# HNCO
# Visualization of Walsh transforms of various functions defined on bit vectors

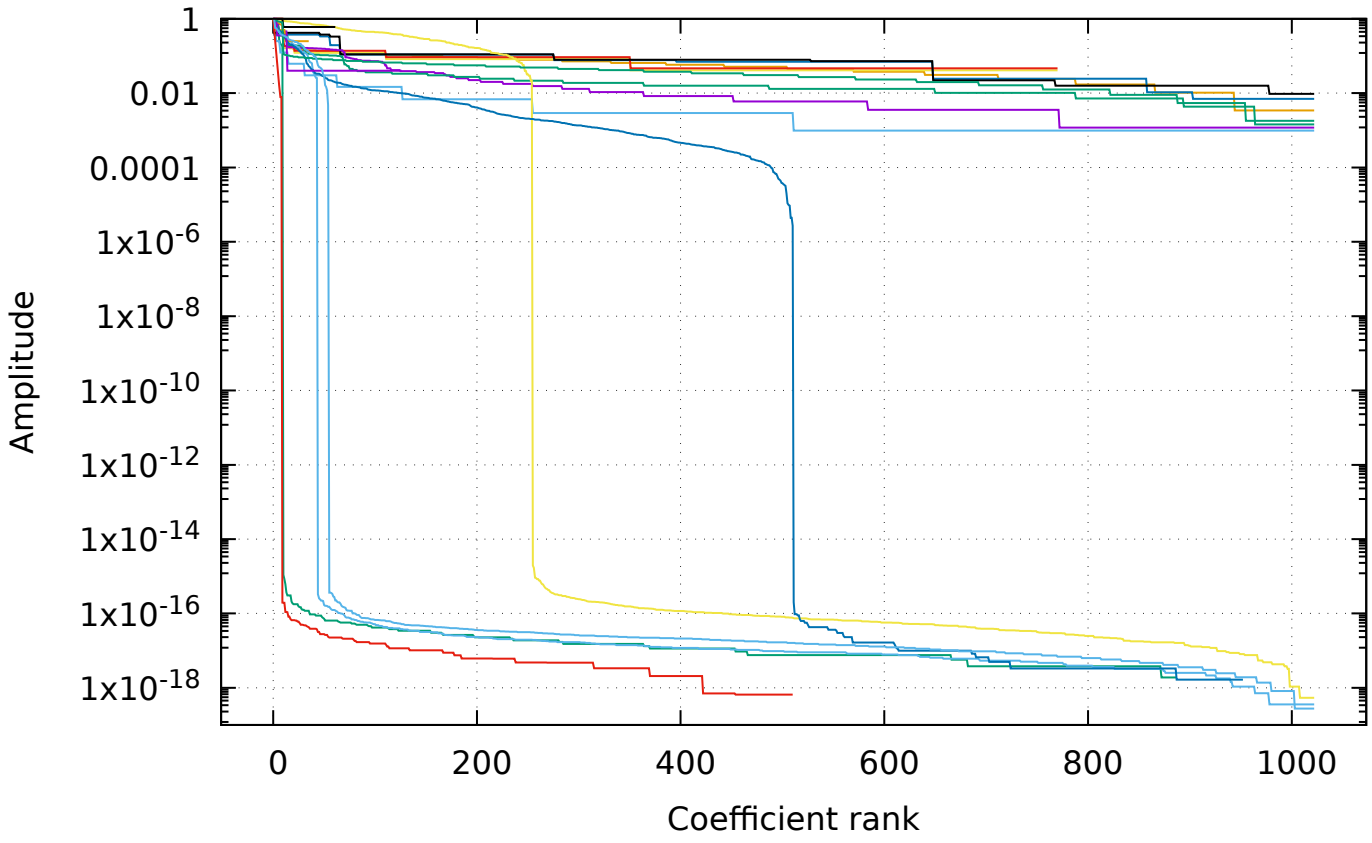
July 1, 2018

**Abstract**

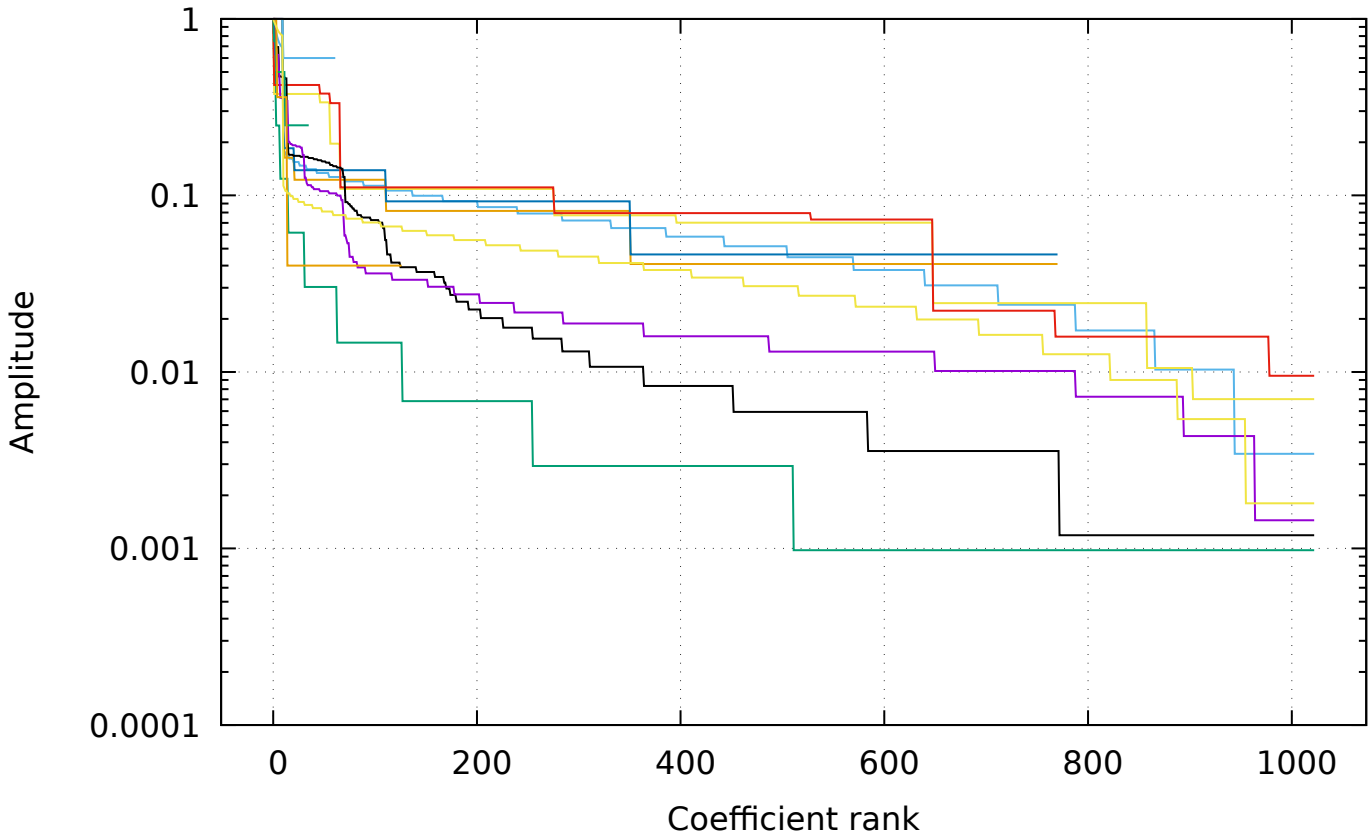
This document proposes to visualize Walsh (or Fourier) transforms of various functions defined on bit vectors (hypercube) of size $n = 10$. For each function, two graphics are displayed. In the first one, coefficients of the Walsh transform are sorted in decreasing order of amplitude and normalized relatively to the greatest amplitude. In particular, we are interested in how fast coefficient amplitudes decrease. The second graphics displays the energy (sum of square of coefficients) as a function of the order (or Hamming weight) of features. This can be thought of as a spectrum.

