

HNCO

Comparison of various black box optimization algorithms

August 21, 2017

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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
# fun_num_traps = 10
# fun_prefix_length = 2
# 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
# neighborhood_iterator = 0
# noise_stddev = 1
# num_iterations = 0
# num_threads = 1
# path = nopath
# plugin_function_name = nofunction
# population_size = 10
# pv_log_num_components = 5
# radius = 2
# rls_patience = 50
# 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
# target = 100
# print_default_parameters
# last_parameter
# exec_name = hnco
# version = 0.6
# Generated from hnco.json
```

2 Plan

```
{
  "exec": "hnco",
  "opt": "--print-performance --map 1 --map-random -s 100 -i 0 -b 300000",
  "num_runs": 20,
  "results": "results",
  "graphics": "graphics",
```

```

"report": "report",
"functions": [
  {
    "id": "one-max",
    "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}"
  },
  {
    "id": "leading-ones",
    "opt": "-F 10 --stop-on-maximum",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "ridge",
    "opt": "-F 11 --stop-on-maximum",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "jump-5",
    "opt": "-F 30 --stop-on-maximum -t 5",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "jump-10",
    "opt": "-F 30 --stop-on-maximum -t 10",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "djump-5",
    "opt": "-F 31 --stop-on-maximum -t 5",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "djump-10",
    "opt": "-F 31 --stop-on-maximum -t 10",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "fp-5",
    "opt": "-F 40 --stop-on-maximum -t 5",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "fp-10",
    "opt": "-F 40 --stop-on-maximum -t 10",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {
    "id": "nk",
    "opt": "-F 60 -p instances/nk.100.4",
