

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.

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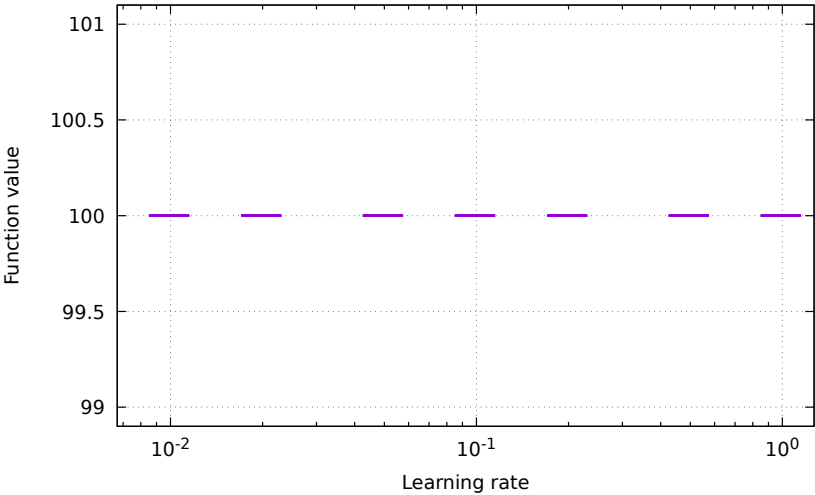
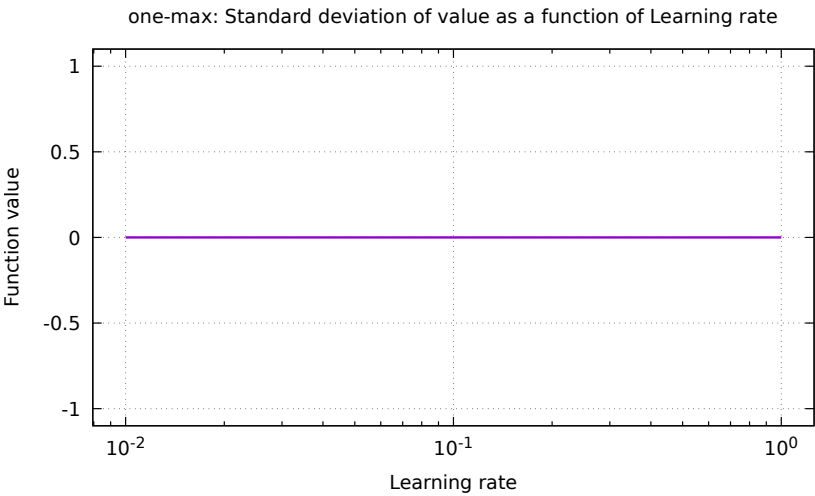
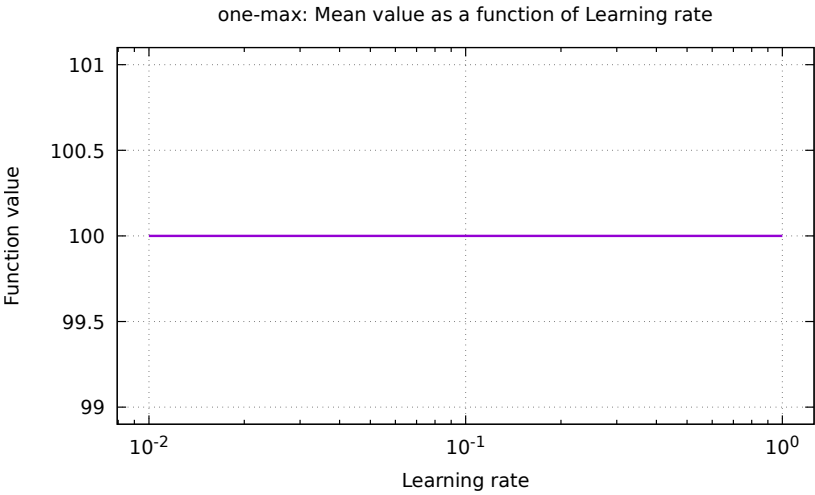
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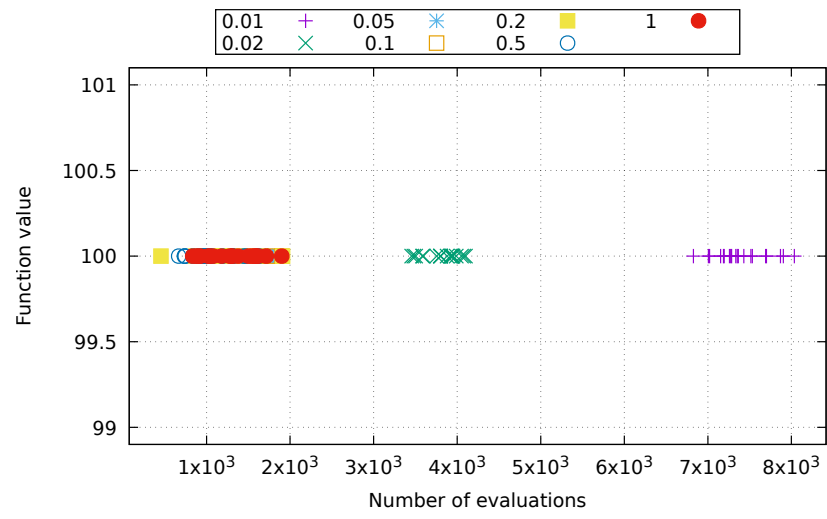
1 Global results