## Contents

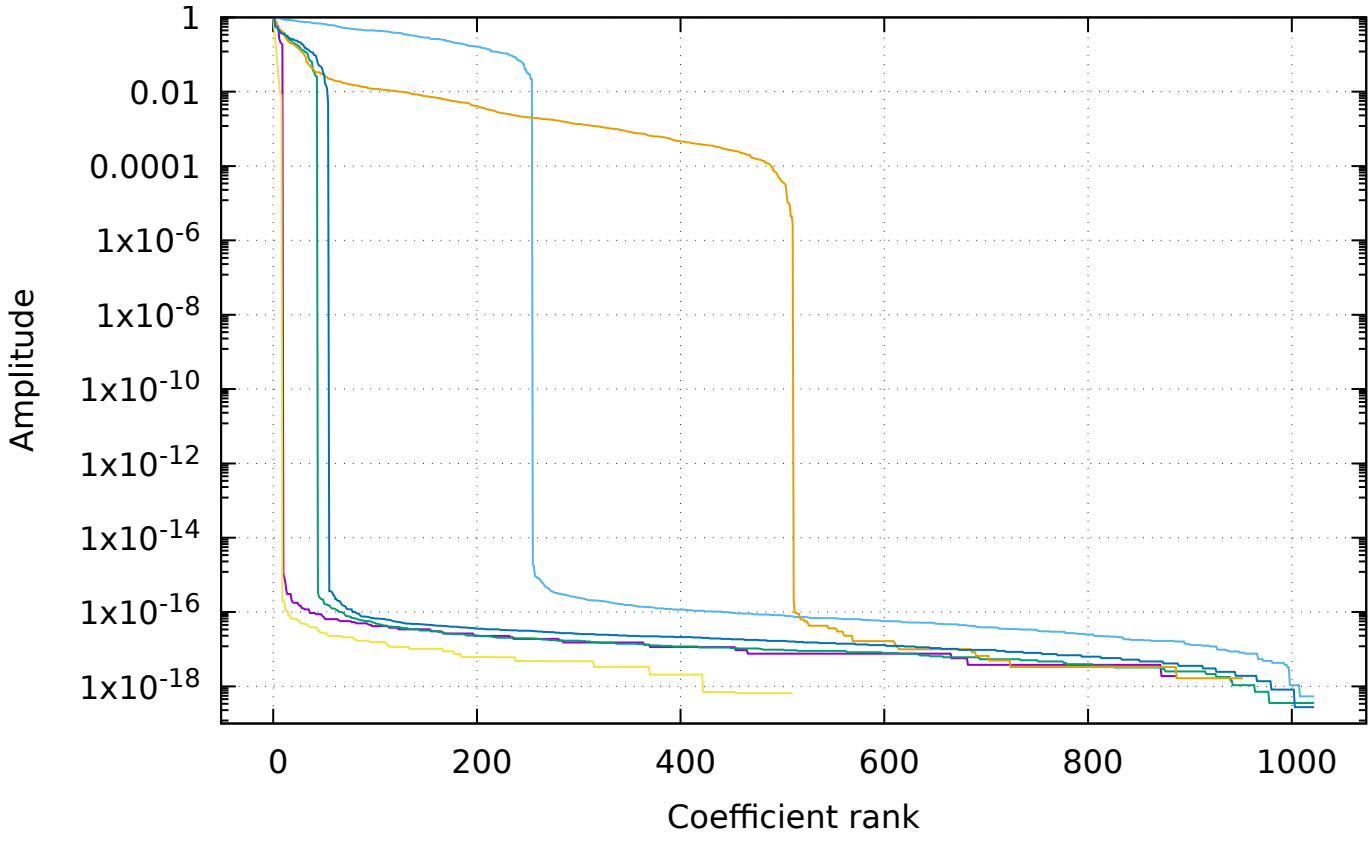
# 1 All functions



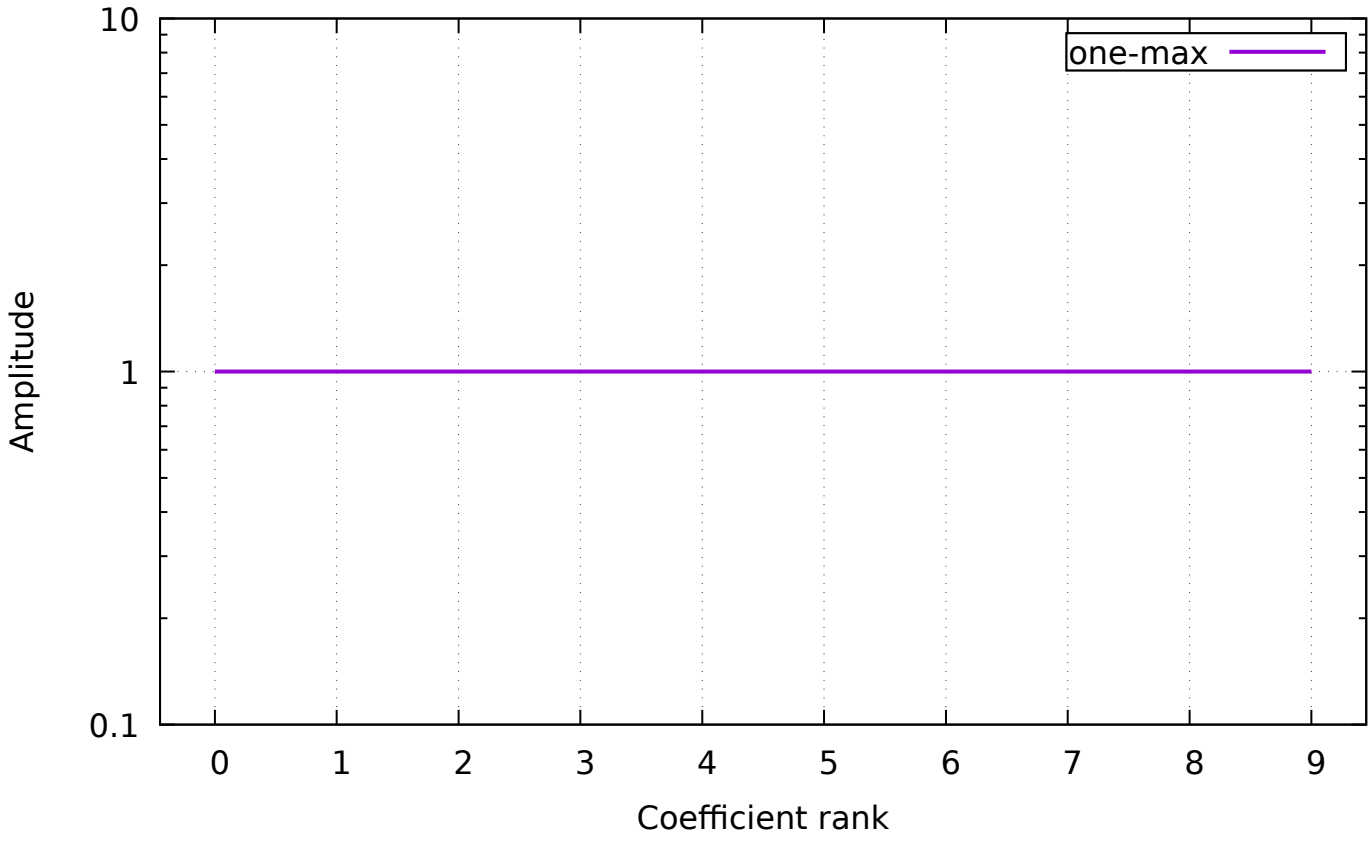
