HNCO
Influence of the learning rate on the performance of PBIL

August 30, 2021

Abstract

PBIL is applied many times to the same collection of fitness functions (bit vector size $n = 100$), each time with a different learning rate taken from a finite set of values. All learning rates are ranked according to their median fitness over 20 independent runs, first for each fitness function, then across the entire collection of fitness functions. The mean and standard deviation of fitness are also plotted as a function of the learning rate.

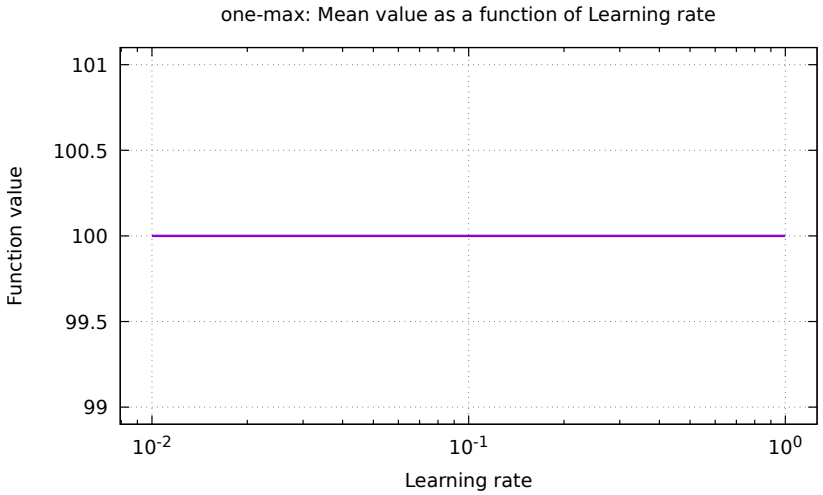
Contents

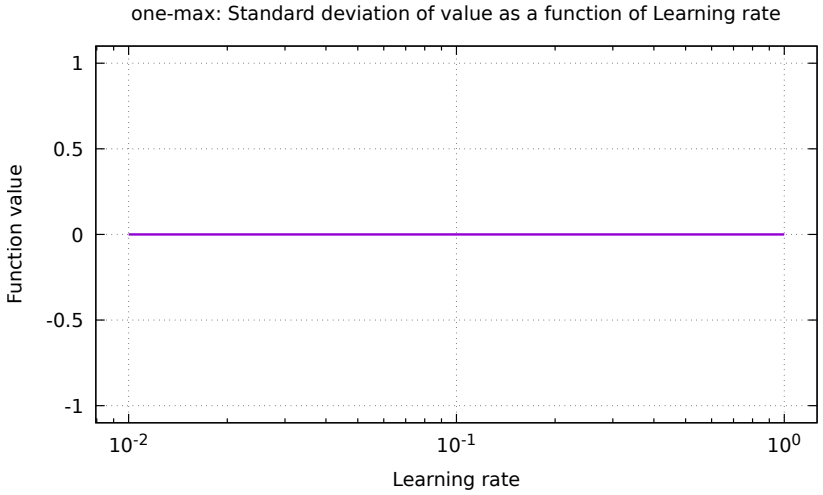
1 Global results

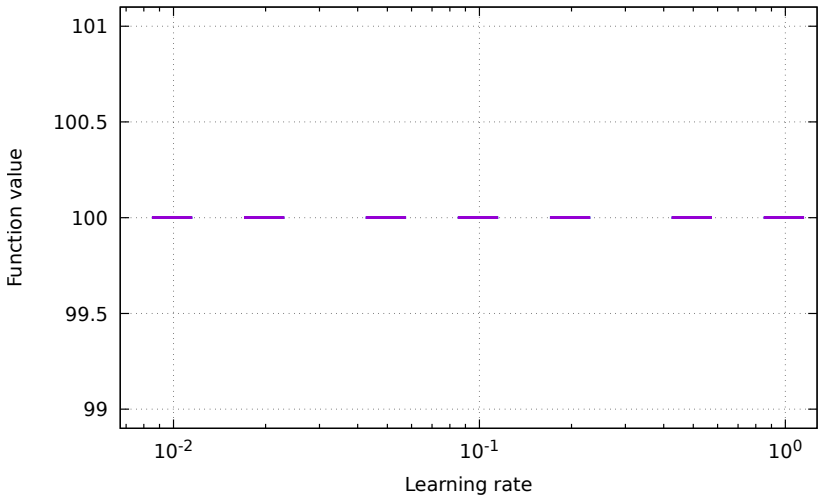
Learning rate	Rank				
	min	Q_1	med.	Q_3	max
1	1	1	1	1	6
0.01	1	1	2	2	7
0.02	1	1	3	3	4
0.5	1	2	3	6	7
0.05	1	1	4	6	7
0.1	1	4	4	6	7
0.2	1	3	5	5	7

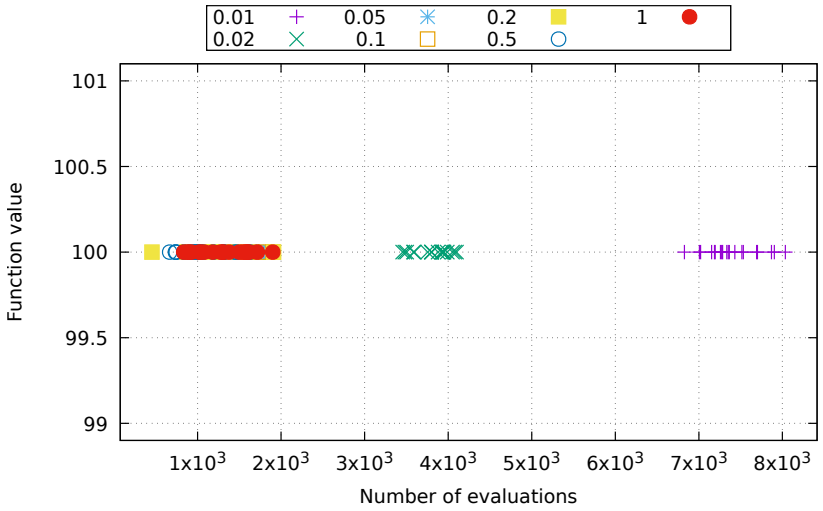
2 Function one-max

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	**100**	**100**	**100**	**100**	**100**
0.02	**100**	**100**	**100**	**100**	**100**
0.05	**100**	**100**	**100**	**100**	**100**
0.1	**100**	**100**	**100**	**100**	**100**
0.2	**100**	**100**	**100**	**100**	**100**
0.5	**100**	**100**	**100**	**100**	**100**
1	**100**	**100**	**100**	**100**	**100**