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

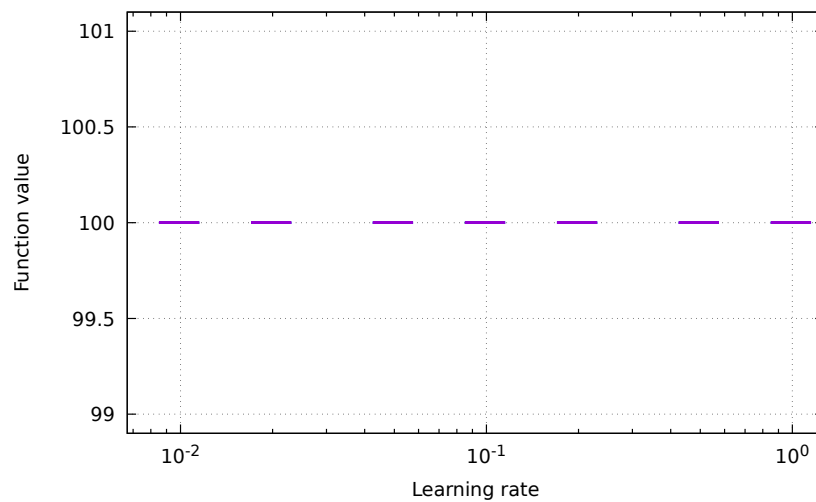
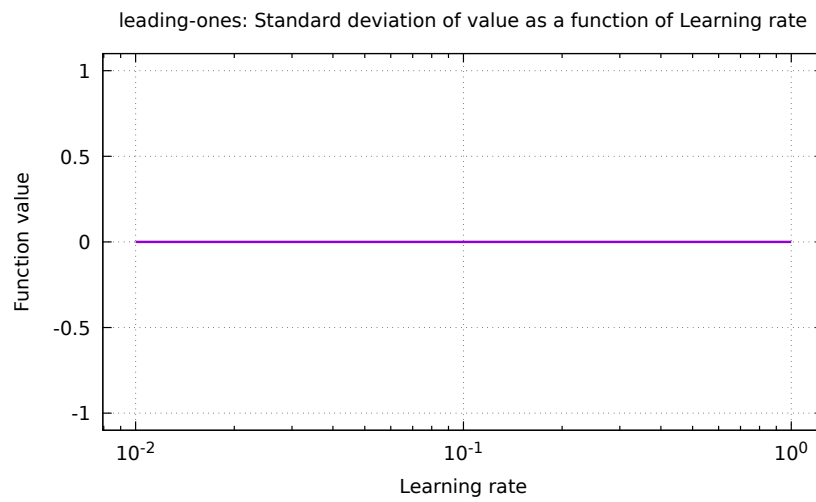
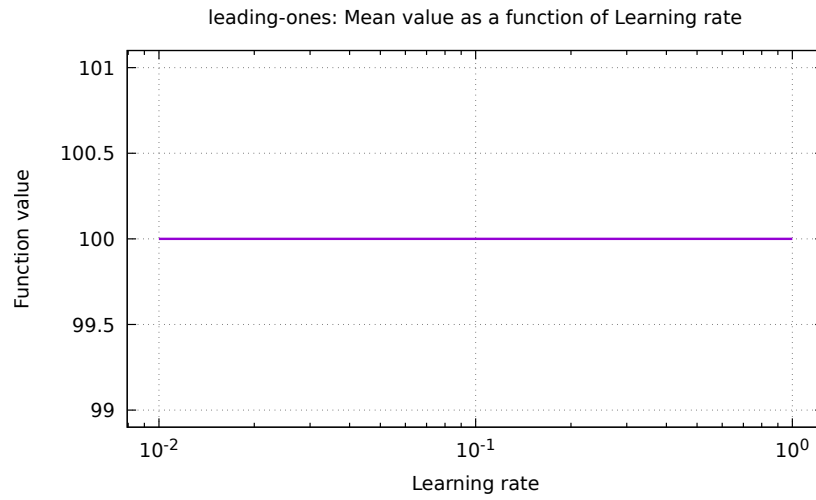
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	100	100	100	100	100
0.02	100	100	100	100	100
0.05	100	100	100	100	100
0.1	100	100	100	100	100
0.2	100	100	100	100	100
0.5	100	100	100	100	100
1	100	100	100	100	100