    "col": ">{\{\nprounddigits{2}\}\}N{1}{2}"
  },
  {
    "id": "max-sat",
    "opt": "-F 70 -p instances/ms.100.3.1000 --cache",
    "col": ">{\{\nprounddigits{0}\}\}N{3}{0}"
  },
  {

```

```

    "id": "labs",
    "opt": "-F 80",
    "col": ">{{\\nprouddigits{2}}}N{1}{2}"
  },
  {
    "id": "ep",
    "opt": "-F 90 -p instances/ep.100",
    "reverse": true,
    "logscale": true,
    "col": ">{{\\nprouddigits{2}}}N{1}{2}"
  },
  {
    "id": "cancel",
    "opt": "-F 100 -s 99",
    "reverse": true,
    "col": ">{{\\nprouddigits{2}}}N{1}{2}"
  },
  {
    "id": "trap",
    "opt": "-F 110 --stop-on-maximum --fun-num-traps 10",
    "col": ">{{\\nprouddigits{0}}}N{3}{0}"
  },
  {
    "id": "hiff",
    "opt": "-F 120 --stop-on-maximum -s 128",
    "col": ">{{\\nprouddigits{0}}}N{3}{0}"
  },
  {
    "id": "plateau",
    "opt": "-F 130 --stop-on-maximum",
    "col": ">{{\\nprouddigits{0}}}N{3}{0}"
  },
  {
    "id": "walsh2",
    "opt": "-F 162 -p instances/walsh2.100 --cache",
    "col": ">{{\\nprouddigits{2}}}N{3}{2}"
  }
],
"algorithms": [
  {
    "id": "rls",
    "opt": "-A 100 --restart"
  },
  {
    "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"
  }
],

```

```

{
  "id": "ea-1c10",
  "opt": "-A 320 --ea-mu 1 --ea-lambda 10"
},
{
  "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"
}
]
}

```

3 Rankings

algorithm	rank distribution									
	1	2	3	4	5	6	7	8	9	10
pbil	10	0	0	3	1	0	1	1	2	1
sa	7	3	3	2	0	1	0	0	2	1
umda	7	2	0	1	1	0	1	1	5	1
hc	6	5	1	2	1	1	0	0	0	3
ea-1p1	6	3	1	3	0	1	2	1	1	1
ga	6	2	1	1	0	2	4	2	0	1
rls	5	5	1	4	1	0	0	1	0	2
ea-1c10	5	2	5	5	1	0	0	0	1	0
ea-10p1	4	3	2	4	3	2	1	0	0	0
ea-1p10	4	2	2	3	0	1	2	4	0	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	0.001
hc	100	100	100	100	100	1	0.007	0.001
sa	100	100	100	100	100	1	0.011	0.002
ea-1p1	100	100	100	100	100	1	0.006	0.001
ea-1p10	100	100	100	100	100	1	0.008	0.002
ea-10p1	100	100	100	100	100	1	0.025	0.006