## 2 group1




## 3 group2



# 4 one-max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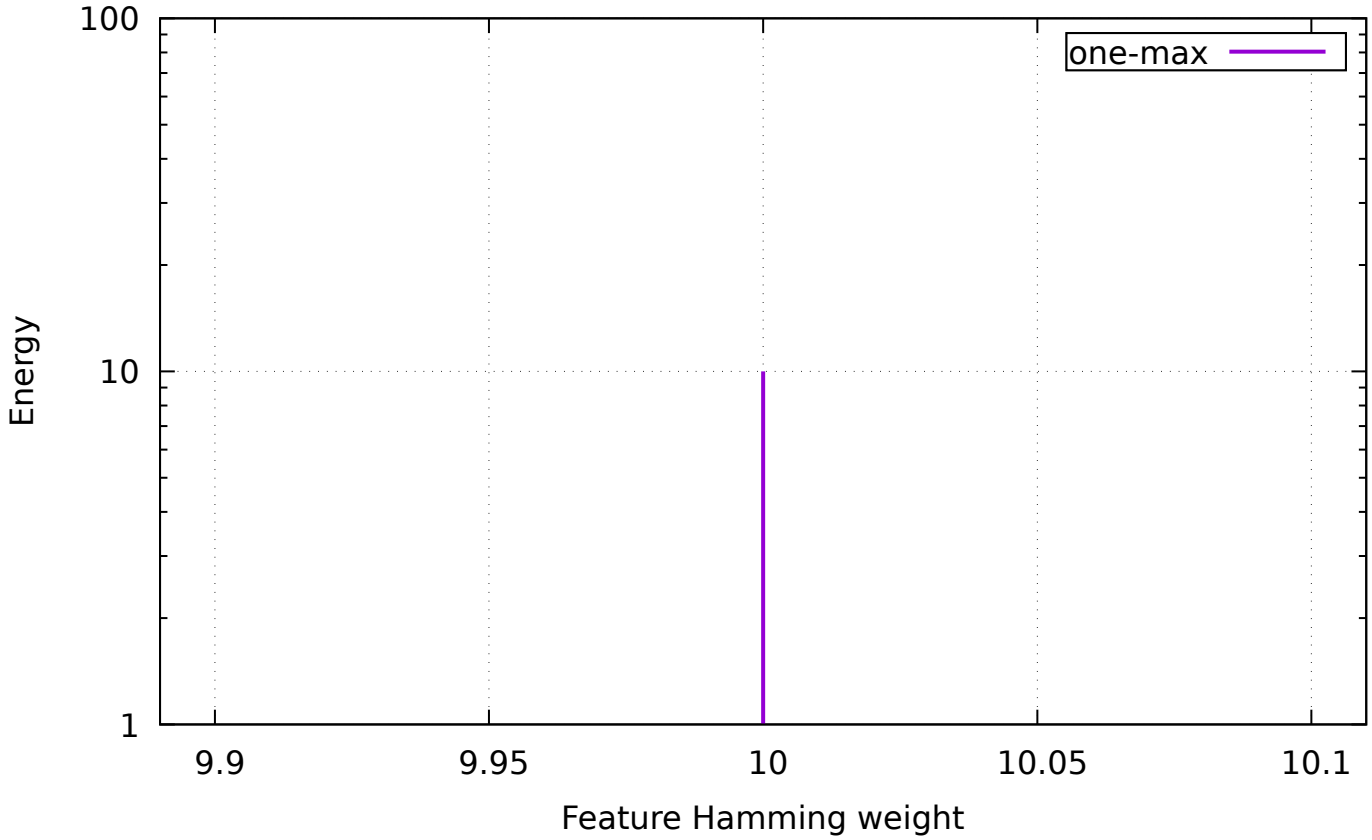
0.1
Amplitude
0
1
2
3
4
5
6
7
8
9
Coefficient rank


one-max