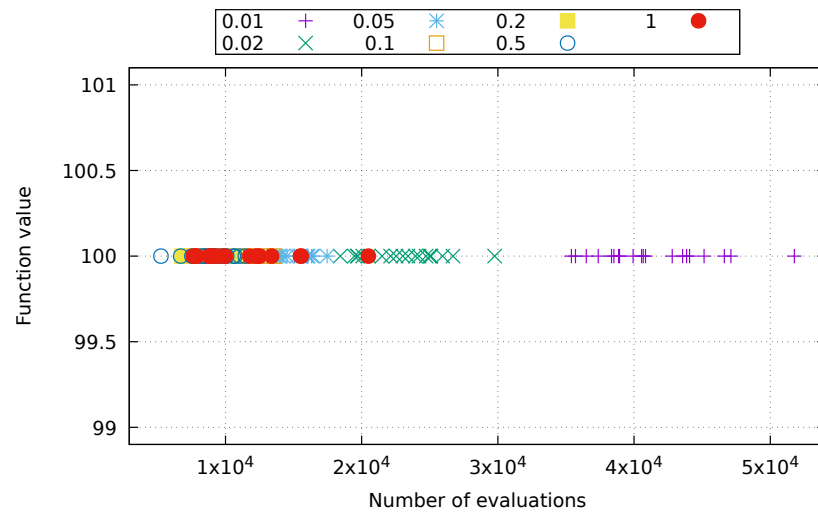




3 Function leading-ones

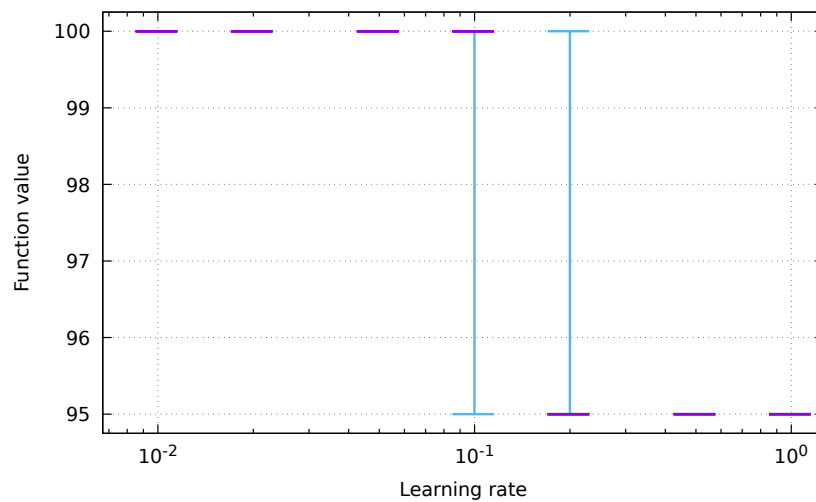
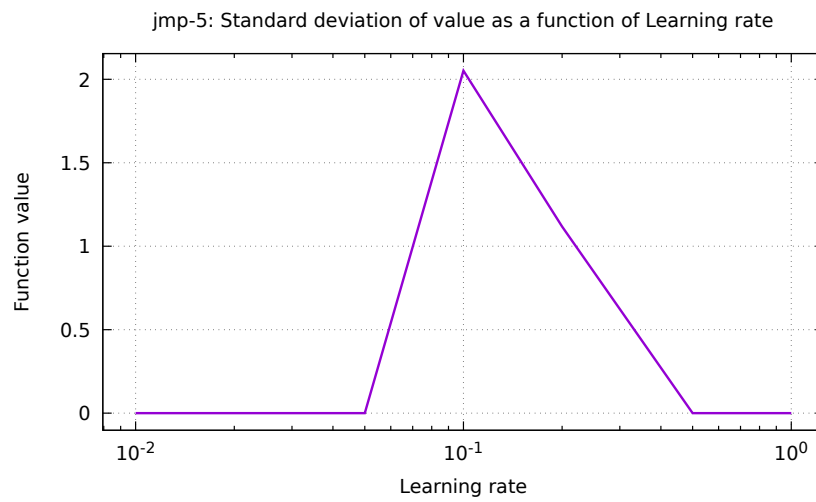
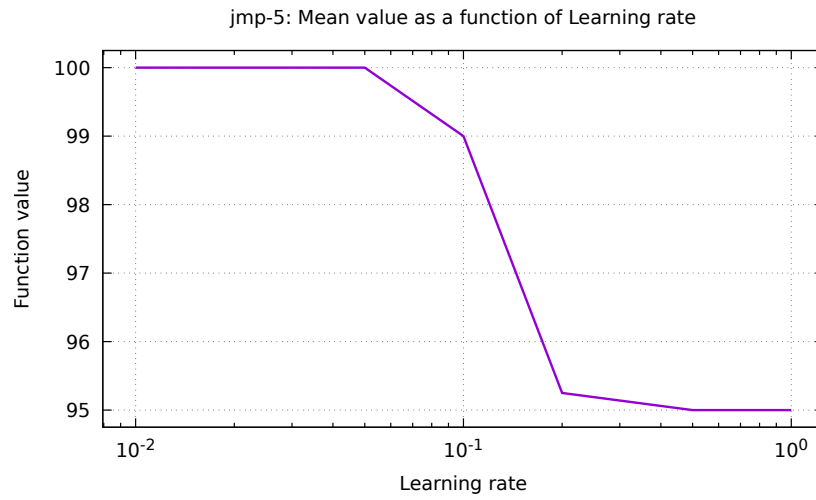
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	100	100	100	100	100
0.02	100	100	100	100	100
0.05	100	100	100	100	100
0.1	100	100	100	100	100
0.2	100	100	100	100	100
0.5	100	100	100	100	100
1	100	100	100	100	100

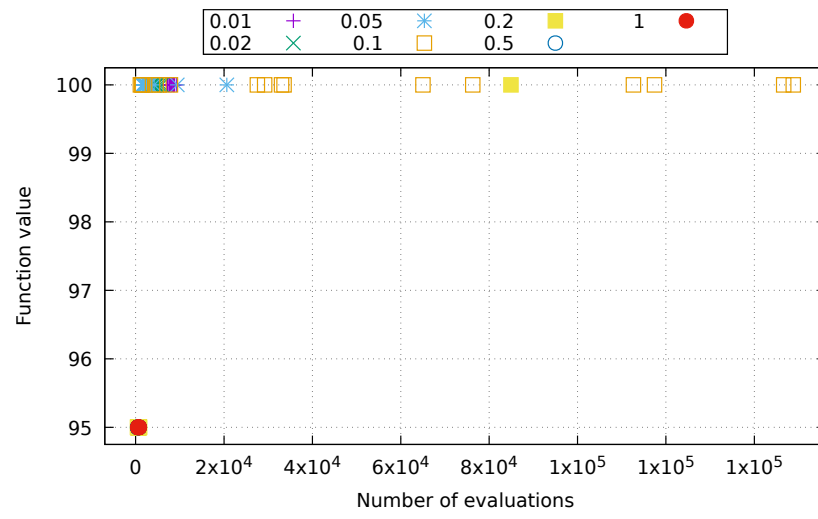




4 Function jmp-5

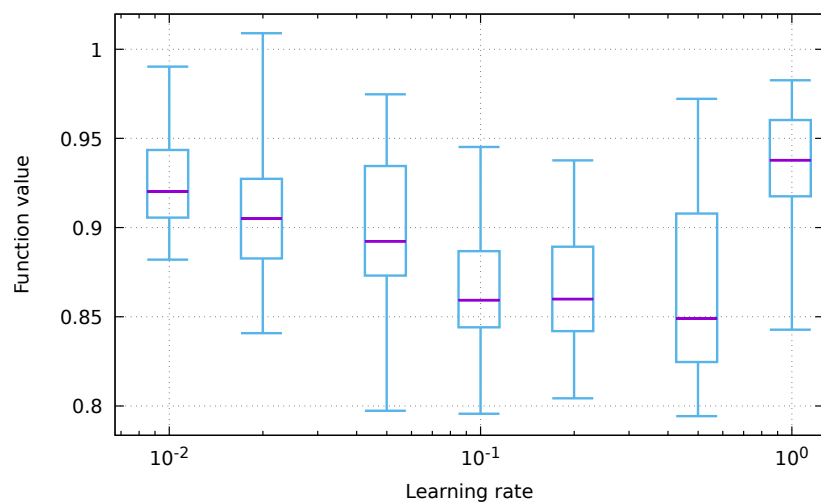
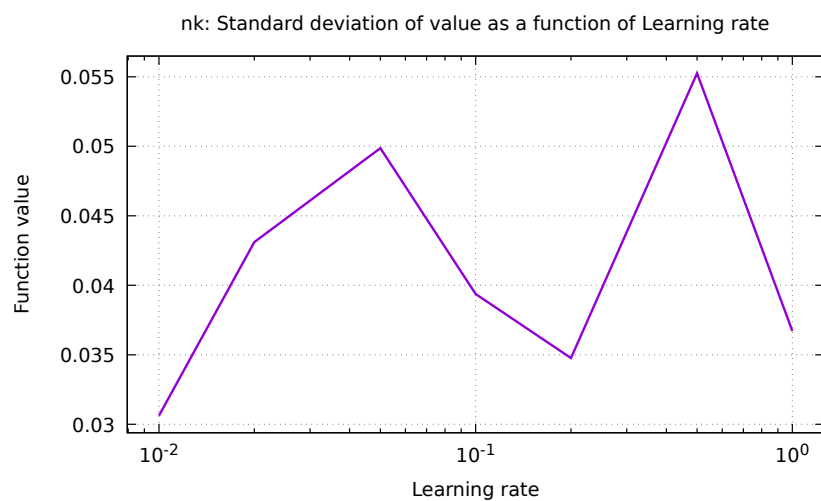
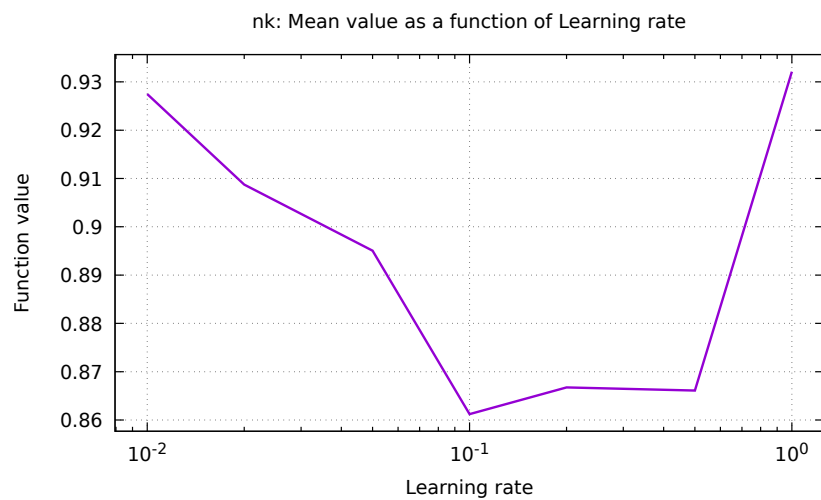
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	100	100	100	100	100
0.02	100	100	100	100	100
0.05	100	100	100	100	100
0.1	95	100	100	100	100
0.2	95	95	95	95	100
0.5	95	95	95	95	95
1	95	95	95	95	95