ea-1c10	100	100	100	100	100	1	0.008	0.002
ga	100	100	100	100	100	1	0.016	0.003
pbil	100	100	100	100	100	1	0.043	0.003
umda	100	100	100	100	100	1	0.010	0.002

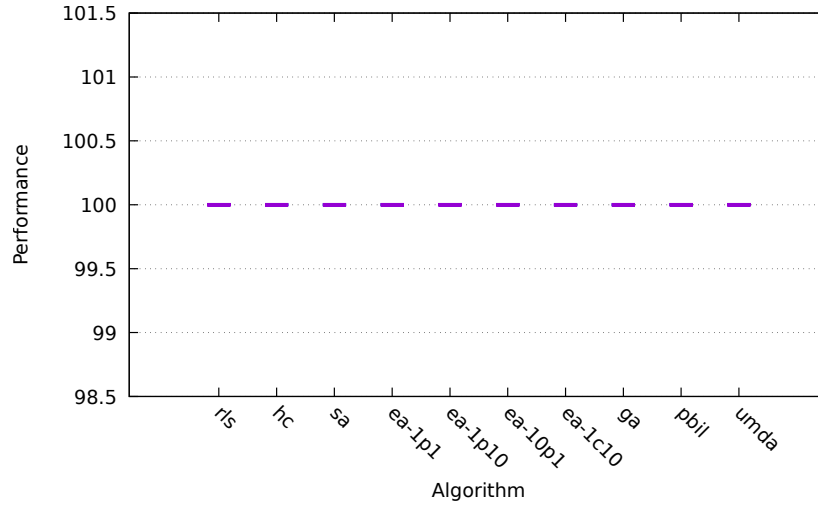


Figure 1: one-max

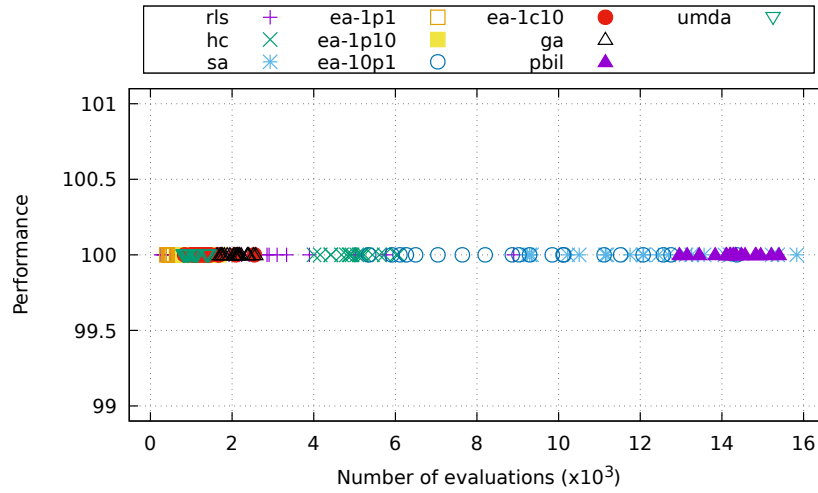


Figure 2: one-max

5 Function lin

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	45.03	45.03	45.03	45.03	45.03	1	0.113	0.004
hc	45.03	45.03	45.03	45.03	45.03	1	0.094	0.003
sa	45.03	45.03	45.03	45.03	45.03	1	0.105	0.003
ea-1p1	45.03	45.03	45.03	45.03	45.03	1	0.169	0.003
ea-1p10	45.03	45.03	45.03	45.03	45.03	1	0.520	0.003
ea-10p1	45.03	45.03	45.03	45.03	45.03	1	0.546	0.007
ea-1c10	45.03	45.03	45.03	45.03	45.03	1	0.523	0.003
ga	45.03	45.03	45.03	45.03	45.03	1	1.045	0.005
pbil	45.03	45.03	45.03	45.03	45.03	1	0.554	0.004
umda	45.03	45.03	45.03	45.03	45.03	1	0.536	0.006

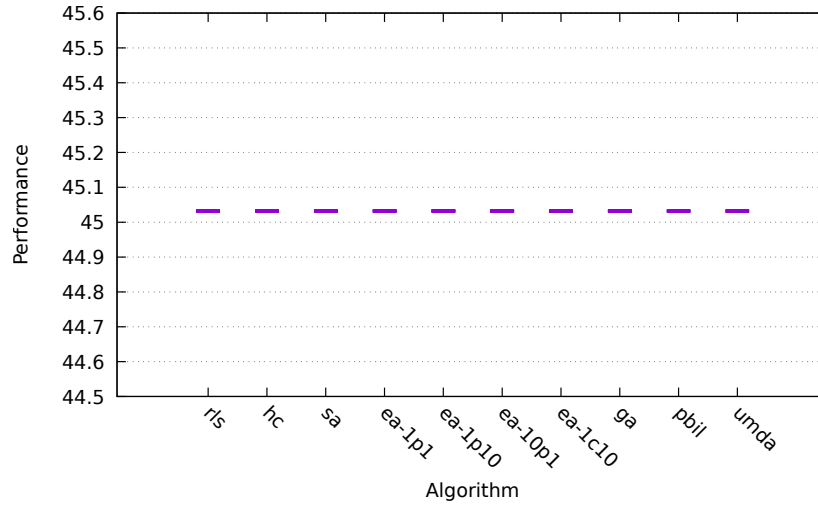


Figure 3: lin

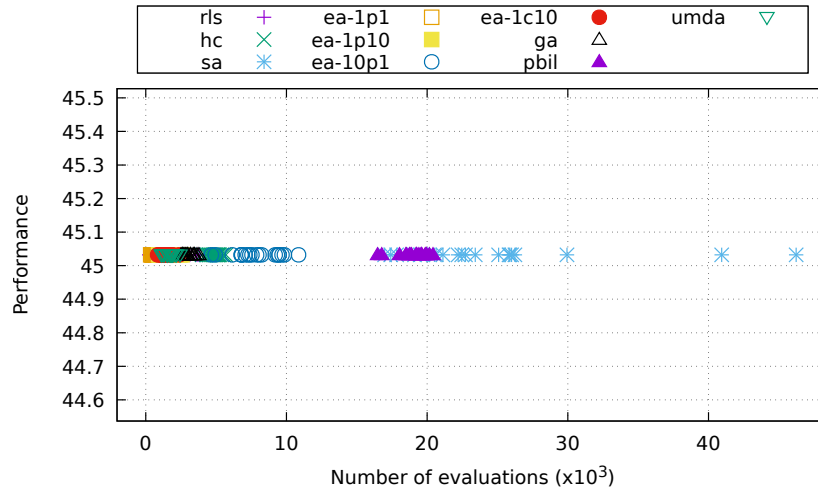


Figure 4: lin

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	0.012	0.006
hc	100	100	100	100	100	1	0.007	0.001
sa	2	100	100	100	100	10	0.020	0.021
ea-1p1	100	100	100	100	100	1	0.010	0.002
ea-1p10	100	100	100	100	100	1	0.022	0.003
ea-10p1	100	100	100	100	100	1	0.117	0.016
ea-1c10	100	100	100	100	100	1	0.026	0.007
ga	100	100	100	100	100	1	0.054	0.007
pbil	100	100	100	100	100	1	0.166	0.010
umda	100	100	100	100	100	1	0.032	0.004

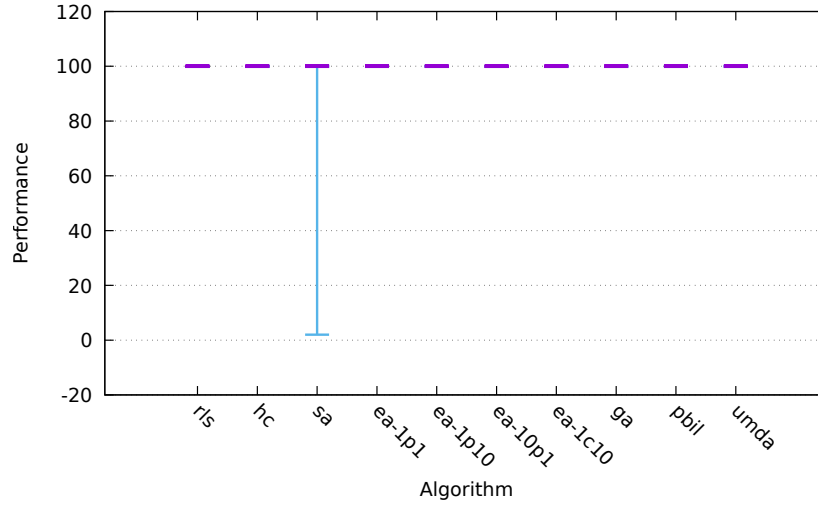


Figure 5: leading-ones

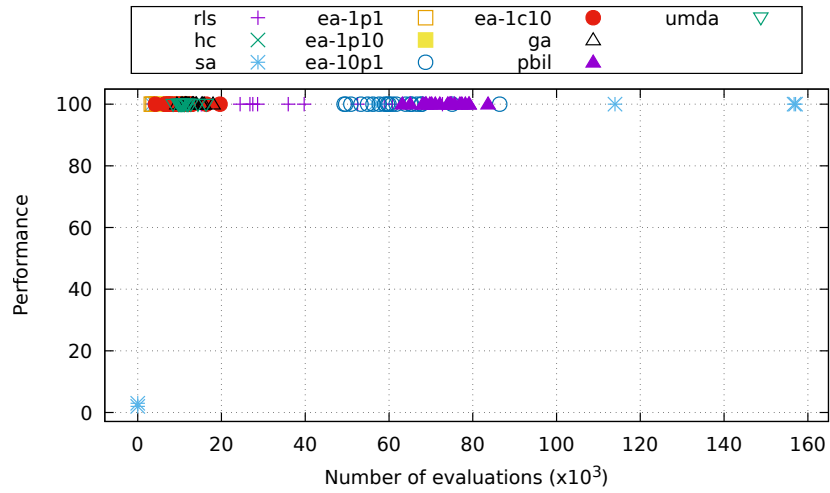


Figure 6: leading-ones

7 Function ridge

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	104	105	105	106	108	10	0.082	0.003
hc	200	200	200	200	200	1	0.011	0.002
sa	200	200	200	200	200	1	0.014	0.003
ea-1p1	200	200	200	200	200	1	0.018	0.004
ea-1p10	200	200	200	200	200	1	0.057	0.003
ea-10p1	190	200	200	200	200	7	0.491	0.038
ea-1c10	118	122	124	127	131	9	0.512	0.003
ga	200	200	200	200	200	1	0.186	0.014