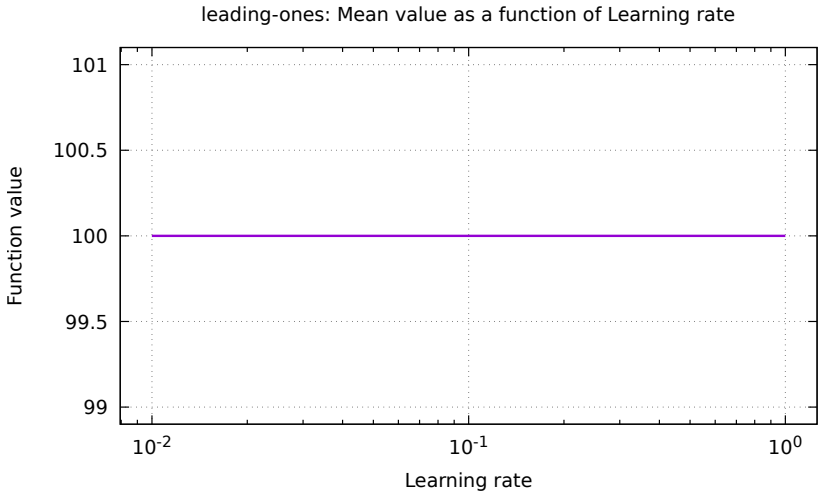


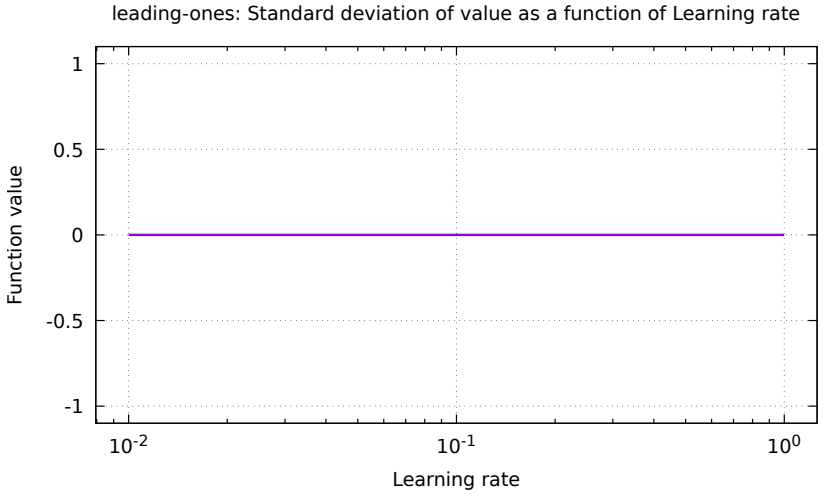


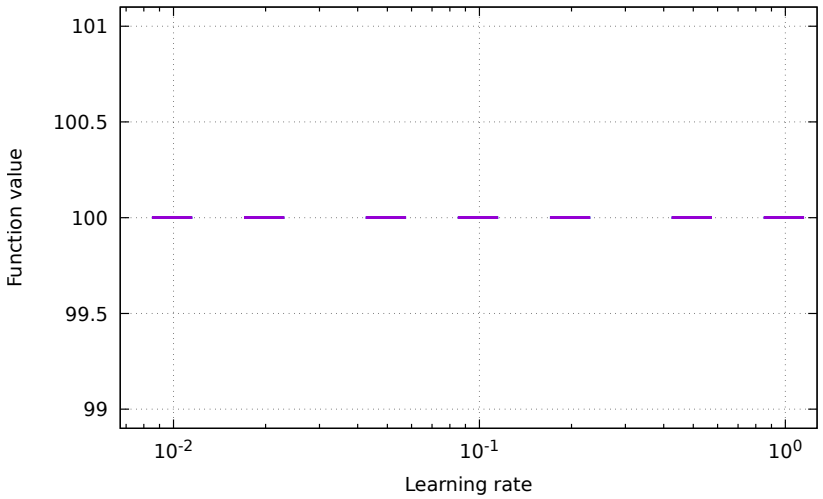

0.01
0.02
0.05
0.1
0.2
0.5
1
101
100.5
100
99.5
99
Function value
1x10^3
2x10^3
3x10^3
4x10^3
5x10^3
6x10^3
7x10^3
8x10^3
Number of evaluations

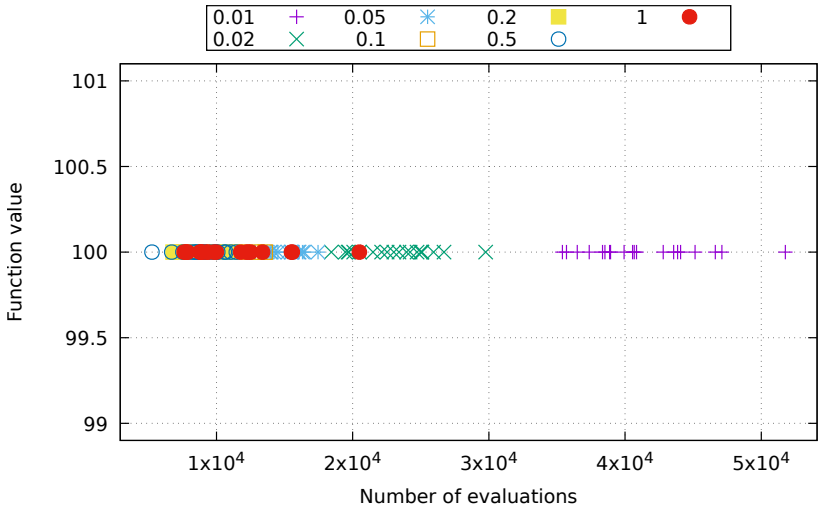
3 Function leading-ones

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	**100**	**100**	**100**	**100**	**100**
0.02	**100**	**100**	**100**	**100**	**100**
0.05	**100**	**100**	**100**	**100**	**100**
0.1	**100**	**100**	**100**	**100**	**100**
0.2	**100**	**100**	**100**	**100**	**100**
0.5	**100**	**100**	**100**	**100**	**100**
1	**100**	**100**	**100**	**100**	**100**