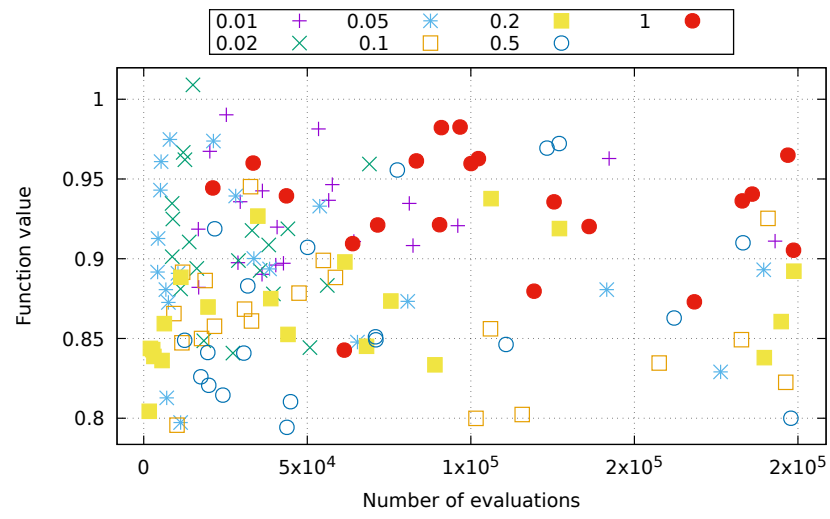




5 Function nk

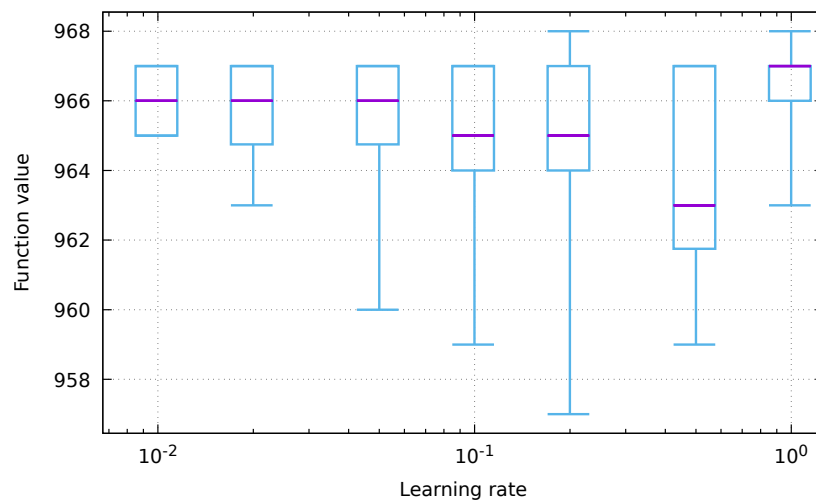
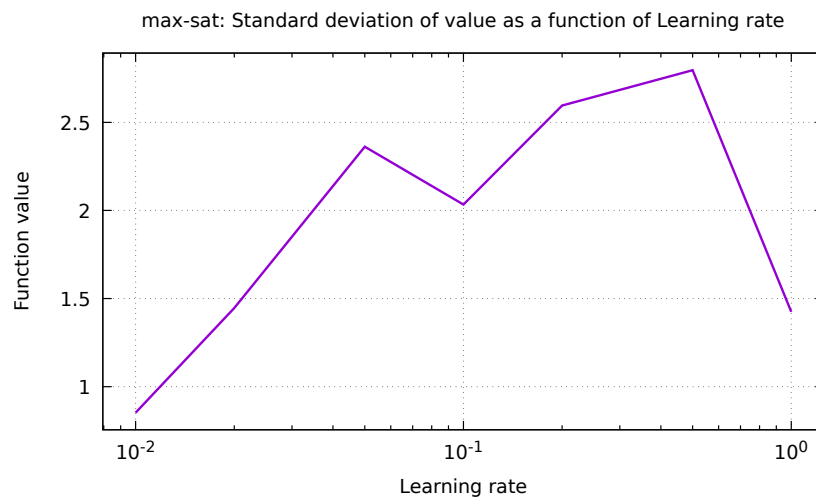
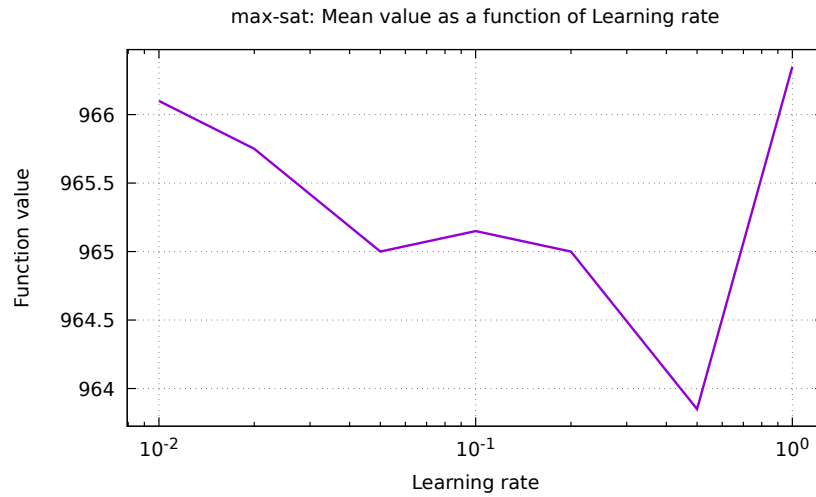
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	0.84	0.92	0.94	0.96	0.98
0.01	0.88	0.91	0.92	0.94	0.99
0.02	0.84	0.88	0.90	0.93	1.01
0.05	0.80	0.87	0.89	0.93	0.97
0.2	0.80	0.84	0.86	0.89	0.94
0.1	0.80	0.84	0.86	0.89	0.95
0.5	0.79	0.82	0.85	0.91	0.97