pbil	153	154	155	156	158	8	0.540	0.005
umda	200	200	200	200	200	1	0.096	0.006

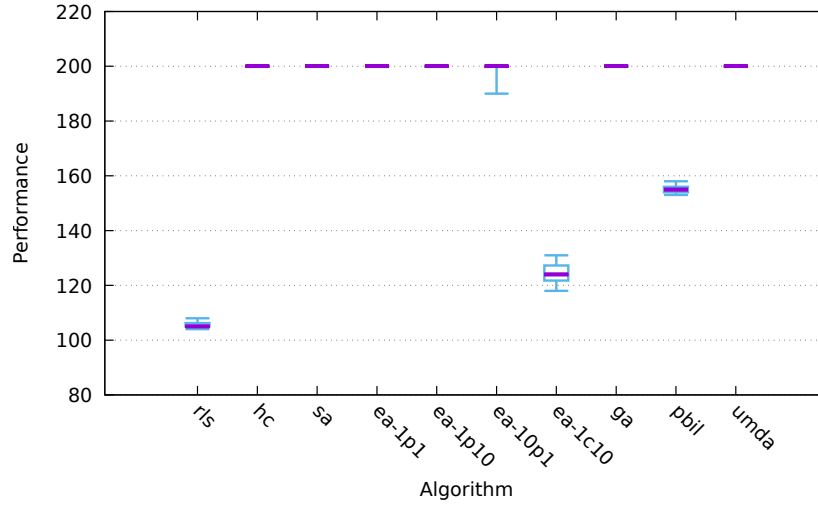


Figure 7: ridge

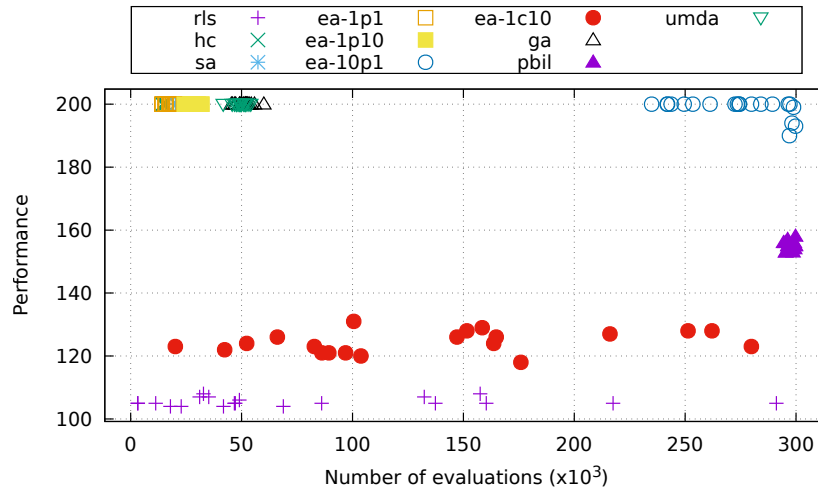


Figure 8: ridge

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	0.079	0.003
hc	95	95	95	95	95	4	0.066	0.001
sa	95	95	95	95	95	4	0.083	0.003
ea-1p1	95	95	95	95	95	4	0.150	0.004
ea-1p10	95	95	95	95	95	4	0.500	0.005
ea-10p1	95	95	95	95	95	4	0.524	0.006
ea-1c10	95	95	95	95	95	4	0.505	0.004
ga	100	100	100	100	100	1	0.151	0.138
pbil	100	100	100	100	100	1	0.046	0.003
umda	100	100	100	100	100	1	0.075	0.073

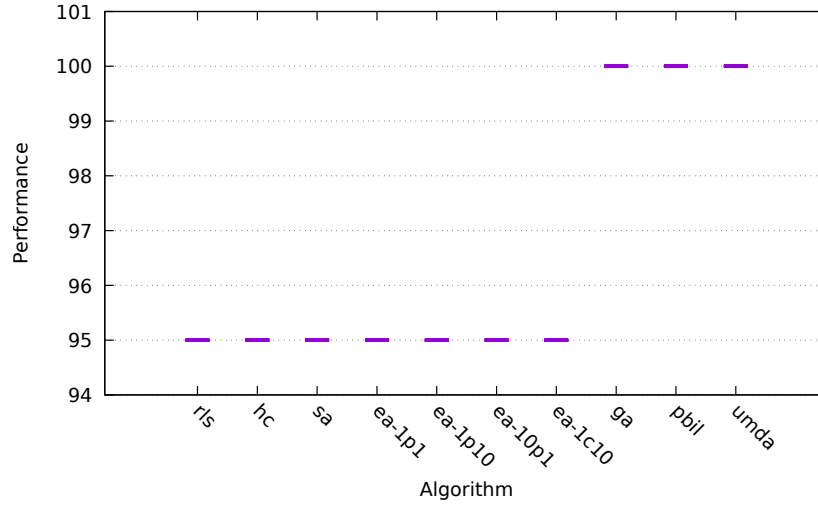


Figure 9: jmp-5

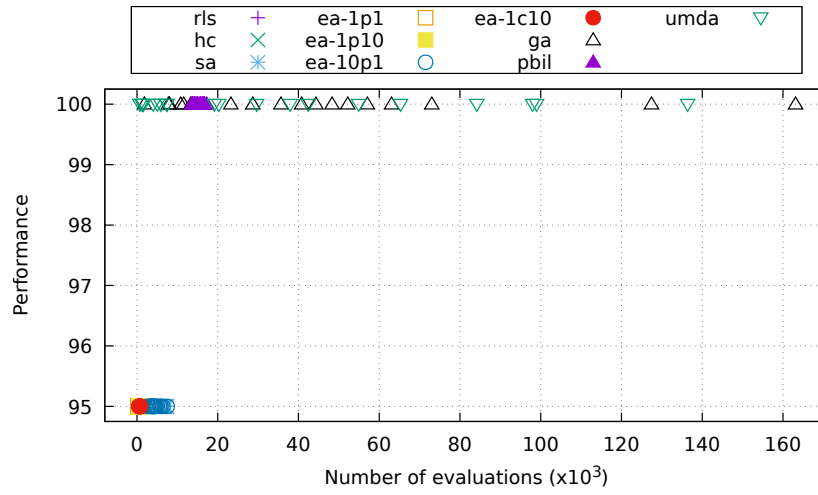


Figure 10: jmp-5

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	0.081	0.003
hc	90	90	90	90	90	2	0.066	0.002
sa	90	90	90	90	90	2	0.082	0.003
ea-1p1	90	90	90	90	90	2	0.150	0.003
ea-1p10	90	90	90	90	90	2	0.501	0.004
ea-10p1	90	90	90	90	90	2	0.524	0.004
ea-1c10	90	90	90	90	90	2	0.502	0.004
ga	90	90	90	90	90	2	1.018	0.005
pbil	90	90	95	100	100	1	0.345	0.255
umda	90	90	90	90	90	2	0.563	0.004

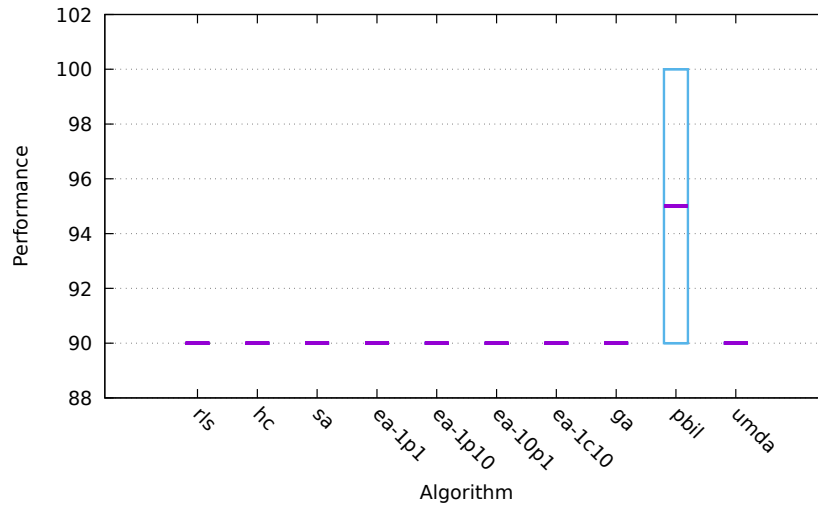


Figure 11: jmp-10

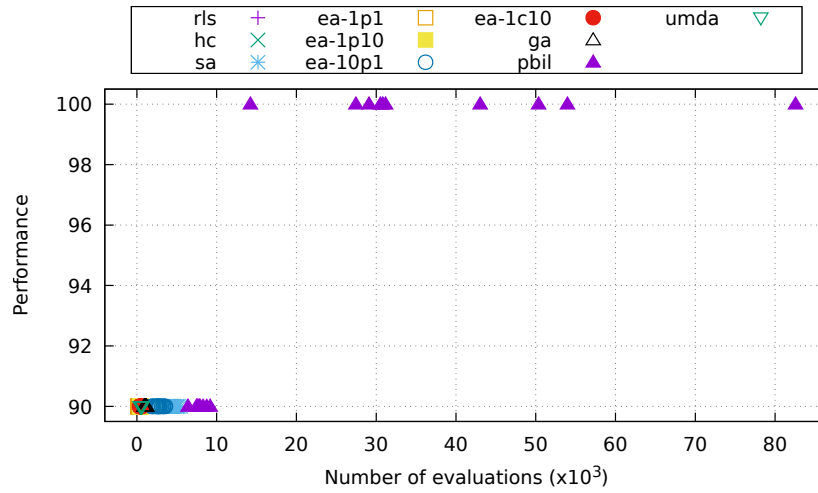


Figure 12: jmp-10

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	0.078	0.004
hc	100	100	100	100	100	4	0.066	0.002
sa	100	100	100	100	100	4	0.084	0.001
ea-1p1	100	100	100	100	100	4	0.150	0.003
ea-1p10	100	100	100	100	100	4	0.499	0.005
ea-10p1	100	100	100	100	100	4	0.526	0.005
ea-1c10	100	100	100	100	100	4	0.503	0.003
ga	105	105	105	105	105	1	0.173	0.121
pbil	105	105	105	105	105	1	0.045	0.004
umda	105	105	105	105	105	1	0.056	0.047

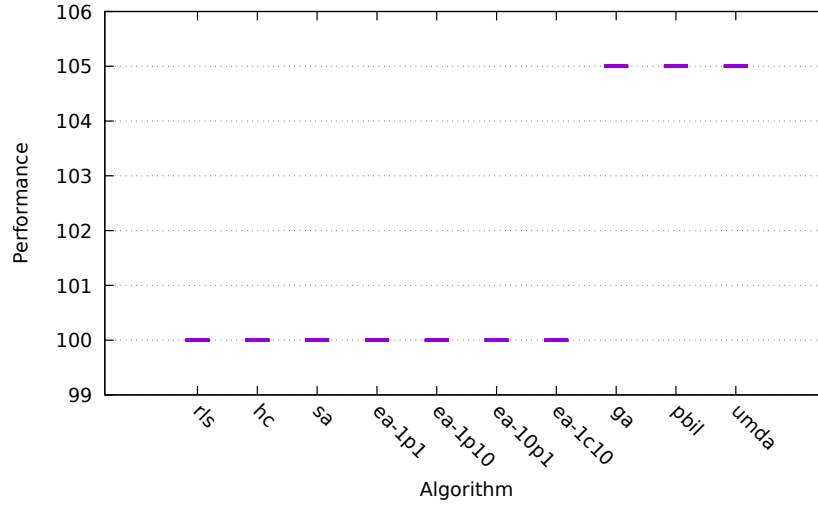


Figure 13: djmp-5

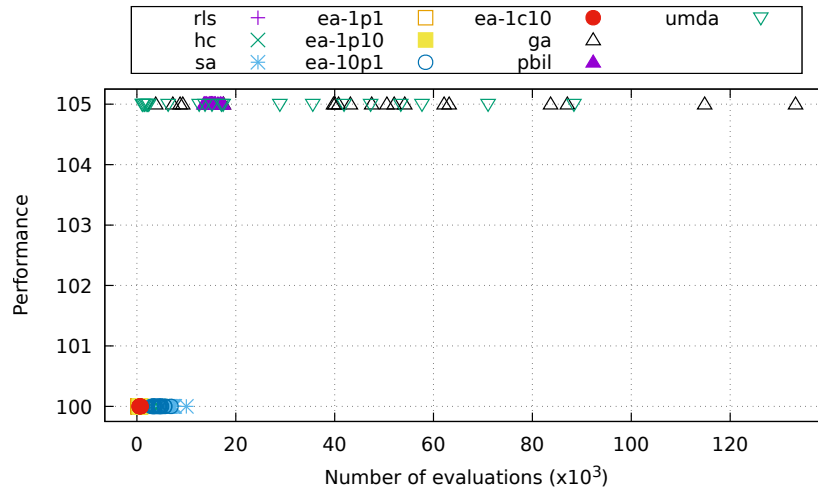


Figure 14: djmp-5

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	0.082	0.002
hc	100	100	100	100	100	2	0.065	0.003
sa	100	100	100	100	100	2	0.083	0.002
ea-1p1	100	100	100	100	100	2	0.152	0.004