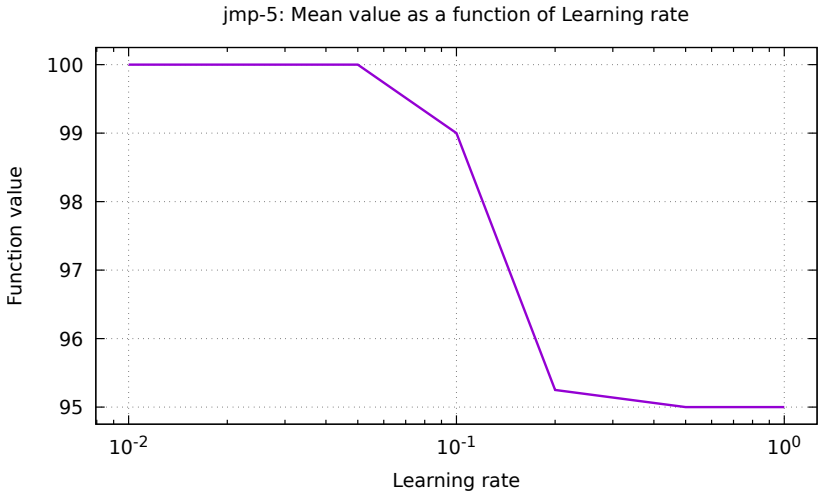


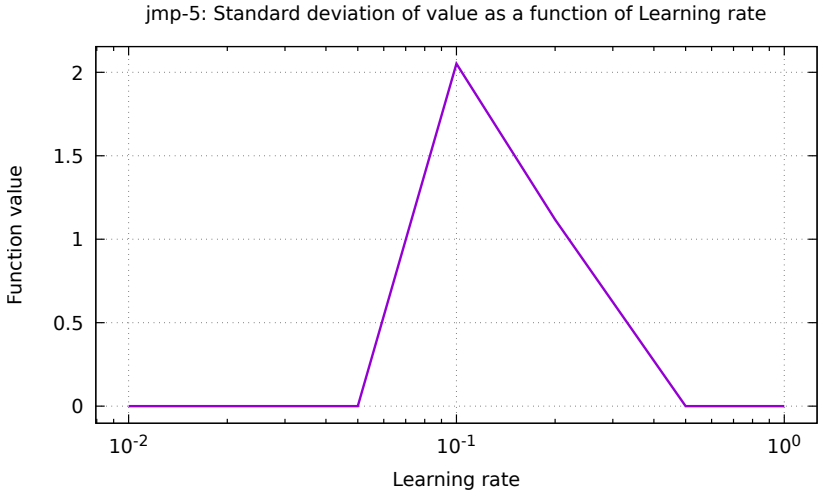


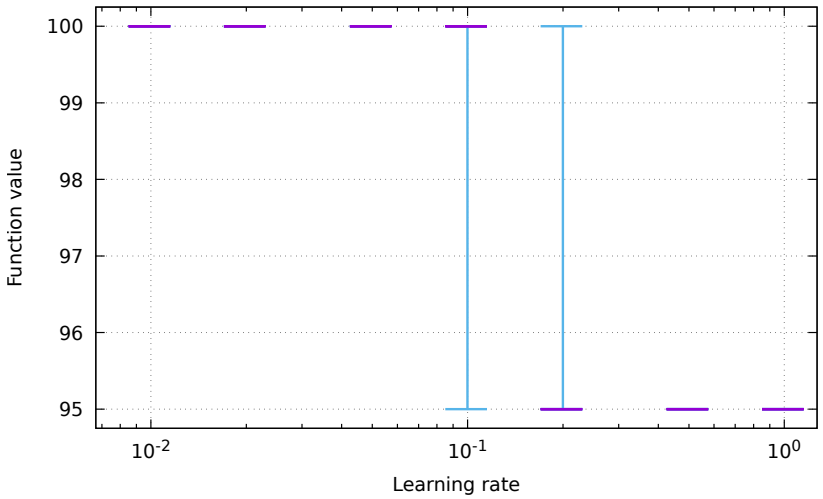

0.01
0.02
0.05
0.1
0.2
0.5
1
101
100.5
100
99.5
99
Function value
1x10^4
2x10^4
3x10^4
4x10^4
5x10^4
Number of evaluations

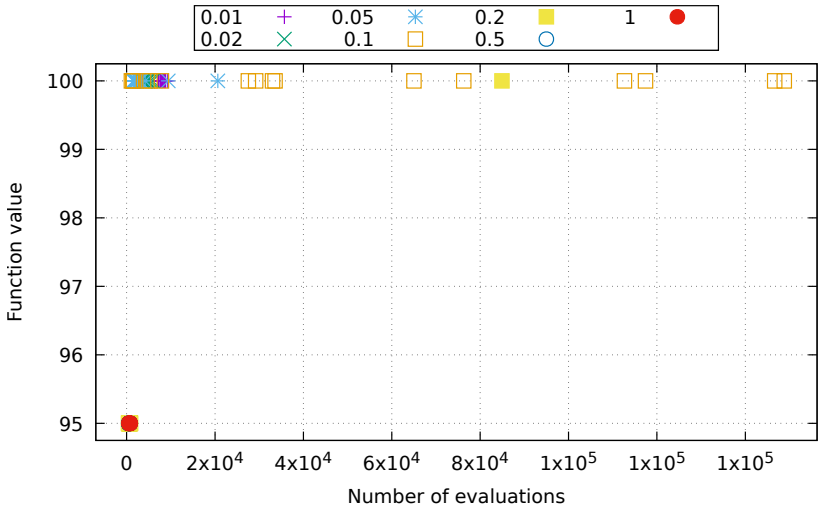
4 Function jmp-5

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	**100**	**100**	**100**	**100**	**100**
0.02	**100**	**100**	**100**	**100**	**100**
0.05	**100**	**100**	**100**	**100**	**100**
0.1	95	**100**	**100**	**100**	**100**
0.2	95	95	95	95	**100**
0.5	95	95	95	95	95
1	95	95	95	95	95



