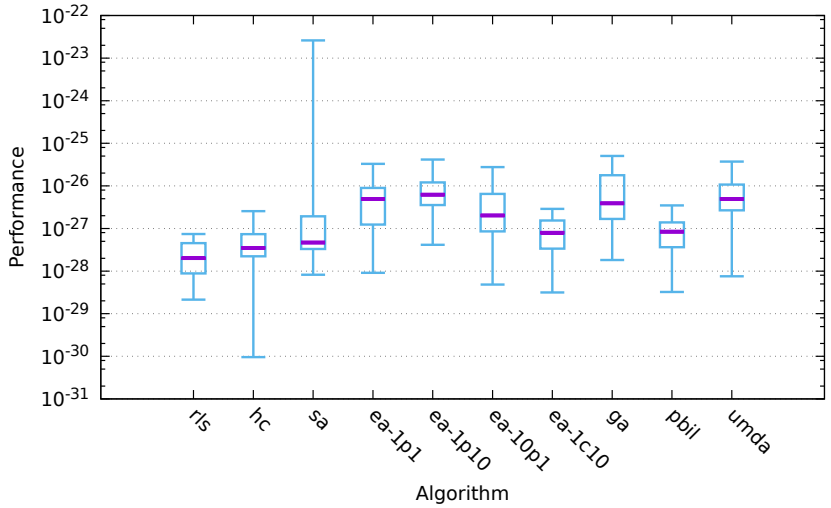

Figure 29: ep

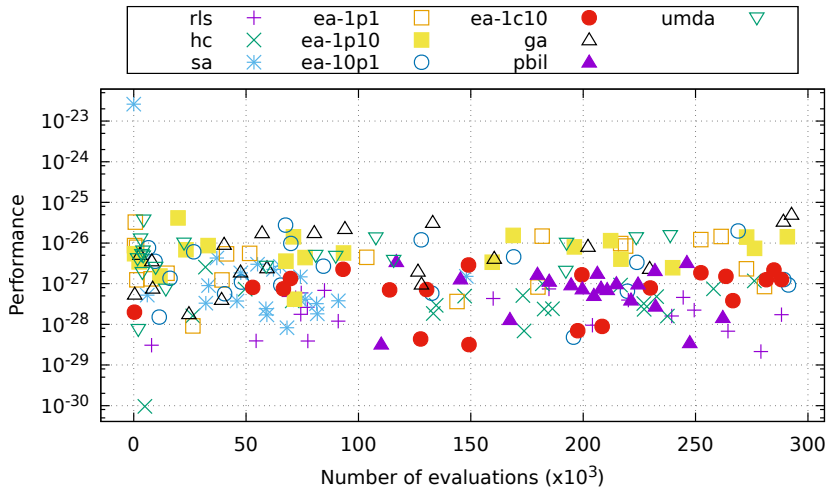

Figure 30: ep

19 Function cancel

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	1.05	1.27	1.65	1.95	2.40	8	0.153	0.041
`hc`	2.49	3.43	3.94	4.87	8.05	10	0.150	0.035
`sa`	0.20	1.42	2.08	3.09	16.65	9	0.211	0.033
`ea-1p1`	0.06	0.25	0.50	1.32	1.48	3	0.787	0.042
`ea-1p10`	0.11	0.21	0.94	1.33	2.08	6	0.538	0.052
`ea-10p1`	0.05	0.12	0.66	1.40	2.75	4	0.584	0.028
`ea-1c10`	0.06	0.09	0.23	0.70	1.46	2	0.546	0.051
`ga`	0.05	0.19	0.87	1.45	2.60	5	1.071	0.050
`pbil`	0.05	0.06	0.08	0.12	0.70	1	0.614	0.045
`umda`	0.20	0.63	1.26	1.51	1.96	7	0.593	0.042