ea-1p10	100	100	100	100	100	2	0.511	0.016
ea-10p1	100	100	100	100	100	2	0.523	0.006
ea-1c10	100	100	100	100	100	2	0.504	0.006
ga	100	100	100	100	100	2	1.017	0.011
pbil	100	100	100	110	110	1	0.367	0.262
umda	100	100	100	100	100	2	0.561	0.003

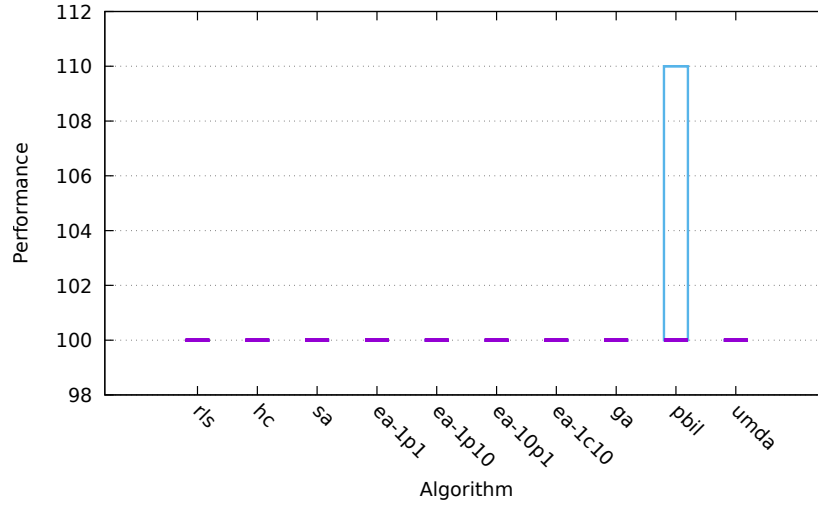


Figure 15: djmp-10

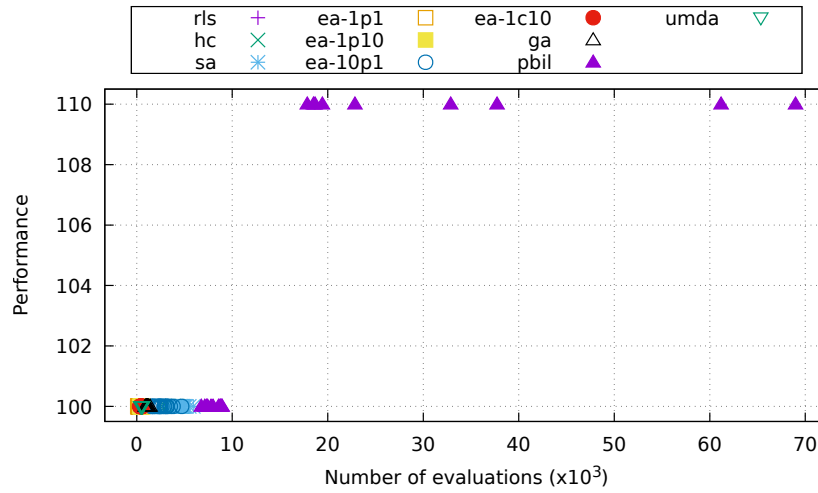


Figure 16: djmp-10

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	0.007
hc	100	100	194	194	194	10	0.050	0.025
sa	6	194	194	194	194	9	0.019	0.024
ea-1p1	194	194	194	194	194	1	0.009	0.002
ea-1p10	100	194	194	194	194	7	0.122	0.201
ea-10p1	194	194	194	194	194	1	0.122	0.016
ea-1c10	194	194	194	194	194	1	0.029	0.008
ga	100	194	194	194	194	7	0.202	0.361
pbil	194	194	194	194	194	1	0.188	0.016
umda	194	194	194	194	194	1	0.031	0.005

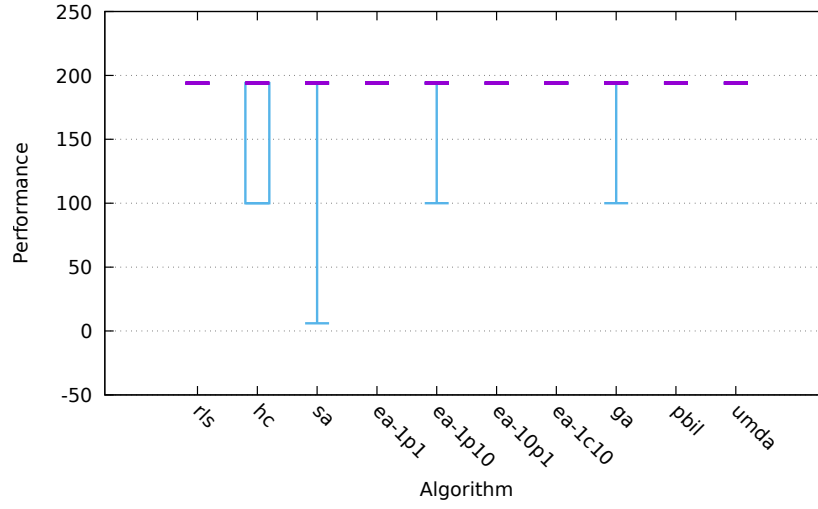


Figure 17: fp-5

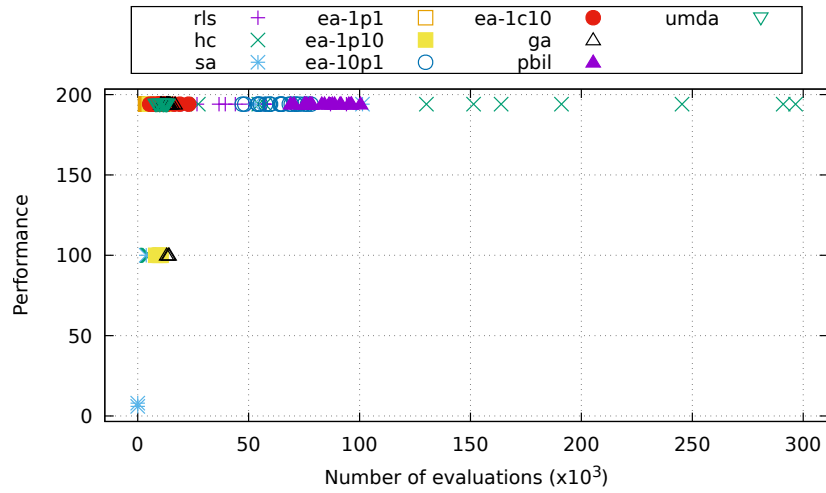


Figure 18: fp-5

13 Function fp-10

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	188	189	189	189	189	2	0.032	0.018
hc	100	100	100	100	100	10	0.070	0.004
sa	5	100	100	189	189	6	0.061	0.036
ea-1p1	100	100	100	122	189	7	0.122	0.066
ea-1p10	100	100	100	100	189	8	0.464	0.153
ea-10p1	100	189	189	189	189	3	0.163	0.130
ea-1c10	100	189	189	189	189	3	0.178	0.167
ga	100	100	100	100	189	8	0.887	0.361
pbil	189	189	189	189	189	1	0.167	0.013
umda	100	100	117	189	189	5	0.305	0.253

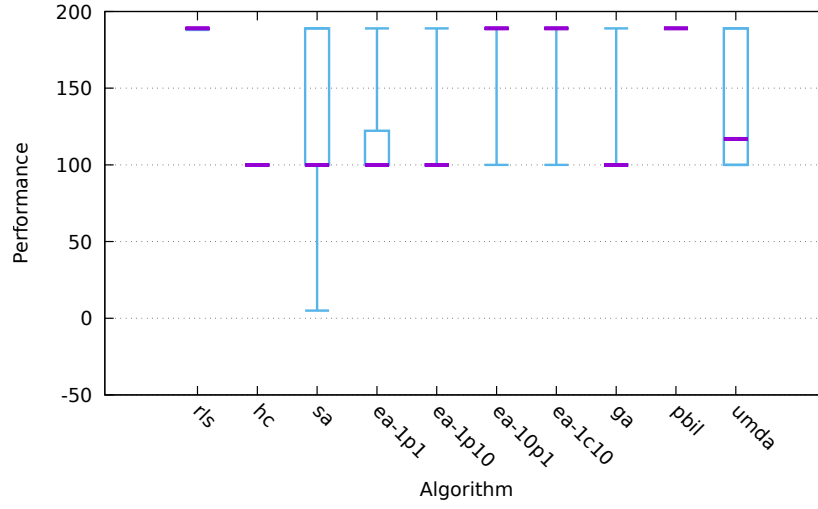


Figure 19: fp-10

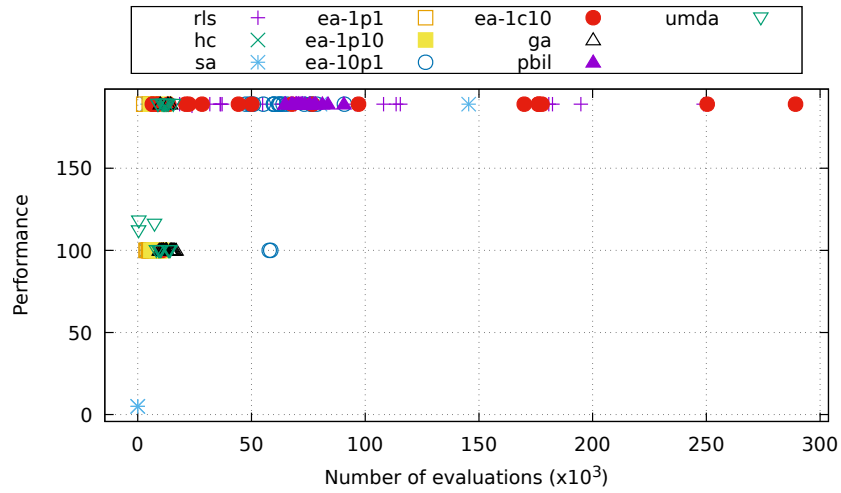


Figure 20: fp-10

14 Function nk

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	0.96	0.98	0.99	1.01	1.06	4	0.277	0.003
hc	0.99	1.00	1.01	1.03	1.06	2	0.261	0.003
sa	1.01	1.03	1.05	1.06	1.10	1	0.279	0.004
ea-1p1	0.86	0.89	0.94	0.98	1.03	8	0.363	0.003
ea-1p10	0.80	0.91	0.94	0.98	1.01	10	0.704	0.003
ea-10p1	0.89	0.98	0.99	1.01	1.05	6	0.729	0.007
ea-1c10	0.94	0.99	1.01	1.03	1.07	3	0.708	0.005
ga	0.90	0.94	0.99	1.01	1.04	7	1.222	0.003