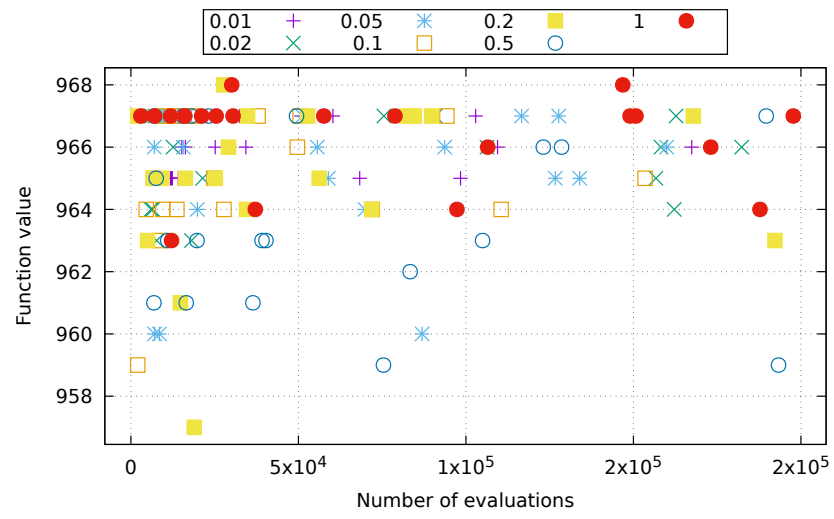




6 Function max-sat

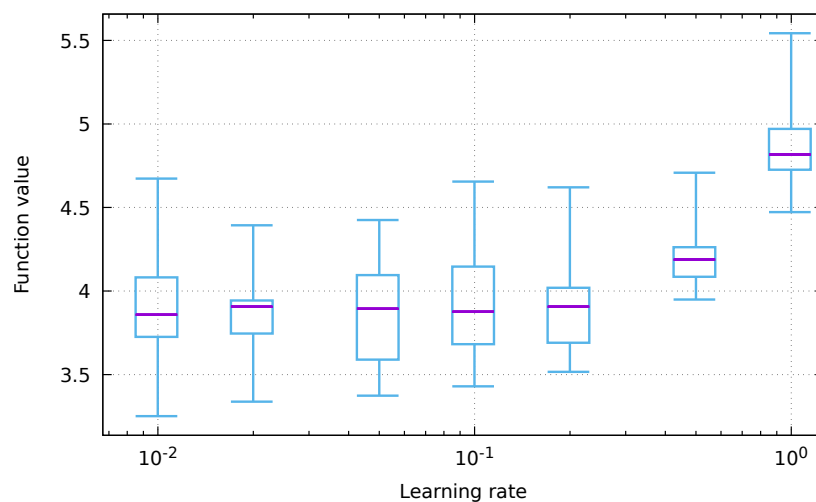
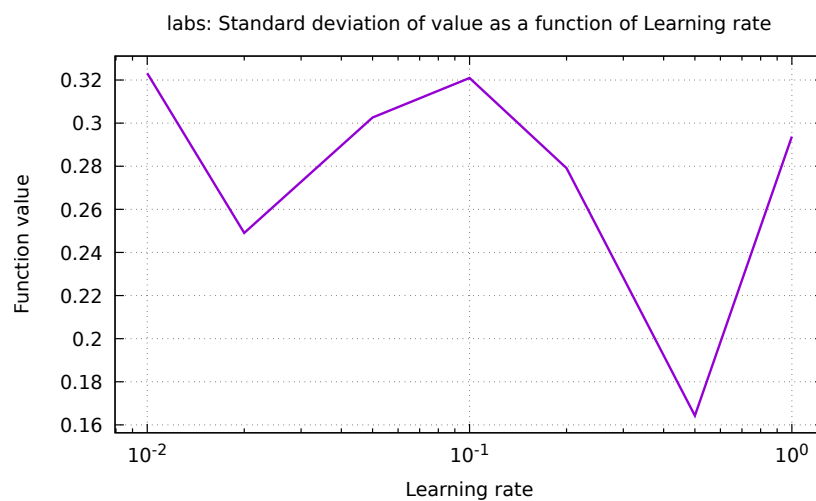
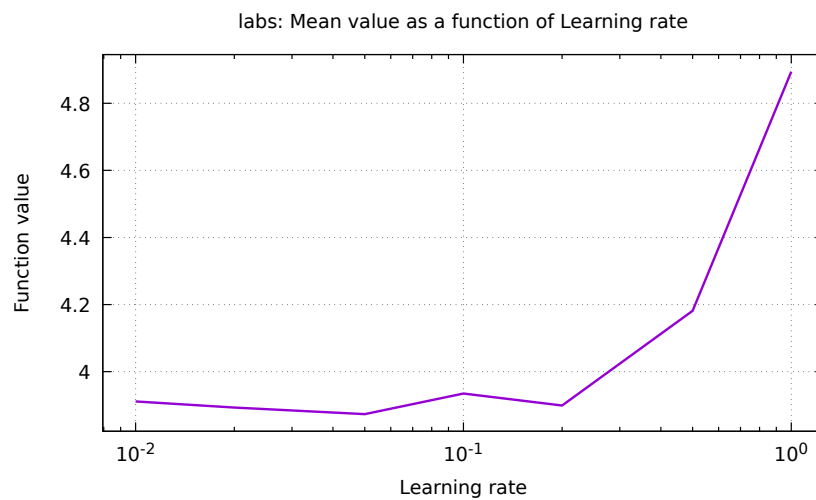
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	963	966	967	967	968
0.01	965	965	966	967	967
0.02	963	965	966	967	967
0.05	960	965	966	967	967
0.2	957	964	965	967	968
0.1	959	964	965	967	967
0.5	959	962	963	967	967