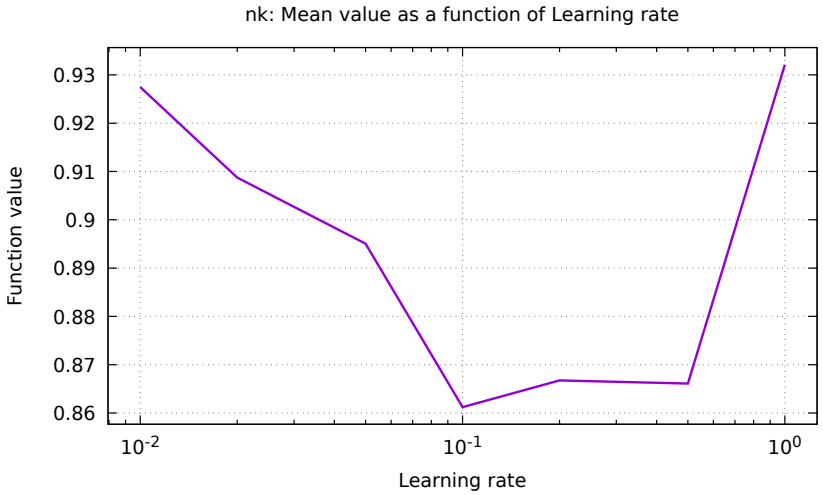


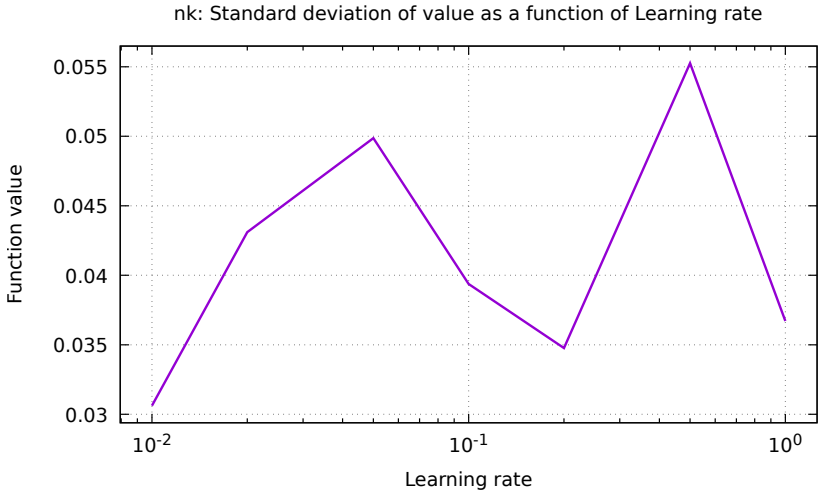


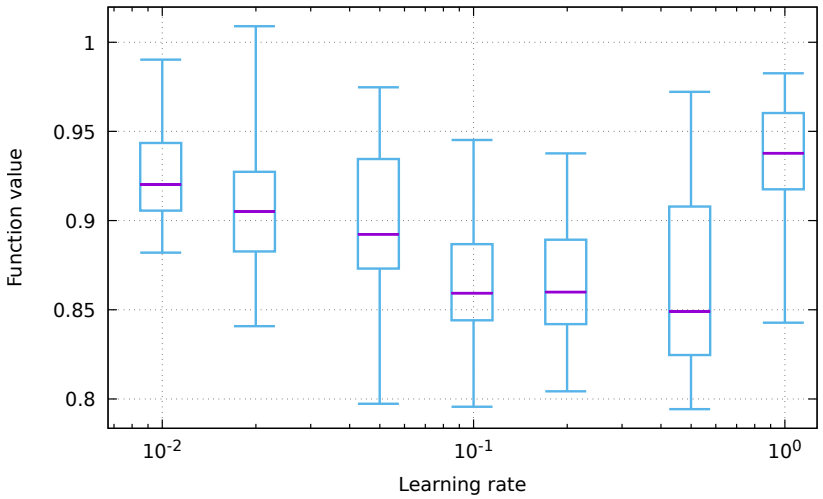

0.01
0.02
0.05
0.1
0.2
0.5
1
100
99
98
97
96
95
Function value
0
2x10^4
4x10^4
6x10^4
8x10^4
1x10^5
1x10^5
1x10^5
Number of evaluations

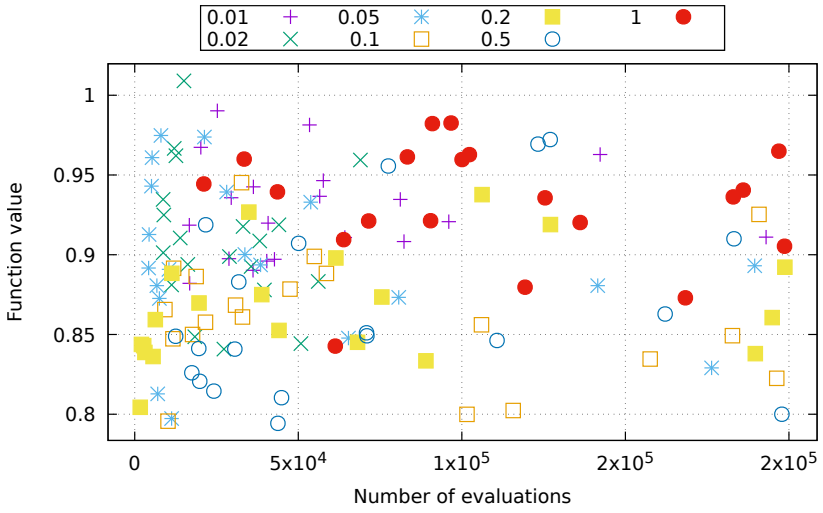
5 Function nk

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	0.84	**0.92**	**0.94**	**0.96**	0.98
0.01	**0.88**	0.91	0.92	0.94	0.99
0.02	0.84	0.88	0.90	0.93	**1.01**
0.05	0.80	0.87	0.89	0.93	0.97
0.2	0.80	0.84	0.86	0.89	0.94
0.1	0.80	0.84	0.86	0.89	0.95
0.5	0.79	0.82	0.85	0.91	0.97



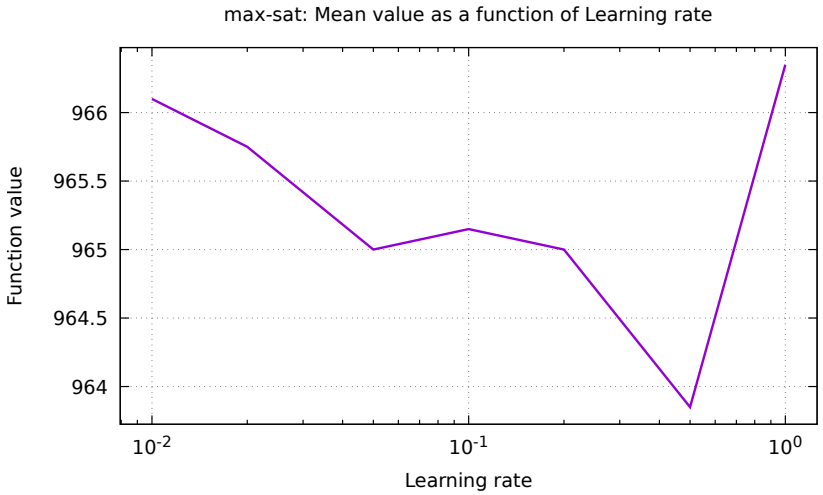


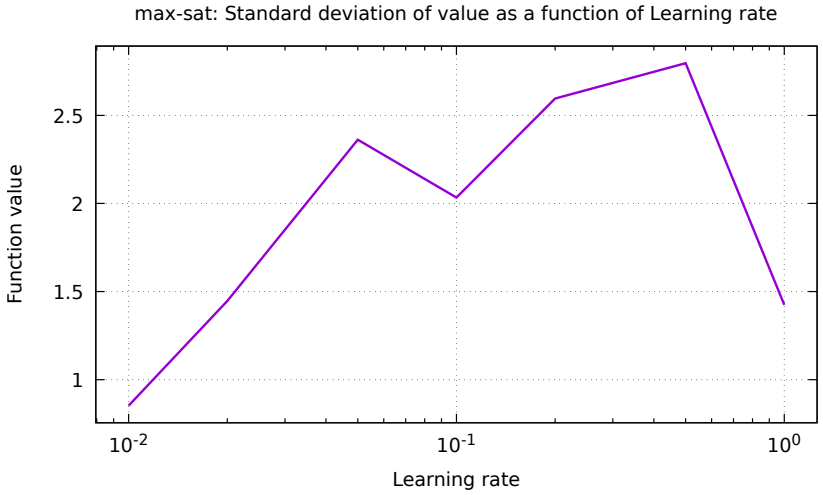


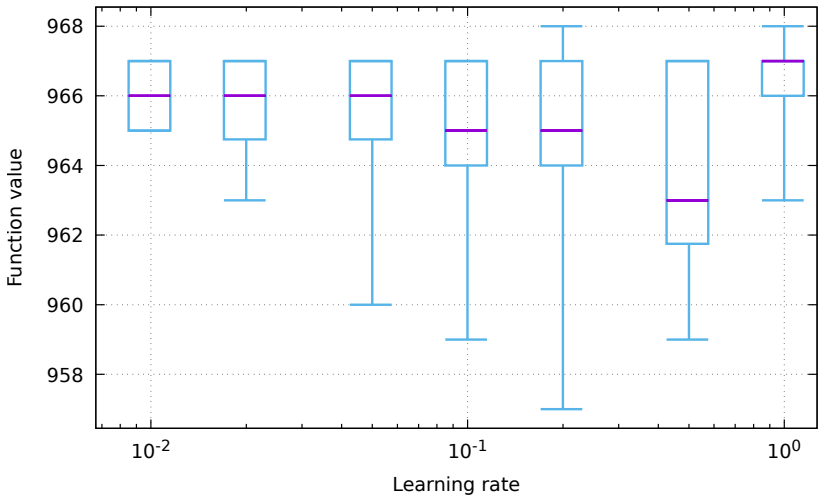

0.01
0.02
0.05
0.1
0.2
0.5
1
Function value
1
0.95
0.9
0.85
0.8
0
5x10^4
1x10^5
2x10^5
2x10^5
Number of evaluations