pbil	0.95	0.99	0.99	1.02	1.05	5	0.751	0.008
umda	0.88	0.93	0.94	0.98	1.02	9	0.715	0.005

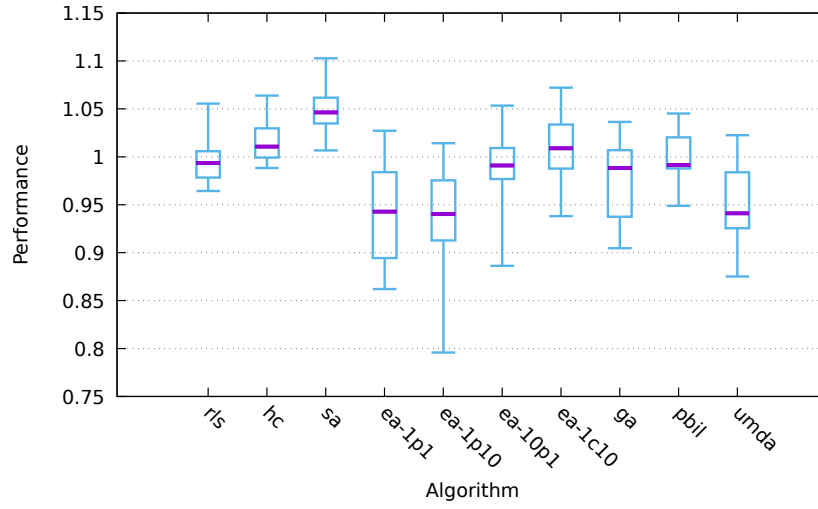


Figure 21: nk

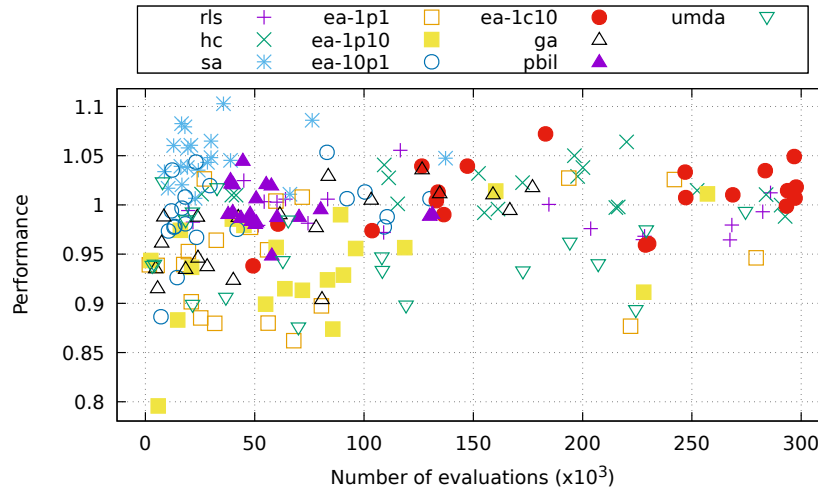


Figure 22: nk

15 Function max-sat

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	971	971	972	972	972	2	2.071	0.018
hc	961	964	968	969	972	6	0.277	0.069
sa	971	972	972	972	972	1	0.624	0.033
ea-1p1	961	965	968	970	972	4	0.893	0.206
ea-1p10	959	964	967	968	972	8	1.085	0.078
ea-10p1	958	965	968	969	972	5	2.071	0.077
ea-1c10	965	969	972	972	972	3	1.258	0.100
ga	957	963	965	968	972	10	1.648	0.147
pbil	964	967	967	967	968	7	1.495	0.050
umda	959	964	965	967	971	9	1.170	0.113

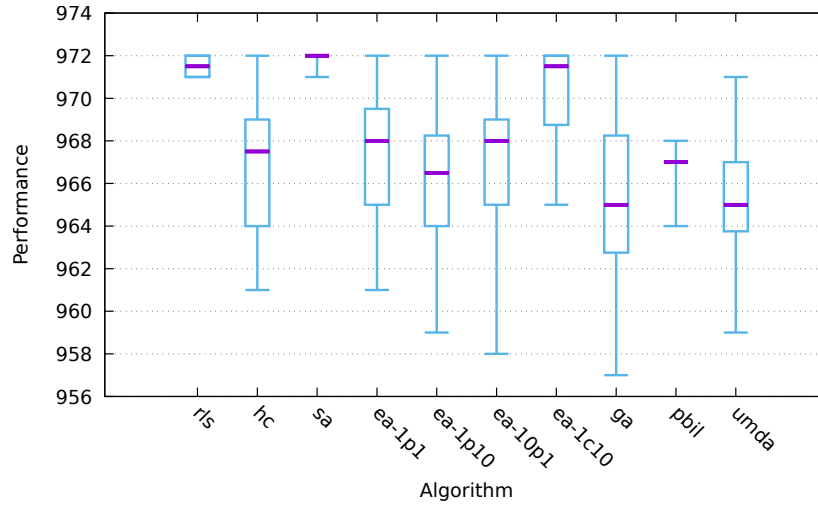


Figure 23: max-sat

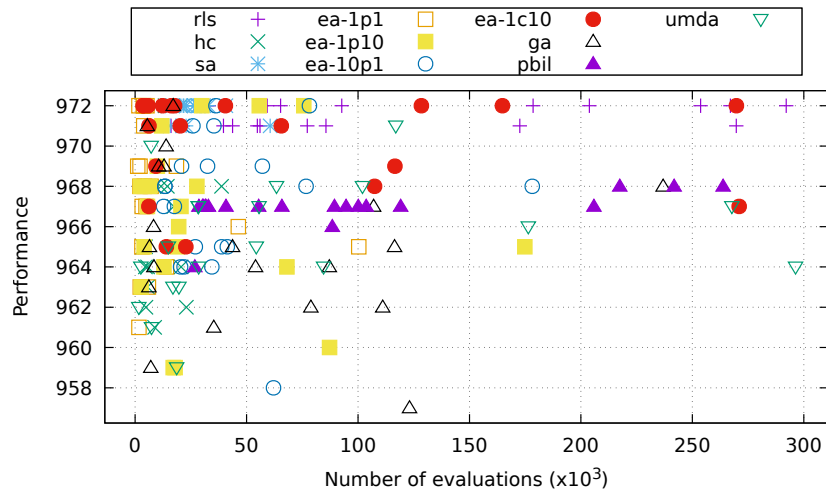


Figure 24: max-sat

16 Function labs

algorithm	performance					time (s)		
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	4.22	4.33	4.44	4.55	5.01	5	1.672	0.009
hc	4.62	4.72	4.79	4.94	5.40	2	1.648	0.005
sa	4.05	4.65	4.77	4.89	5.07	3	1.663	0.007
ea-1p1	3.67	3.99	4.16	4.40	4.84	6	1.734	0.005
ea-1p10	3.68	3.86	4.01	4.13	4.54	8	2.083	0.007
ea-10p1	4.24	4.53	4.71	4.88	5.24	4	2.107	0.004
ea-1c10	4.57	4.74	4.83	5.00	5.38	1	2.085	0.006
ga	3.69	3.82	4.02	4.48	4.95	7	2.603	0.008
pbil	3.29	3.71	3.88	4.14	4.35	10	2.215	0.011
umda	3.52	3.62	3.89	3.99	4.60	9	2.105	0.009

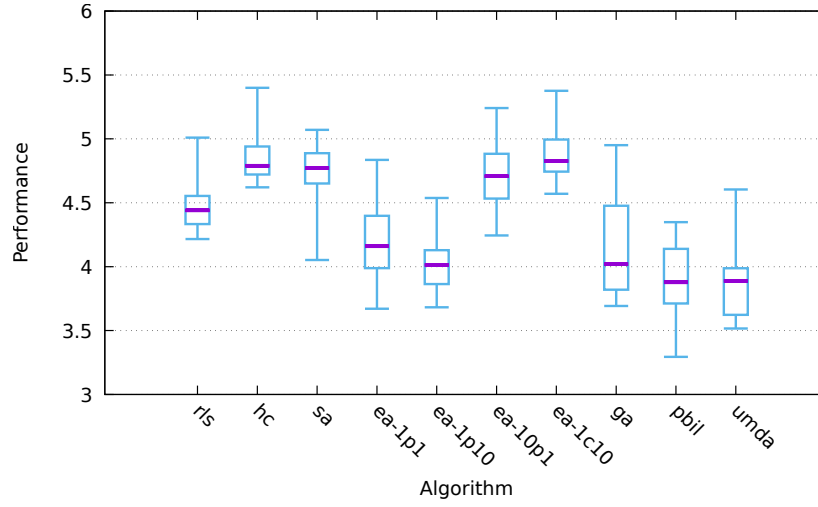


Figure 25: labs

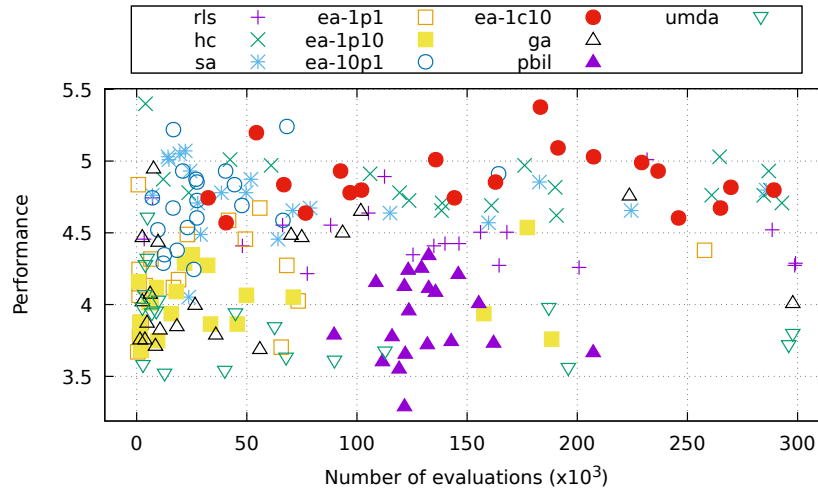


Figure 26: labs

17 Function ep

algorithm	performance						time (s)		
	min	Q_1	med.	Q_3	max	rk	mean	SD	
rls	6.33×10^{-32}	9.68×10^{-31}	2.58×10^{-30}	4.56×10^{-30}	8.33×10^{-30}	1	0.128	0.003	
hc	8.34×10^{-31}	3.28×10^{-30}	3.89×10^{-30}	4.51×10^{-30}	2.58×10^{-29}	2	0.101	0.003	
sa	7.39×10^{-31}	1.24×10^{-30}	4.82×10^{-30}	9.42×10^{-30}	1.73×10^{-29}	3	0.113	0.004	
ea-1p1	3.00×10^{-30}	1.76×10^{-29}	1.92×10^{-29}	3.34×10^{-29}	1.59×10^{-28}	10	0.177	0.003	