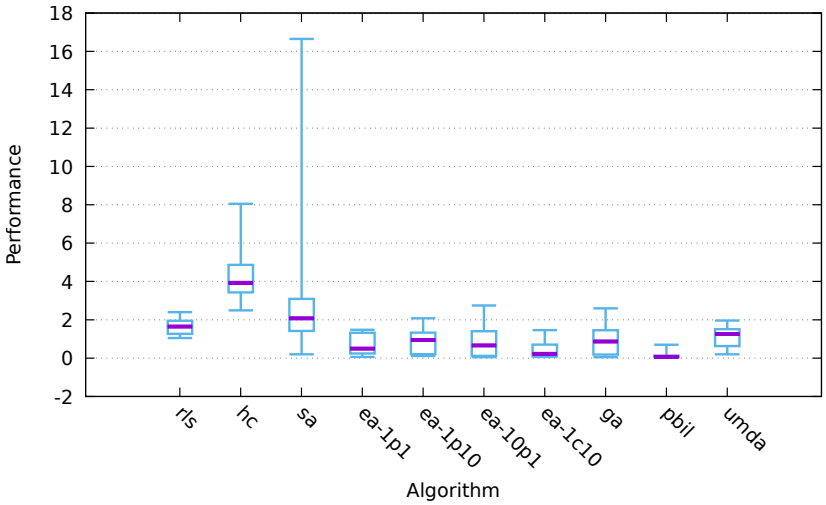

Figure 31: cancel

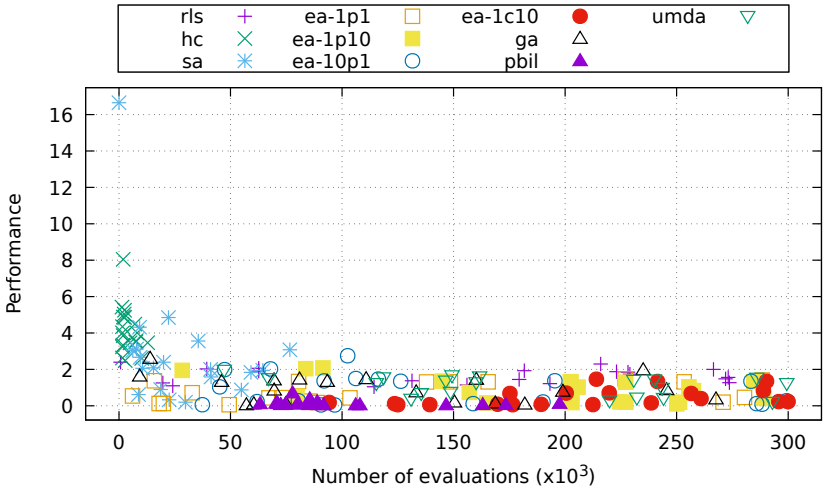

Figure 32: cancel

20 Function trap

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	91	91	91	91	91	2	0.171	0.041
`hc`	91	91	91	92	92	1	0.168	0.032
`sa`	90	90	90	90	91	3	0.224	0.024
`ea-1p1`	90	90	90	90	90	7	0.817	0.041
`ea-1p10`	90	90	90	90	91	3	0.571	0.042
`ea-10p1`	90	90	90	90	91	3	0.557	0.057
`ea-1c10`	90	90	90	90	91	3	0.531	0.054
`ga`	90	90	90	90	90	7	1.088	0.030
`pbil`	90	90	90	90	90	7	0.607	0.046
`umda`	90	90	90	90	90	7	0.576	0.046