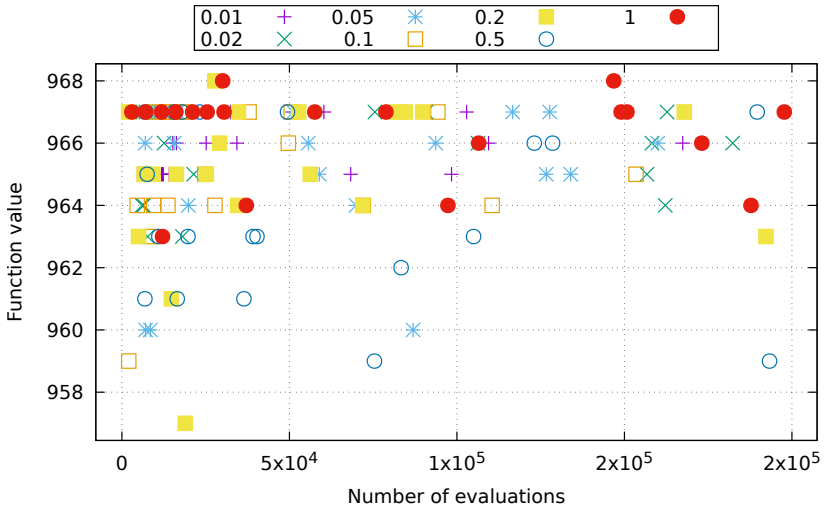
6 Function max-sat

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	963	**966**	**967**	**967**	**968**
0.01	**965**	965	966	**967**	967
0.02	963	965	966	**967**	967
0.05	960	965	966	**967**	967
0.2	957	964	965	**967**	**968**
0.1	959	964	965	**967**	967
0.5	959	962	963	**967**	967



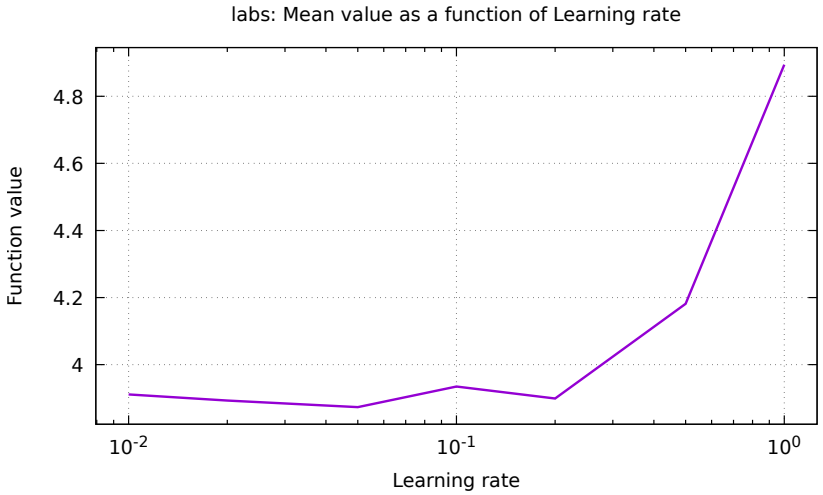


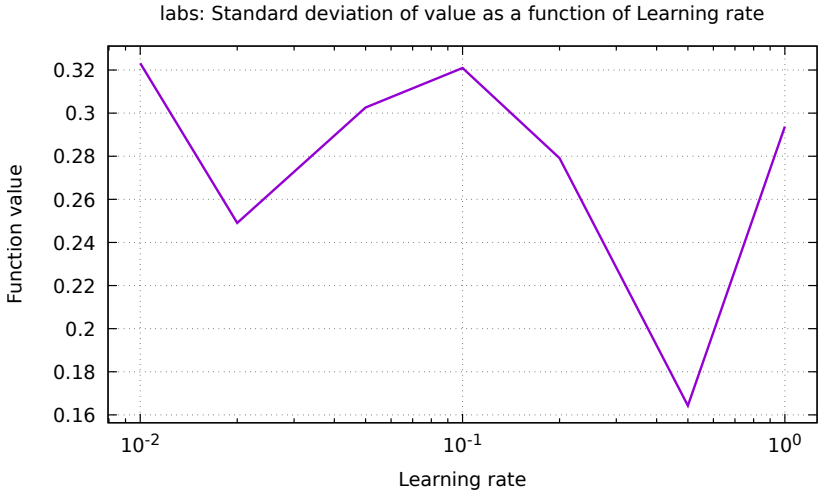


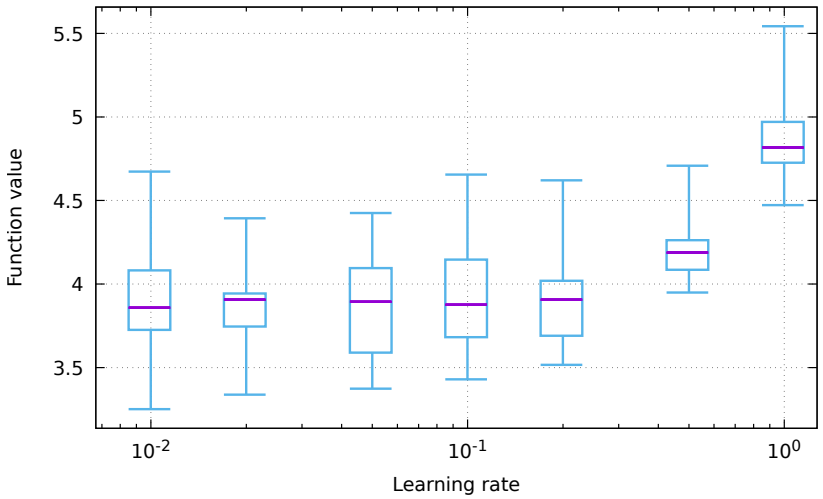

0.01
0.02
0.05
0.1
0.2
0.5
1
968
966
964
962
960
958
Function value
0
5x10^4
1x10^5
2x10^5
2x10^5
Number of evaluations

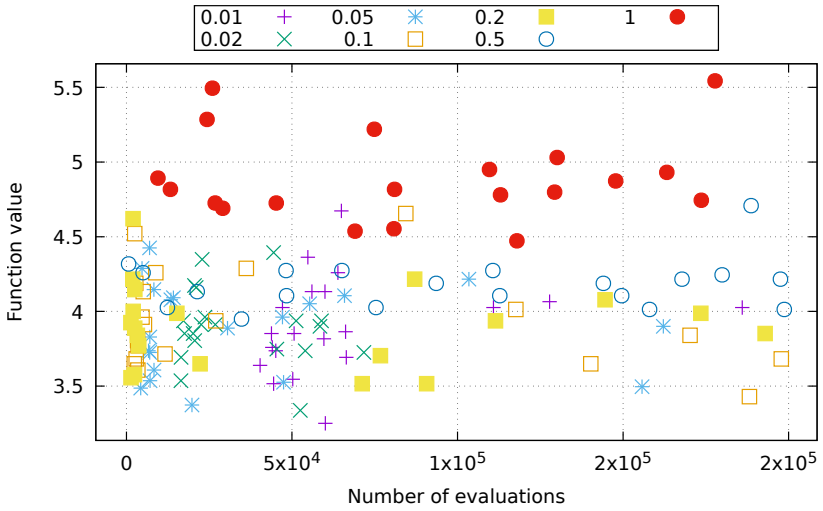
7 Function labs

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	**4.47**	**4.73**	**4.82**	**4.97**	**5.54**
0.5	3.95	4.09	4.19	4.26	4.71
0.2	3.52	3.69	3.91	4.02	4.62
0.02	3.34	3.75	3.91	3.94	4.39
0.05	3.37	3.59	3.89	4.10	4.42
0.1	3.43	3.68	3.88	4.15	4.66
0.01	3.25	3.73	3.86	4.08	4.67