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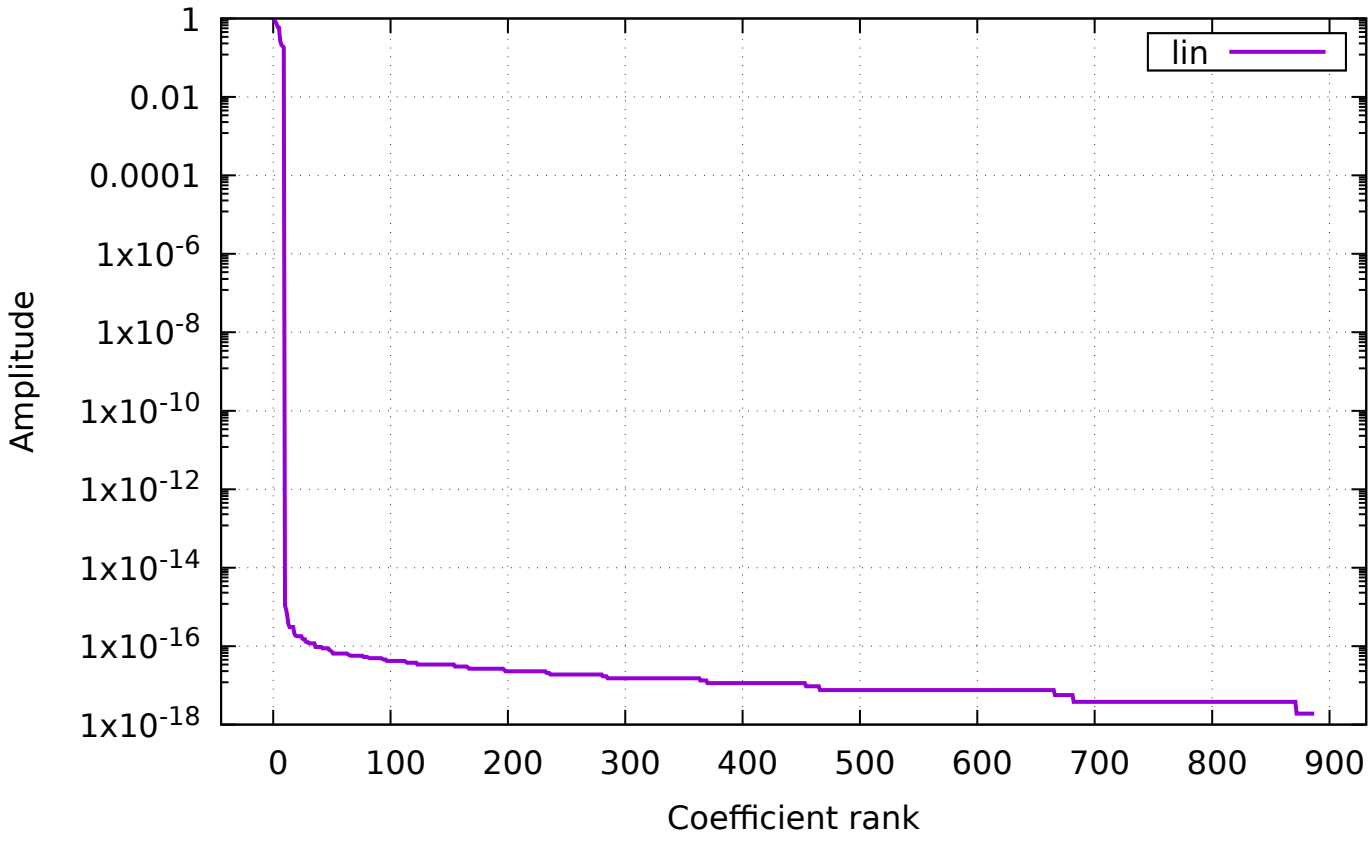
10
1
Energy
9.9
9.95