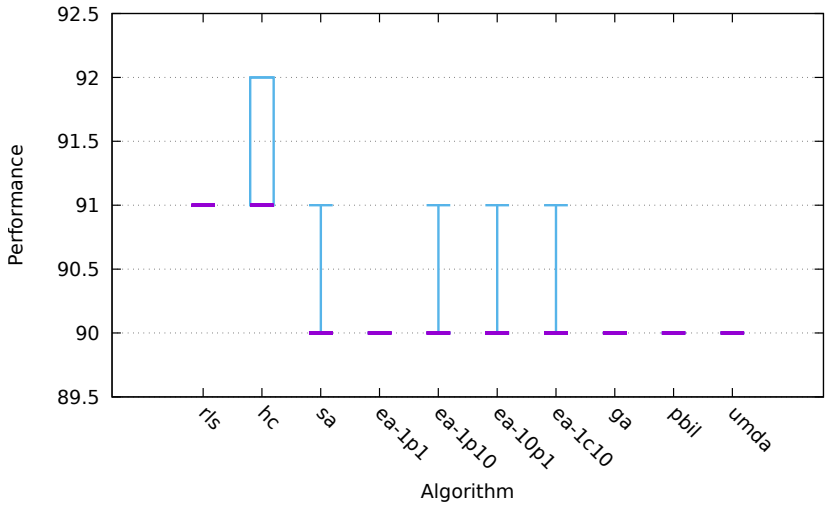

Figure 33: trap

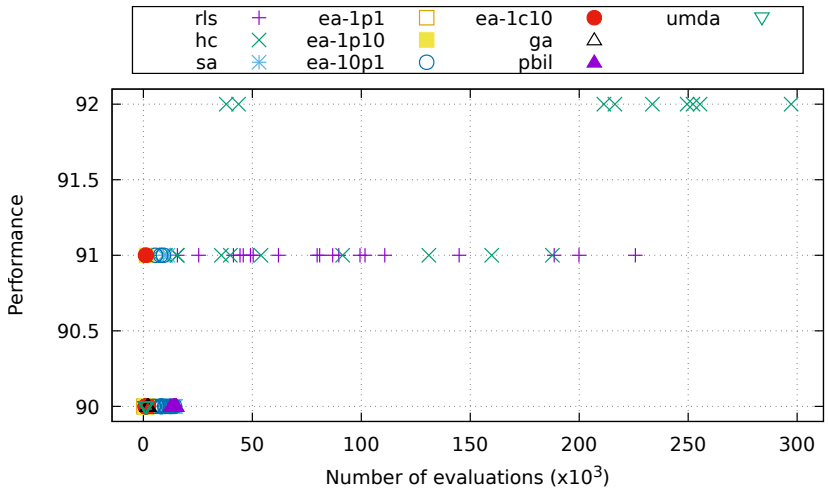

Figure 34: trap

21 Function hiff

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	404	411	416	424	442	10	0.356	0.052
hc	472	487	494	508	552	8	0.340	0.050
sa	672	696	736	800	1,024	1	0.411	0.087
ea-1p1	448	470	496	522	544	7	1.148	0.054
ea-1p10	448	470	492	512	576	9	0.876	0.053
ea-10p1	560	644	672	704	800	3	0.911	0.055
ea-1c10	600	672	696	741	784	2	0.877	0.045
ga	448	480	500	520	552	6	1.464	0.065
pbil	464	507	533	576	592	4	0.958	0.063
umda	444	495	512	536	576	5	0.925	0.040