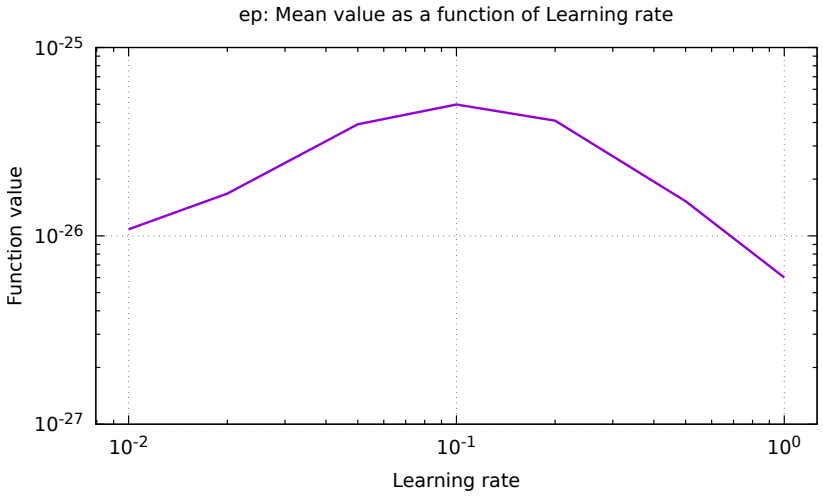


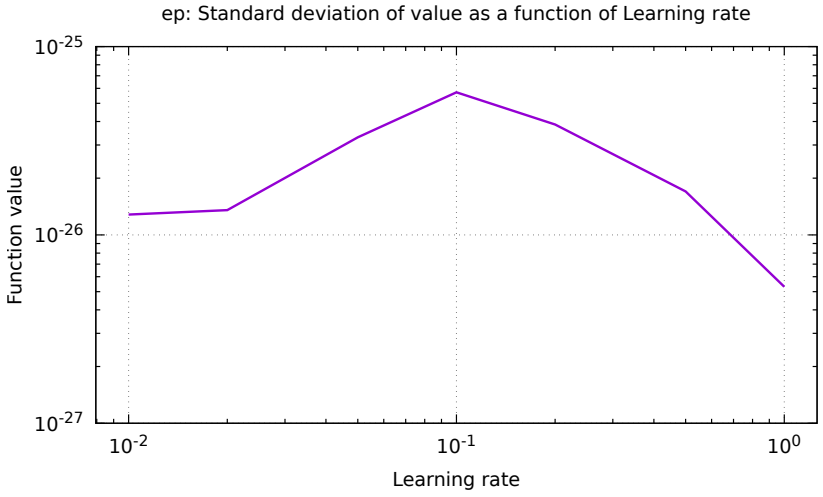


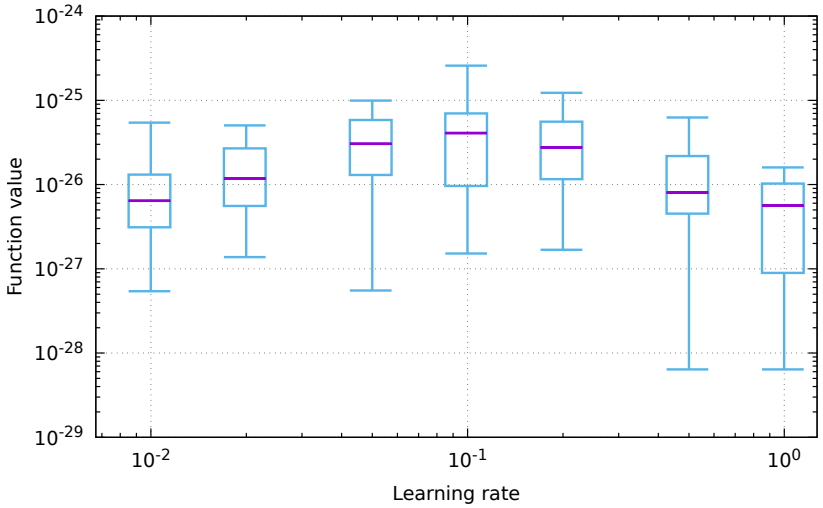

0.01
0.02
0.05
0.1
0.2
0.5
1
Function value
5.5
5
4.5
4
3.5
0
5x10^4
1x10^5
2x10^5
2x10^5
Number of evaluations

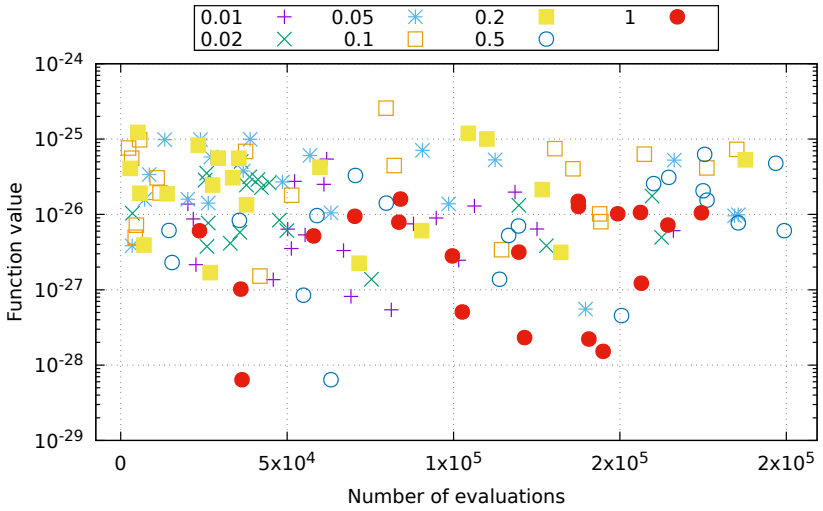
8 Function ep

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	$\mathbf{6.4 \times 10^{-29}}$	$\mathbf{8.9 \times 10^{-28}}$	$\mathbf{5.6 \times 10^{-27}}$	$\mathbf{1.0 \times 10^{-26}}$	$\mathbf{1.6 \times 10^{-26}}$
0.01	5.4×10^{-28}	3.1×10^{-27}	6.4×10^{-27}	1.3×10^{-26}	5.4×10^{-26}
0.5	6.4×10^{-29}	4.5×10^{-27}	8.0×10^{-27}	2.2×10^{-26}	6.3×10^{-26}
0.02	1.4×10^{-27}	5.6×10^{-27}	1.2×10^{-26}	2.7×10^{-26}	5.0×10^{-26}
0.2	1.7×10^{-27}	1.2×10^{-26}	2.8×10^{-26}	5.6×10^{-26}	1.2×10^{-25}
0.05	5.5×10^{-28}	1.3×10^{-26}	3.0×10^{-26}	5.8×10^{-26}	9.9×10^{-26}
0.1	1.5×10^{-27}	9.6×10^{-27}	4.1×10^{-26}	7.0×10^{-26}	2.6×10^{-25}