ea-1p10	2.91×10^{-30}	6.55×10^{-30}	1.47×10^{-29}	3.92×10^{-29}	1.19×10^{-28}	8	0.527	0.003	
ea-10p1	1.72×10^{-32}	3.54×10^{-30}	8.11×10^{-30}	1.53×10^{-29}	2.97×10^{-29}	6	0.561	0.005	
ea-1c10	3.76×10^{-32}	1.60×10^{-30}	6.38×10^{-30}	9.87×10^{-30}	4.85×10^{-29}	5	0.533	0.004	
ga	2.87×10^{-31}	6.22×10^{-30}	9.68×10^{-30}	2.47×10^{-29}	2.04×10^{-28}	7	1.055	0.006	
pbil	4.49×10^{-31}	1.78×10^{-30}	5.51×10^{-30}	8.29×10^{-30}	2.03×10^{-29}	4	0.774	0.019	
umda	4.79×10^{-30}	7.50×10^{-30}	1.64×10^{-29}	3.81×10^{-29}	1.63×10^{-28}	9	0.552	0.004	

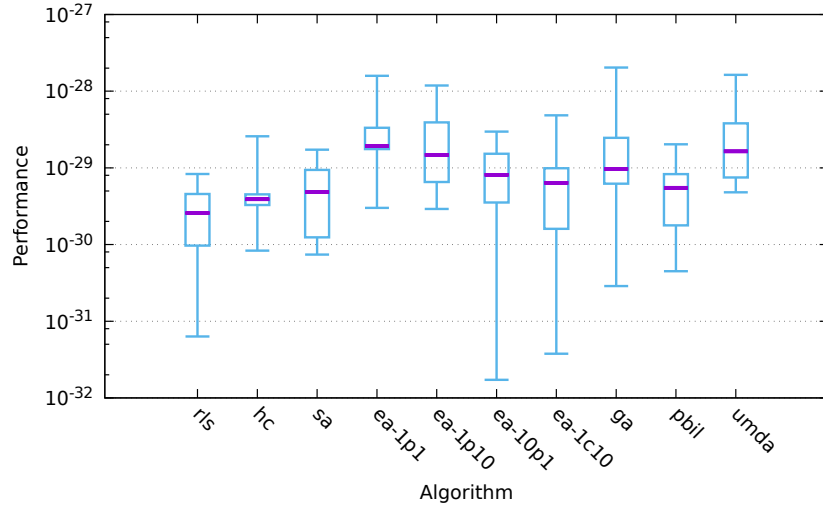


Figure 27: ep

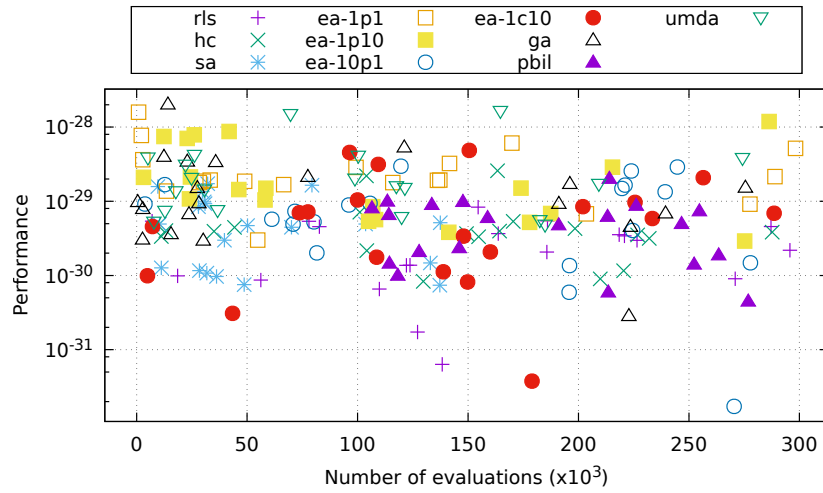


Figure 28: ep

18 Function cancel

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	0.88	1.46	1.75	2.08	2.39	8	0.103	0.003
hc	0.82	3.12	4.42	5.24	8.78	10	0.090	0.003
sa	0.12	1.40	1.83	2.31	13.56	9	0.109	0.003
ea-1p1	0.03	0.14	0.21	0.70	1.37	2	0.174	0.003
ea-1p10	0.06	0.18	0.41	0.88	1.58	3	0.523	0.006
ea-10p1	0.04	0.36	0.70	1.05	2.11	5	0.547	0.005
ea-1c10	0.11	0.45	0.70	0.98	1.68	4	0.524	0.004
ga	0.08	0.51	0.76	1.02	1.80	6	1.034	0.003
pbil	0.04	0.06	0.07	0.11	0.19	1	0.592	0.006
umda	0.06	0.64	1.20	1.59	2.71	7	0.537	0.004

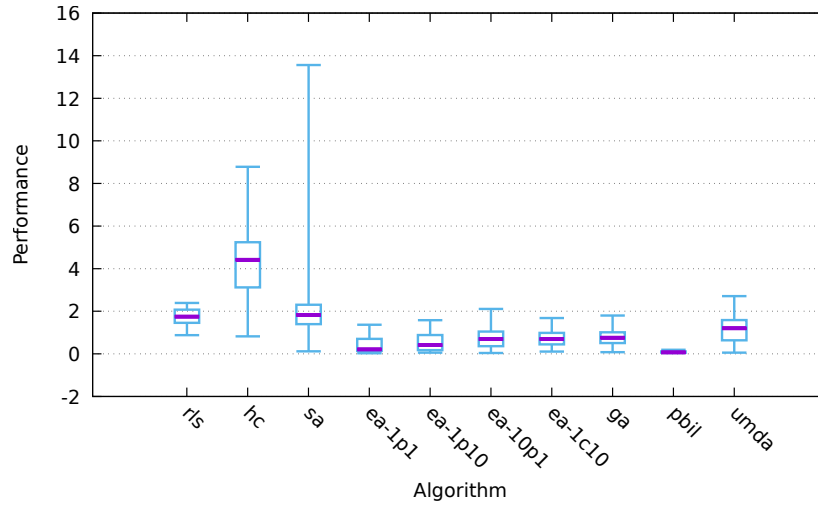


Figure 29: cancel

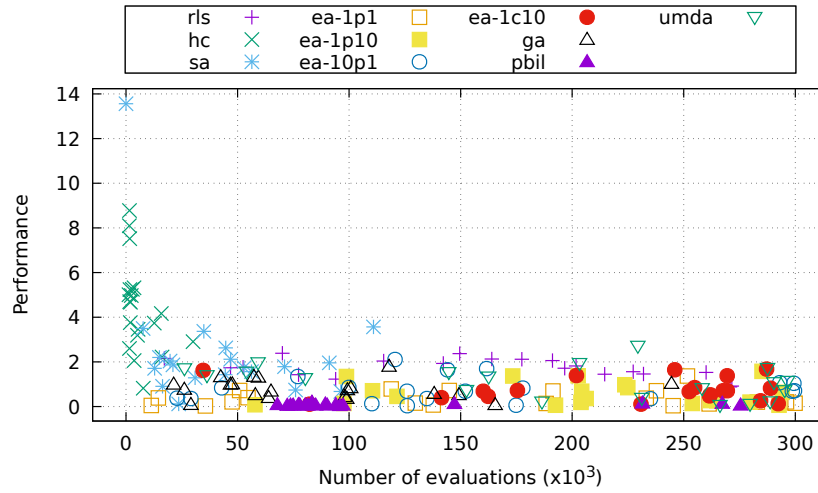


Figure 30: cancel

19 Function trap

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	91	91	91	91	91	2	0.109	0.002
hc	91	91	91	92	92	1	0.096	0.003
sa	90	90	90	90	91	3	0.113	0.003
ea-1p1	90	90	90	90	91	3	0.178	0.003
ea-1p10	90	90	90	90	91	3	0.529	0.006
ea-10p1	90	90	90	90	91	3	0.556	0.007
ea-1c10	90	90	90	90	91	3	0.534	0.003
ga	90	90	90	90	91	3	1.045	0.005
pbil	90	90	90	90	90	9	0.559	0.004
umda	90	90	90	90	90	9	0.546	0.006

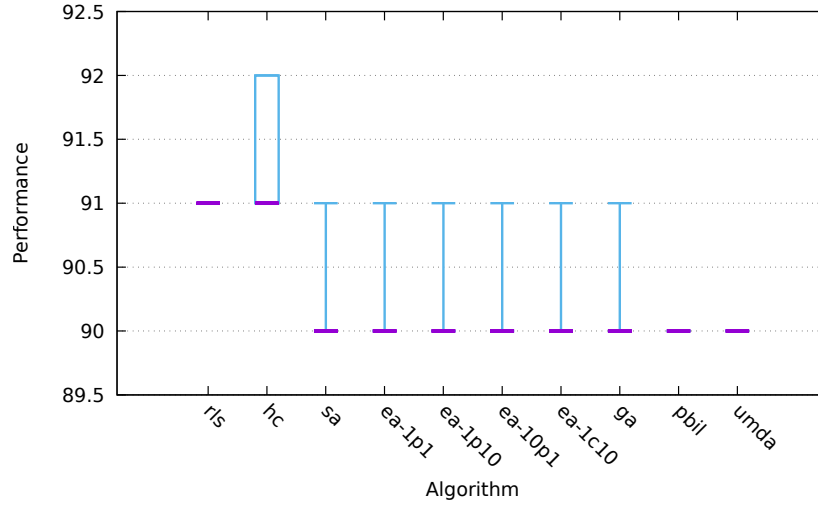


Figure 31: trap

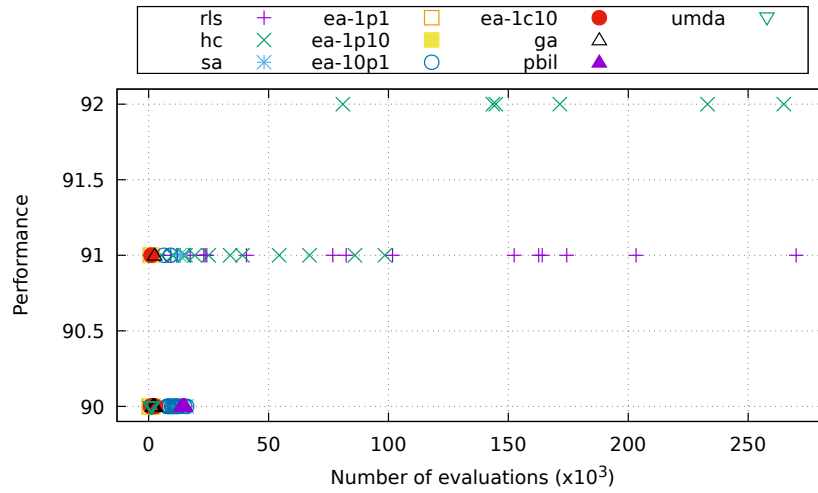


Figure 32: trap

20 Function hiff