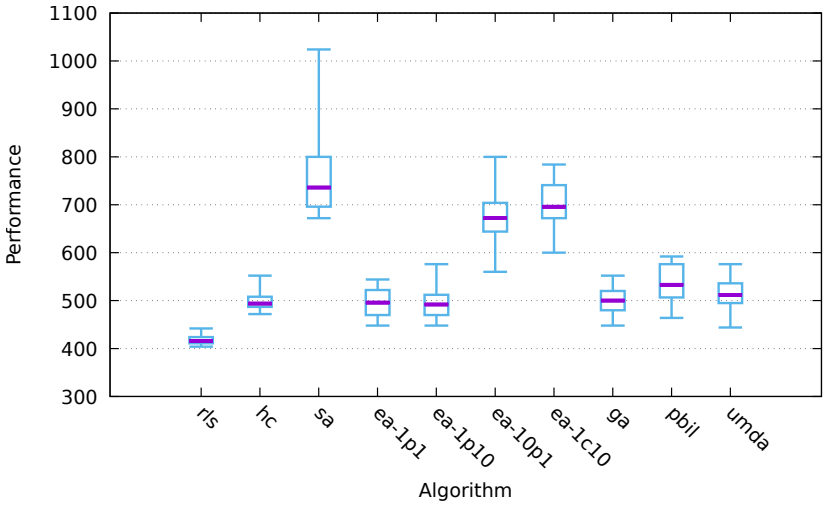

Figure 35: hiff

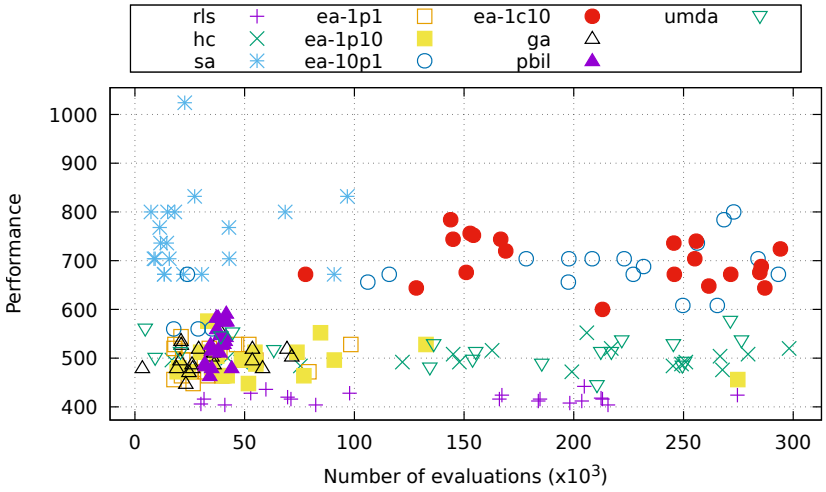

Figure 36: hiff

22 Function plateau

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
`rls`	101	101	101	101	101	3	0.149	0.025
`hc`	101	101	101	101	101	3	0.117	0.033
`sa`	101	101	101	102	102	1	0.161	0.047
`ea-1p1`	101	101	101	101	102	2	0.716	0.169
`ea-1p10`	101	101	101	101	101	3	0.554	0.044
`ea-10p1`	101	101	101	101	101	3	0.521	0.061
`ea-1c10`	101	101	101	101	101	3	0.514	0.055
`ga`	101	101	101	101	101	3	1.035	0.051
`pbil`	101	101	101	101	101	3	0.584	0.060
`umda`	101	101	101	101	101	3	0.579	0.047

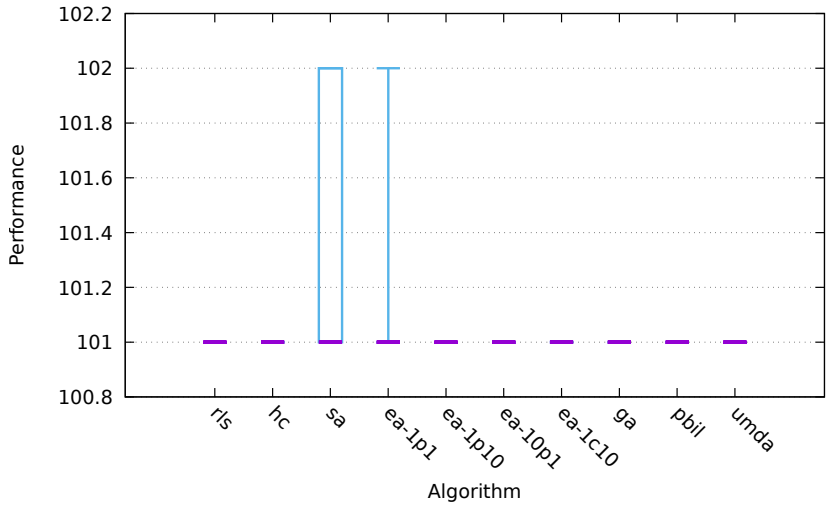

Figure 37: plateau

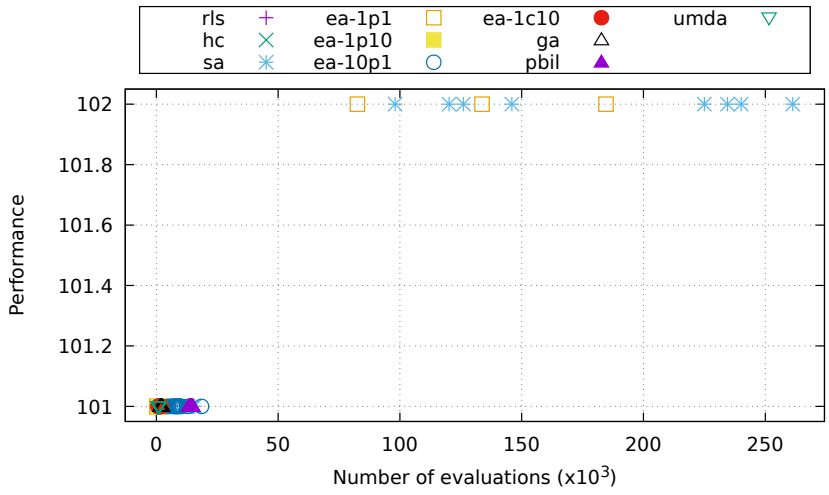

Figure 38: plateau