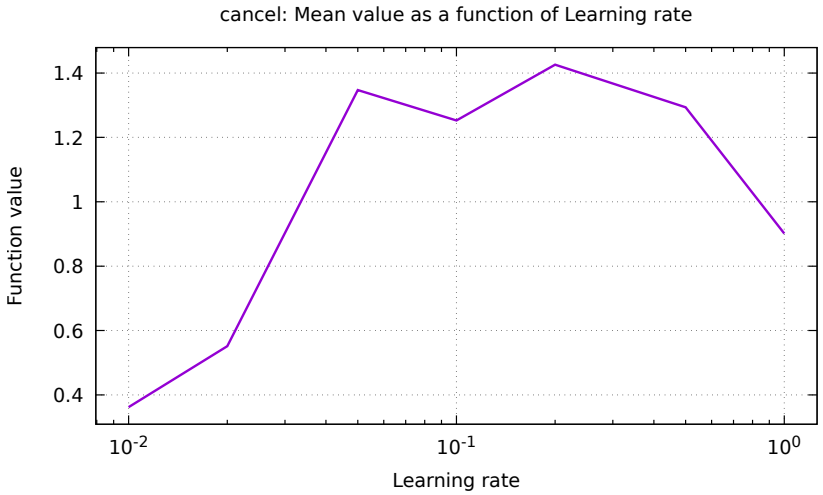


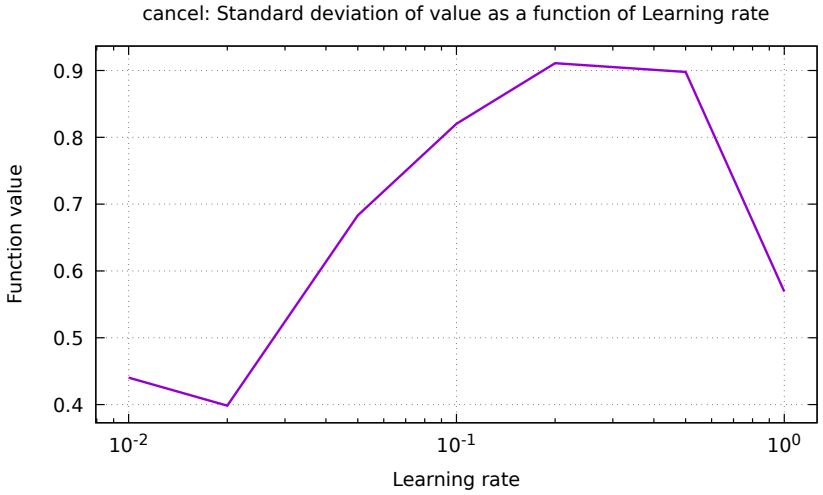


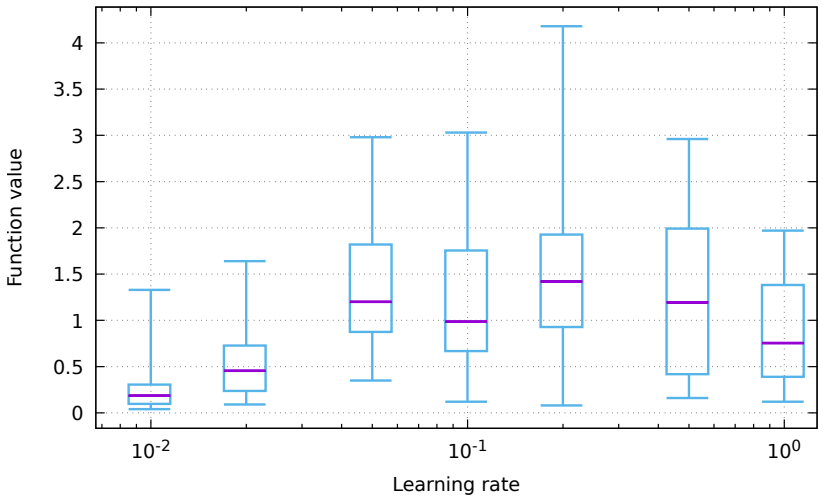

0.01
0.02
0.05
0.1
0.2
0.5
1
Function value
10-24
10-25
10-26
10-27
10-28
10-29
0
5x104
1x105
2x105
2x105
Number of evaluations

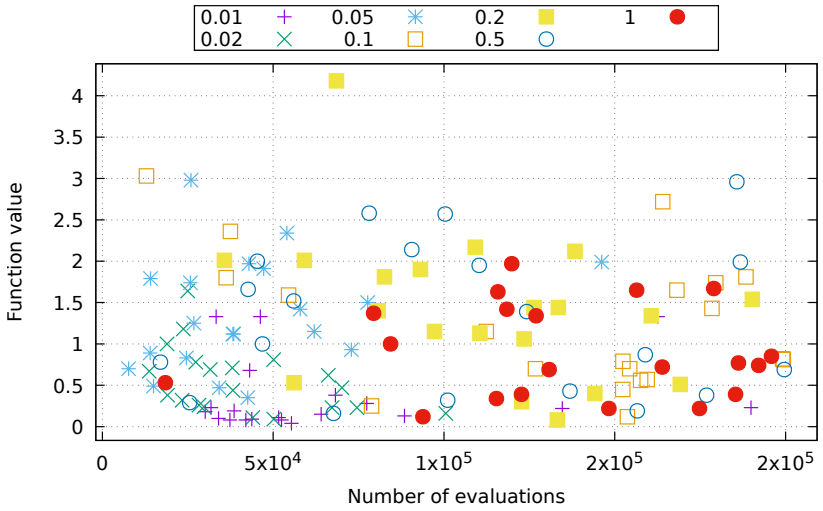
9 Function cancel

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	**0.04**	**0.10**	**0.19**	**0.31**	**1.33**
0.02	0.09	0.24	0.46	0.73	1.64
1	0.12	0.39	0.76	1.38	1.97
0.1	0.12	0.67	0.99	1.76	3.03
0.5	0.16	0.42	1.20	1.99	2.96
0.05	0.35	0.88	1.20	1.82	2.98
0.2	0.08	0.93	1.42	1.93	4.18