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	406	412	422	439	464	10	0.295	0.004
hc	484	496	508	523	544	5	0.278	0.004
sa	640	696	768	800	1,024	1	0.311	0.070
ea-1p1	424	472	484	500	576	9	0.370	0.008
ea-1p10	424	478	488	504	576	7	0.836	0.011
ea-10p1	576	620	664	704	800	2	0.890	0.017
ea-1c10	596	627	646	691	768	3	0.851	0.005
ga	456	480	504	528	608	6	1.455	0.007
pbil	512	529	552	575	656	4	0.933	0.031
umda	452	472	488	517	558	8	0.875	0.031

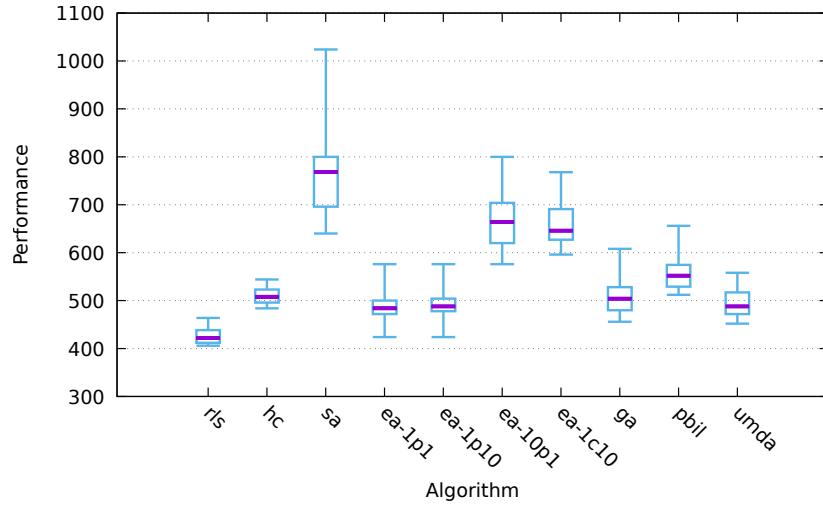


Figure 33: hiff

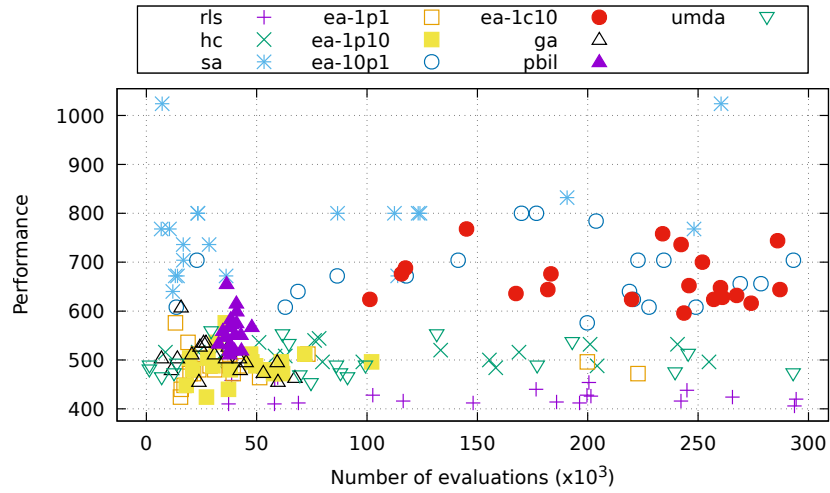


Figure 34: hiff

21 Function plateau

algorithm	performance						time (s)	
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	101	101	101	101	101	4	0.083	0.003
hc	101	101	101	101	102	3	0.072	0.010
sa	101	101	101	102	102	1	0.084	0.014
ea-1p1	101	101	101	102	102	1	0.146	0.019
ea-1p10	101	101	101	101	101	4	0.514	0.009
ea-10p1	101	101	101	101	101	4	0.538	0.007
ea-1c10	101	101	101	101	101	4	0.512	0.007
ga	101	101	101	101	101	4	1.026	0.020
pbil	101	101	101	101	101	4	0.539	0.004
umda	101	101	101	101	101	4	0.523	0.004

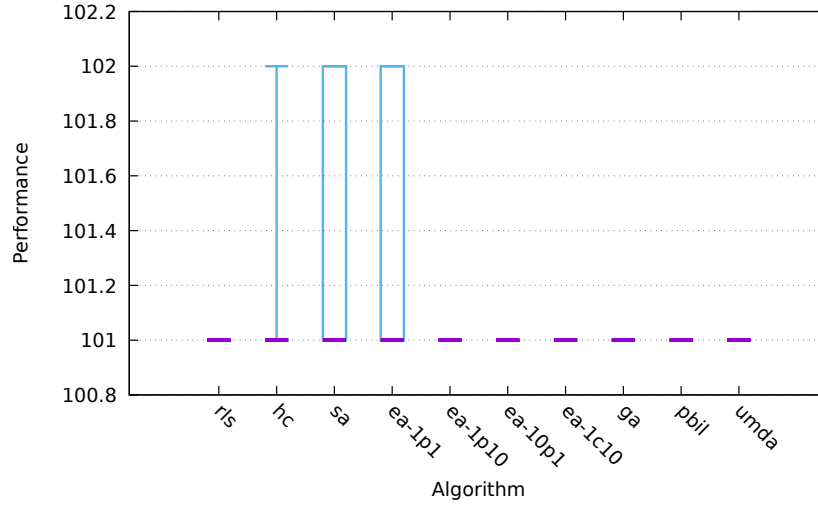


Figure 35: plateau

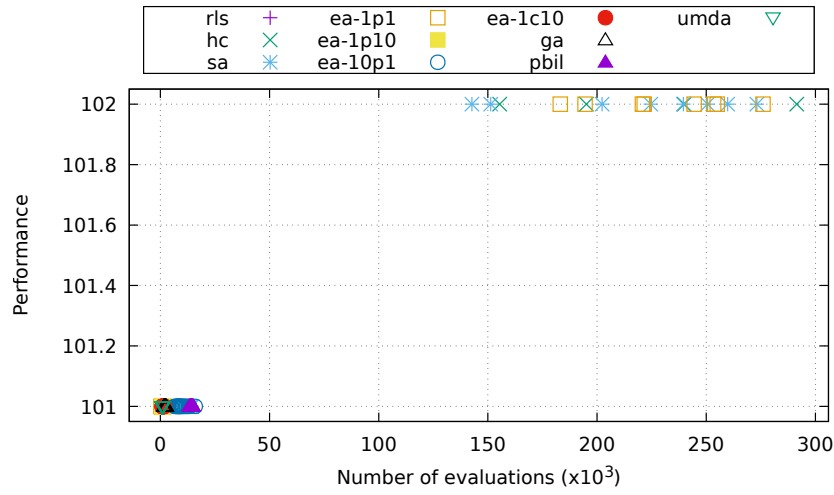


Figure 36: plateau

22 Function walsh2

algorithm	performance					time (s)		
	min	Q_1	med.	Q_3	max	rk	mean	SD
rls	687.45	698.86	705.06	710.14	720.24	3	4.131	0.031
hc	701.41	712.51	716.57	720.04	720.85	1	4.395	0.032
sa	701.56	712.67	713.69	720.24	721.22	2	0.777	0.055
ea-1p1	627.85	654.11	672.12	680.79	708.91	7	0.975	0.041
ea-1p10	644.36	659.70	674.39	683.50	716.57	6	1.147	0.062
ea-10p1	658.56	682.53	690.94	707.90	716.57	5	1.692	0.053
ea-1c10	688.27	698.23	701.58	710.31	720.24	4	1.703	0.164
ga	613.45	645.16	669.55	688.37	707.56	8	1.687	0.039
pbil	625.56	648.94	668.34	689.89	713.69	9	1.802	0.077
umda	617.56	647.96	660.06	679.94	715.23	10	1.182	0.045

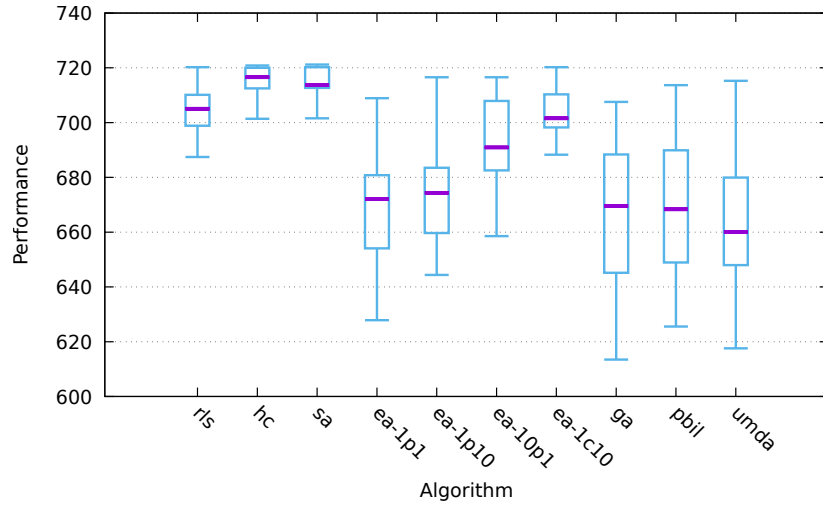


Figure 37: walsh2

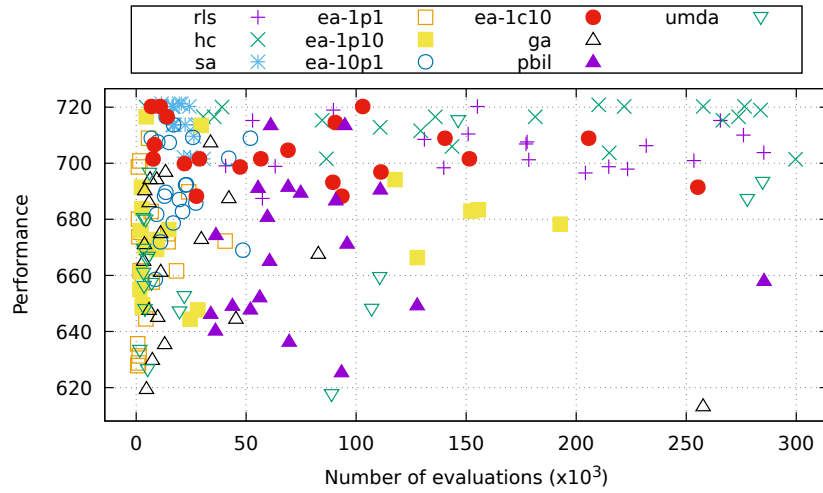


Figure 38: walsh2