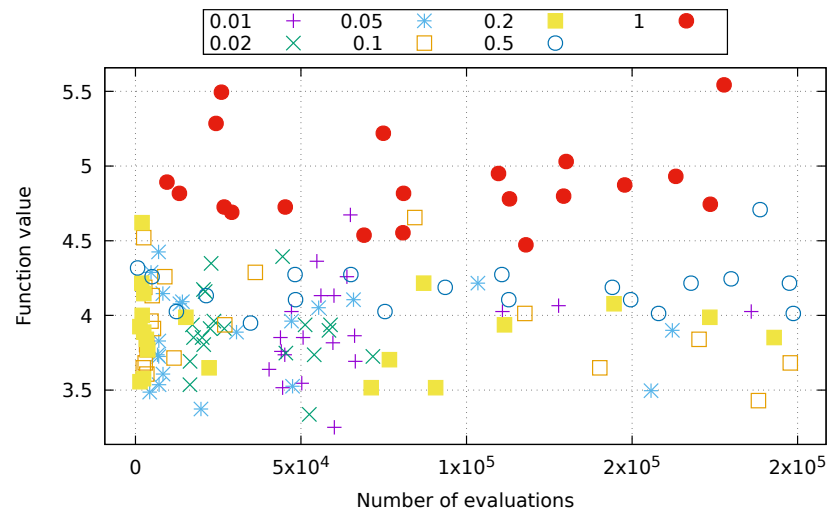




7 Function labs

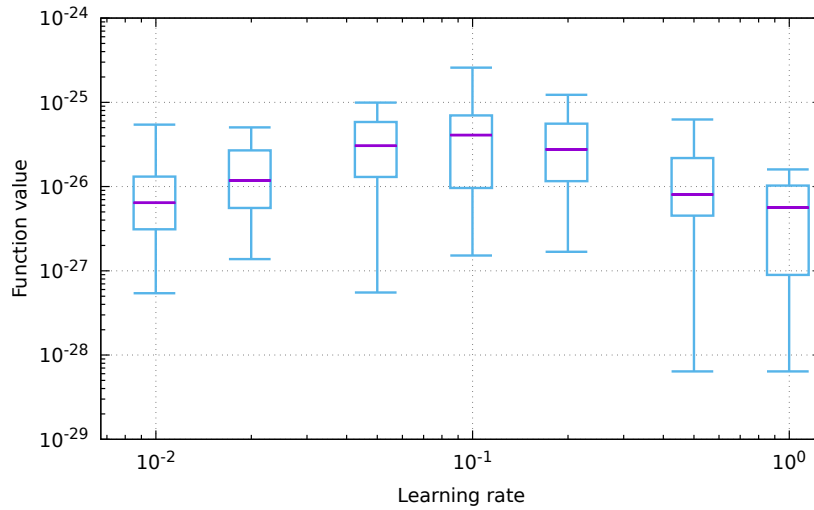
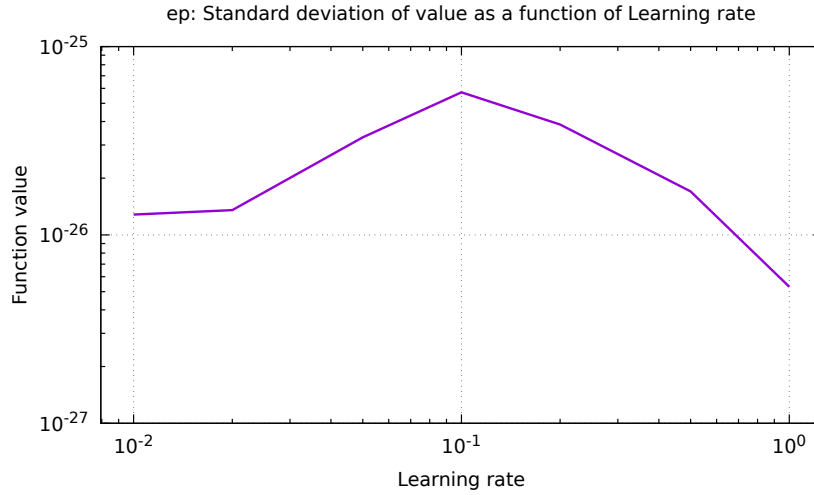
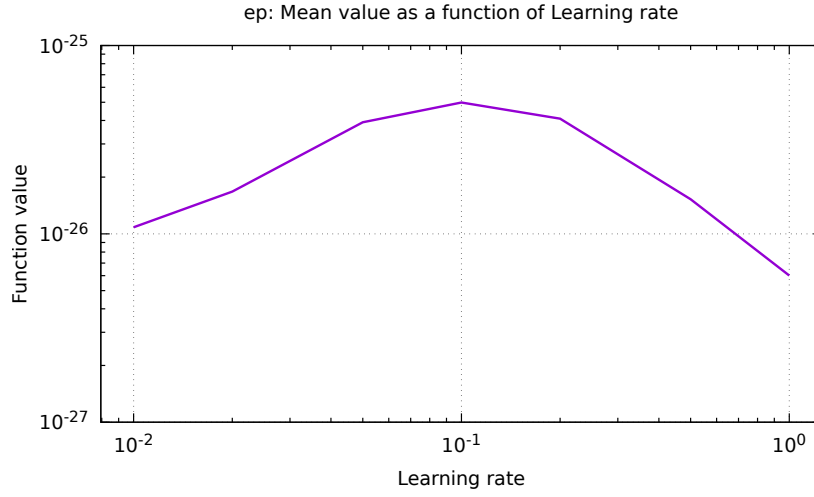
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	4.47	4.73	4.82	4.97	5.54
0.5	3.95	4.09	4.19	4.26	4.71
0.2	3.52	3.69	3.91	4.02	4.62
0.02	3.34	3.75	3.91	3.94	4.39
0.05	3.37	3.59	3.89	4.10	4.42
0.1	3.43	3.68	3.88	4.15	4.66
0.01	3.25	3.73	3.86	4.08	4.67