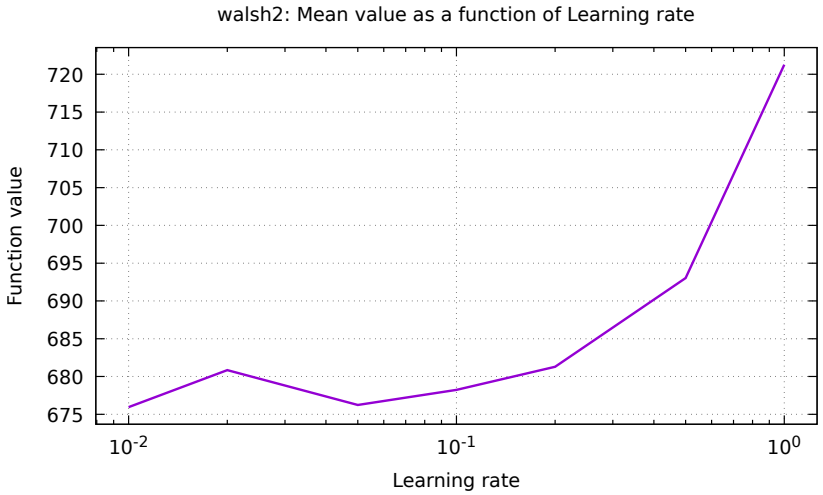


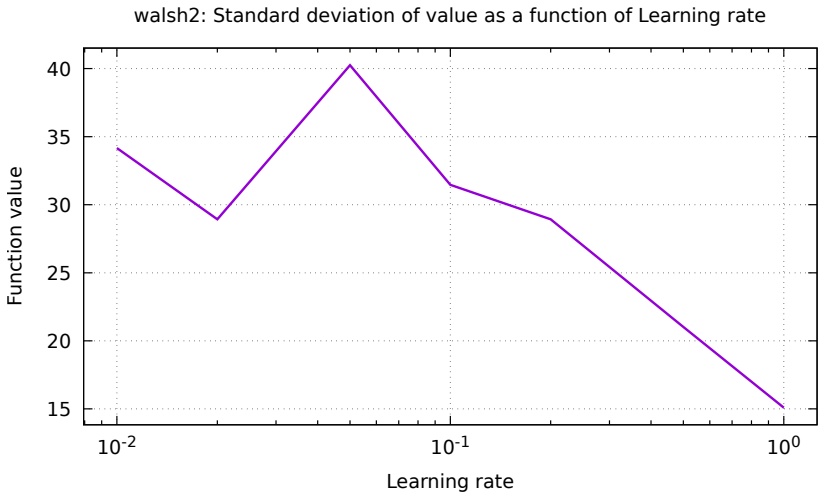


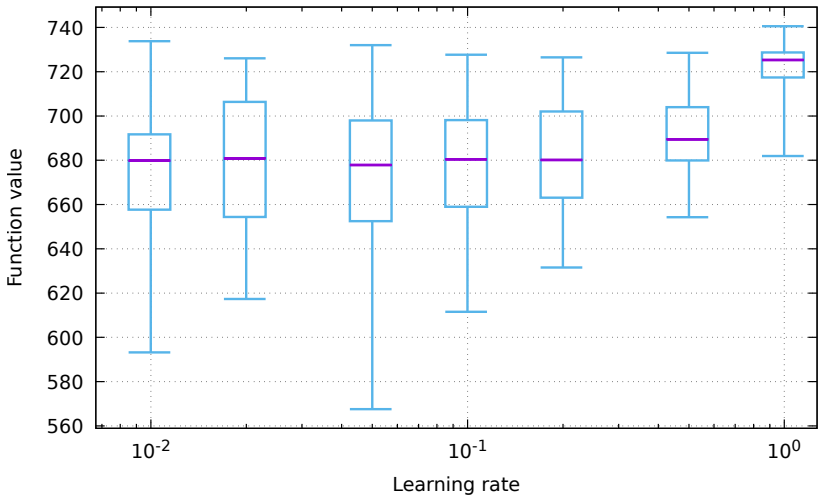

0.01
0.02
0.05
0.1
0.2
0.5
1
Function value
Number of evaluations
0
0.5
1
1.5
2
2.5
3
3.5
4
0
5x10^4
1x10^5
2x10^5
2x10^5

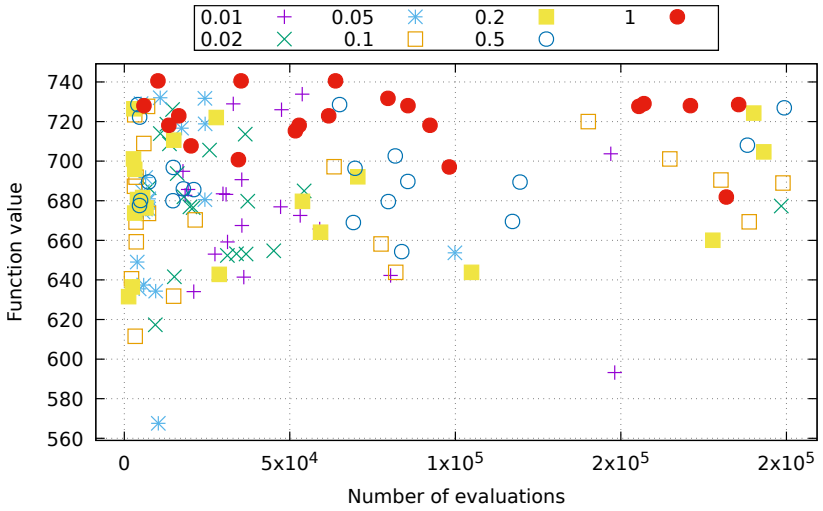
10 Function walsh2

Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	**681.90**	**717.40**	**725.26**	**728.68**	**740.55**
0.5	654.29	679.89	689.48	703.96	728.55
0.02	617.32	654.36	680.89	706.38	726.07
0.1	611.54	658.97	680.46	698.16	727.67
0.2	631.53	663.07	680.14	702.00	726.48
0.01	593.18	657.67	679.82	691.70	733.81
0.05	567.56	652.51	677.87	697.97	732.02









A Plan

```
{
    "exec": "hnco",
    "opt": "-A 500 -x 10 -y 1 --print-results --map 1 --map-random -s 100",
    "budget": 200000,
    "num_runs": 20,
    "parallel": true,
    "parameter": {
        "id": "learning-rate",
        "name": "Learning rate",
        "values": [ 1e-2, 2e-2, 5e-2, 1e-1, 2e-1, 5e-1, 1 ]
    },
    "graphics": {
        "logscale": true,
        "candlesticks": {
            "title": true,
            "boxwidth": "$1 * 0.3"
        }
    },
    "functions": [
        {
            "id": "one-max",
            "opt": "-F 0 --stop-on-maximum",
            "rounding": {
                "value": { "before": 3, "after": 0 },
                "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": "jmp-5",
            "opt": "-F 30 --stop-on-maximum -t 5",
            "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": "walsh2",
            "opt": "-F 162 -p instances/walsh2.100",
            "rounding": {
                "value": { "before": 3, "after": 2 },
                "time": { "before": 1, "after": 2 } }
        }
    ]
}
```

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
```

```
# fp_expression = (1-x)^2+100*(y-x^2)^2
# fp_lower_bound = -2
# fp_num_bits = 8
# fp_precision = 0.01
# fp_upper_bound = 2
# 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_rate = 1
# neighborhood = 0
# neighborhood_iterator = 0
# noise_stddev = 1
# num_iterations = 0
# num_threads = 1
# path = function.txt
# pn_mutation_rate = 1
# pn_neighborhood = 0
# pn_radius = 2
# population_size = 10
# pv_log_num_components = 5
# radius = 2
# rep_categorical_representation = 0
# 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 = 0.18
# Generated from hnco.json
```