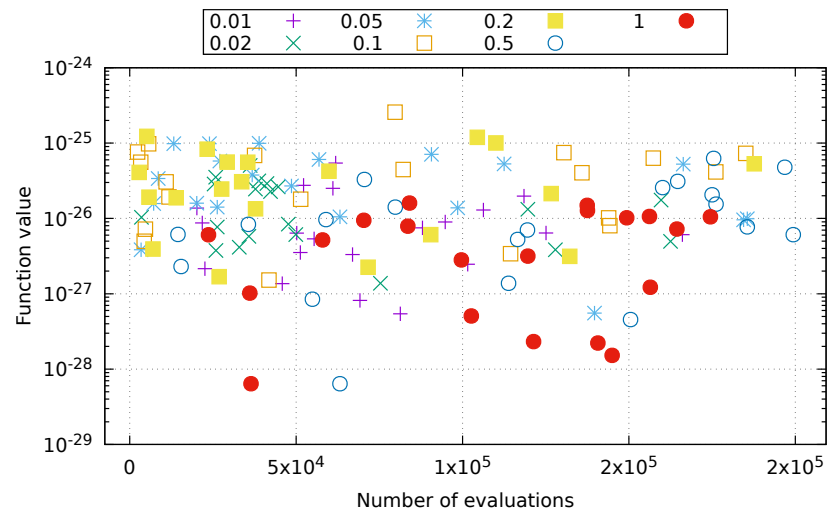




8 Function ep

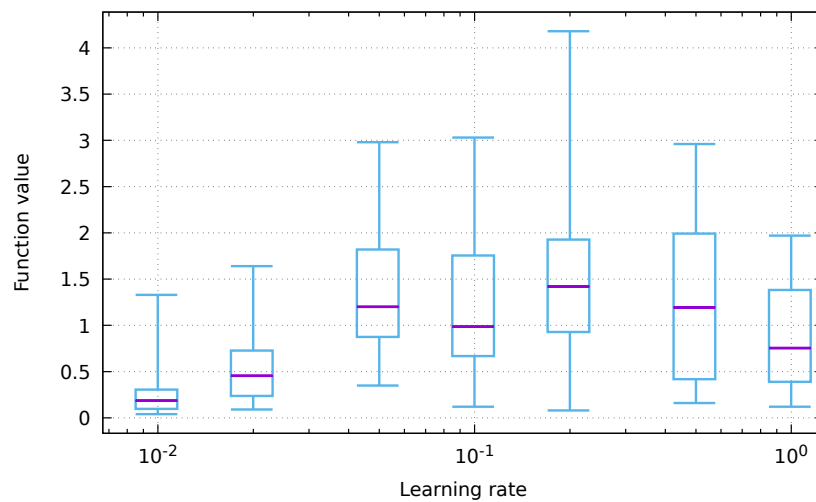
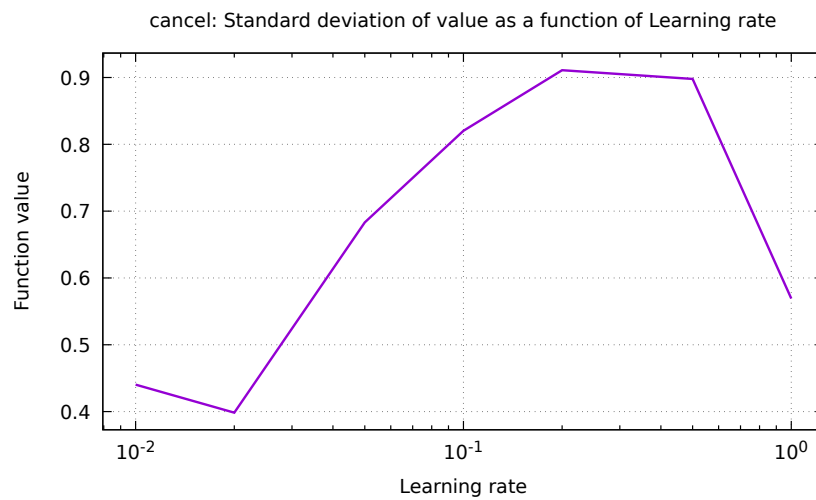
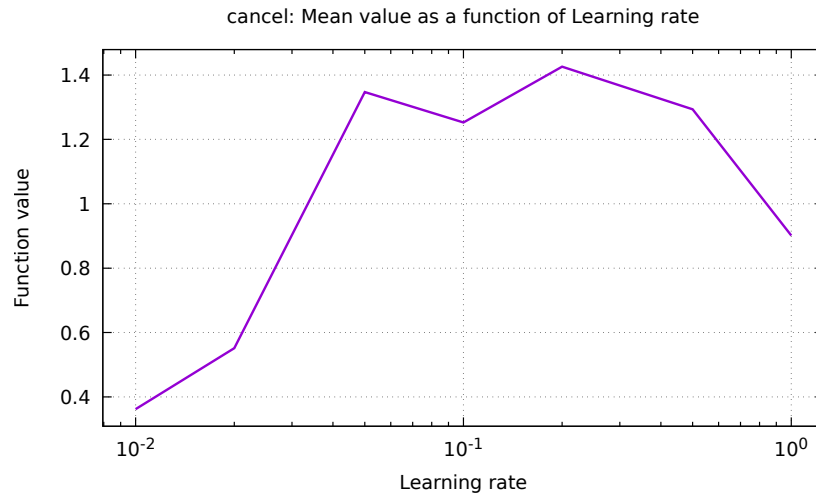
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
1	6.4×10^{-29}	8.9×10^{-28}	5.6×10^{-27}	1.0×10^{-26}	1.6×10^{-26}
0.01	5.4×10^{-28}	3.1×10^{-27}	6.4×10^{-27}	1.3×10^{-26}	5.4×10^{-26}
0.5	6.4×10^{-29}	4.5×10^{-27}	8.0×10^{-27}	2.2×10^{-26}	6.3×10^{-26}
0.02	1.4×10^{-27}	5.6×10^{-27}	1.2×10^{-26}	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}

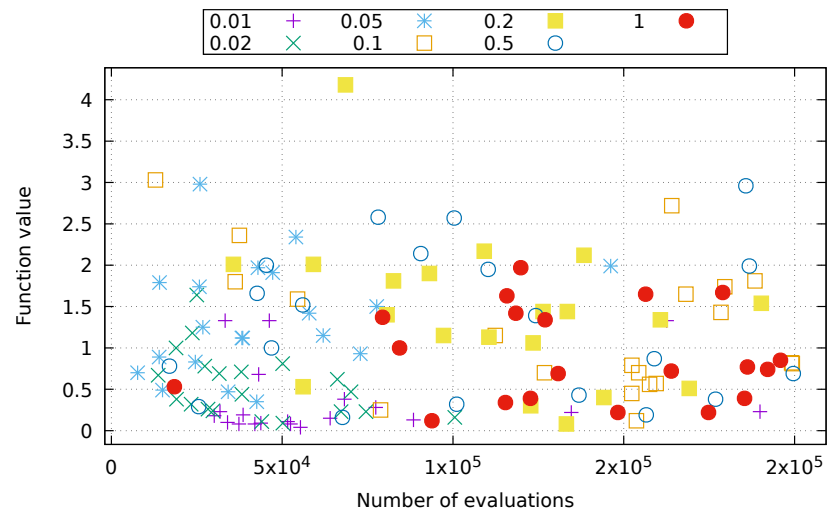




9 Function cancel

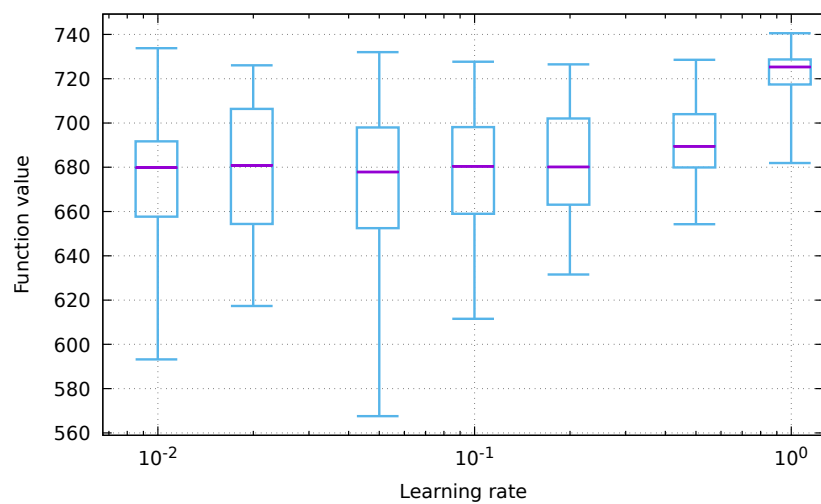
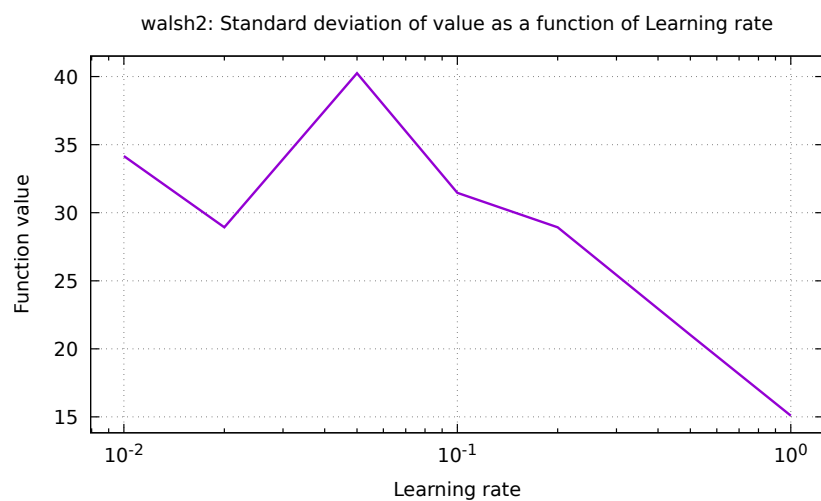
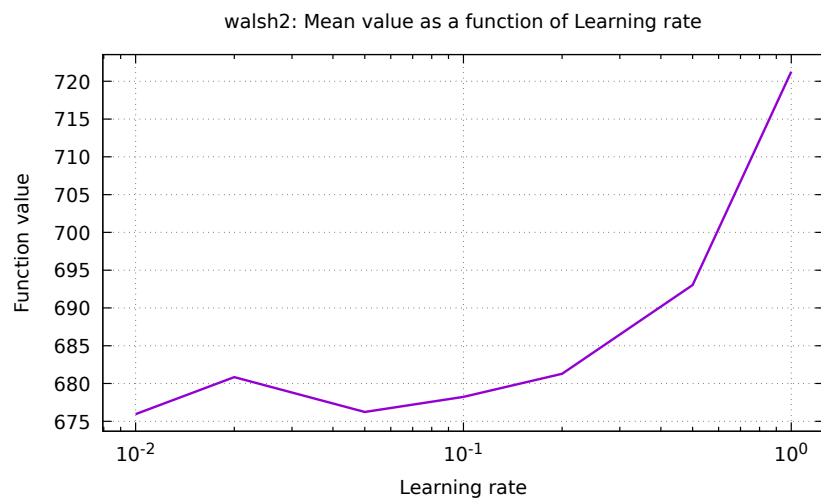
Learning rate	Function value				
	min	Q_1	med.	Q_3	max
0.01	0.04	0.10	0.19	0.31	1.33
0.02	0.09	0.24	0.46	0.73	1.64
1	0.12	0.39	0.76	1.38	1.97
0.1	0.12	0.67	0.99	1.76	3.03
0.5	0.16	0.42	1.20	1.99	2.96
0.05	0.35	0.88	1.20	1.82	2.98
0.2	0.08	0.93	1.42	1.93	4.18

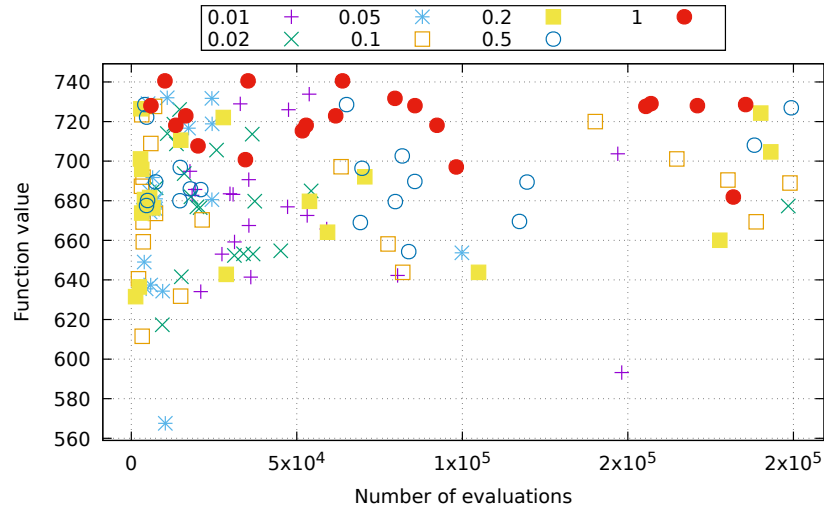




10 Function walsh2

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

```