10
10.05
10.1
Feature Hamming weight

## 5 lin


lin
Amplitude
Coefficient rank
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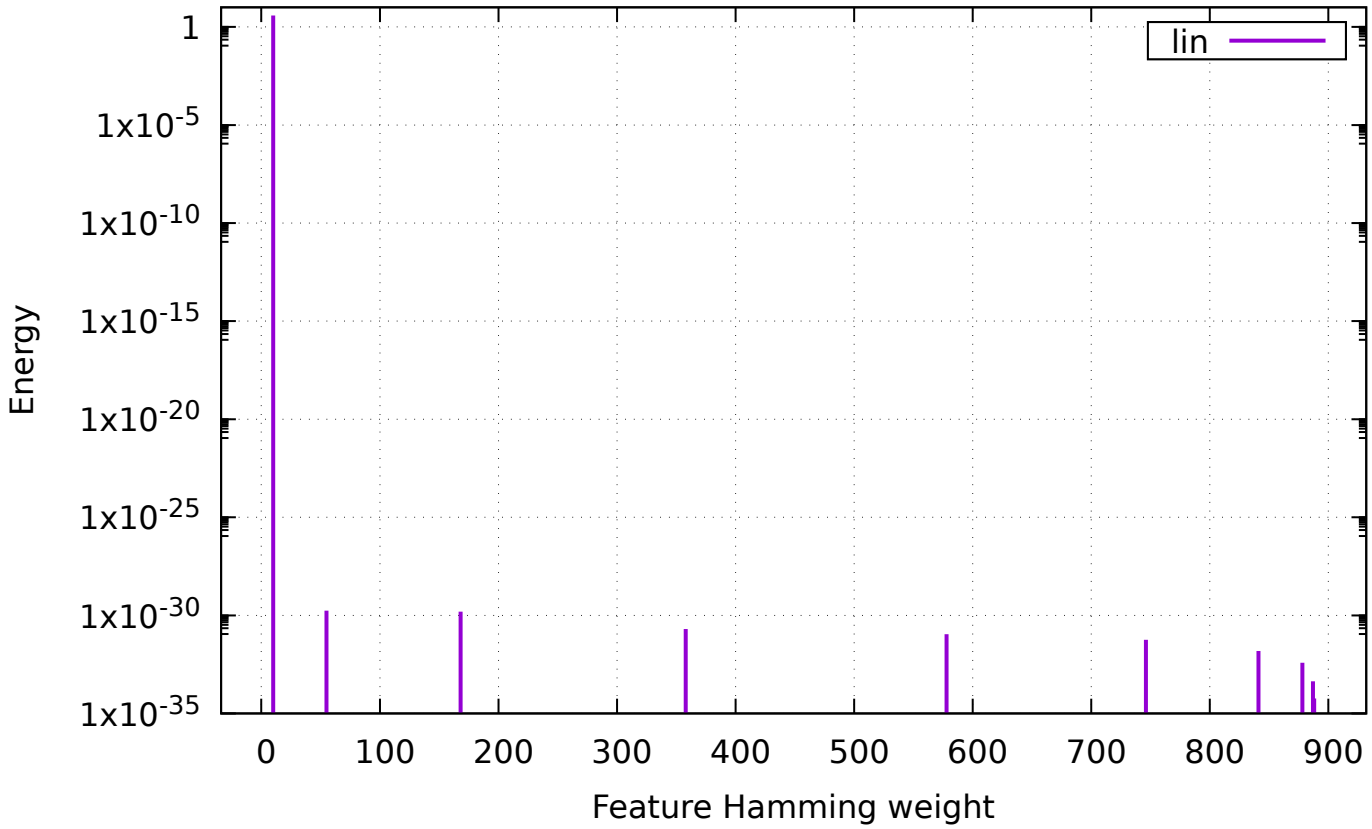
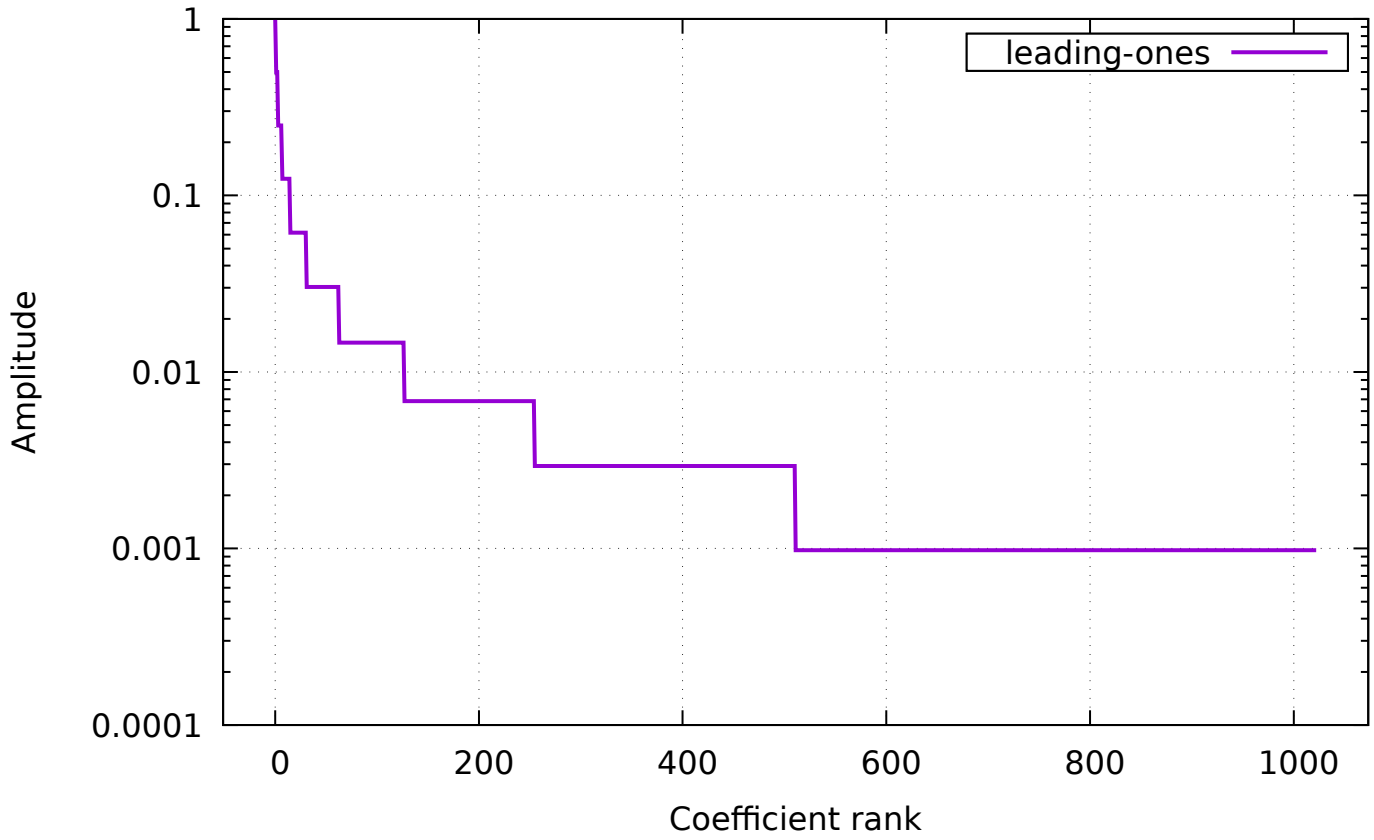
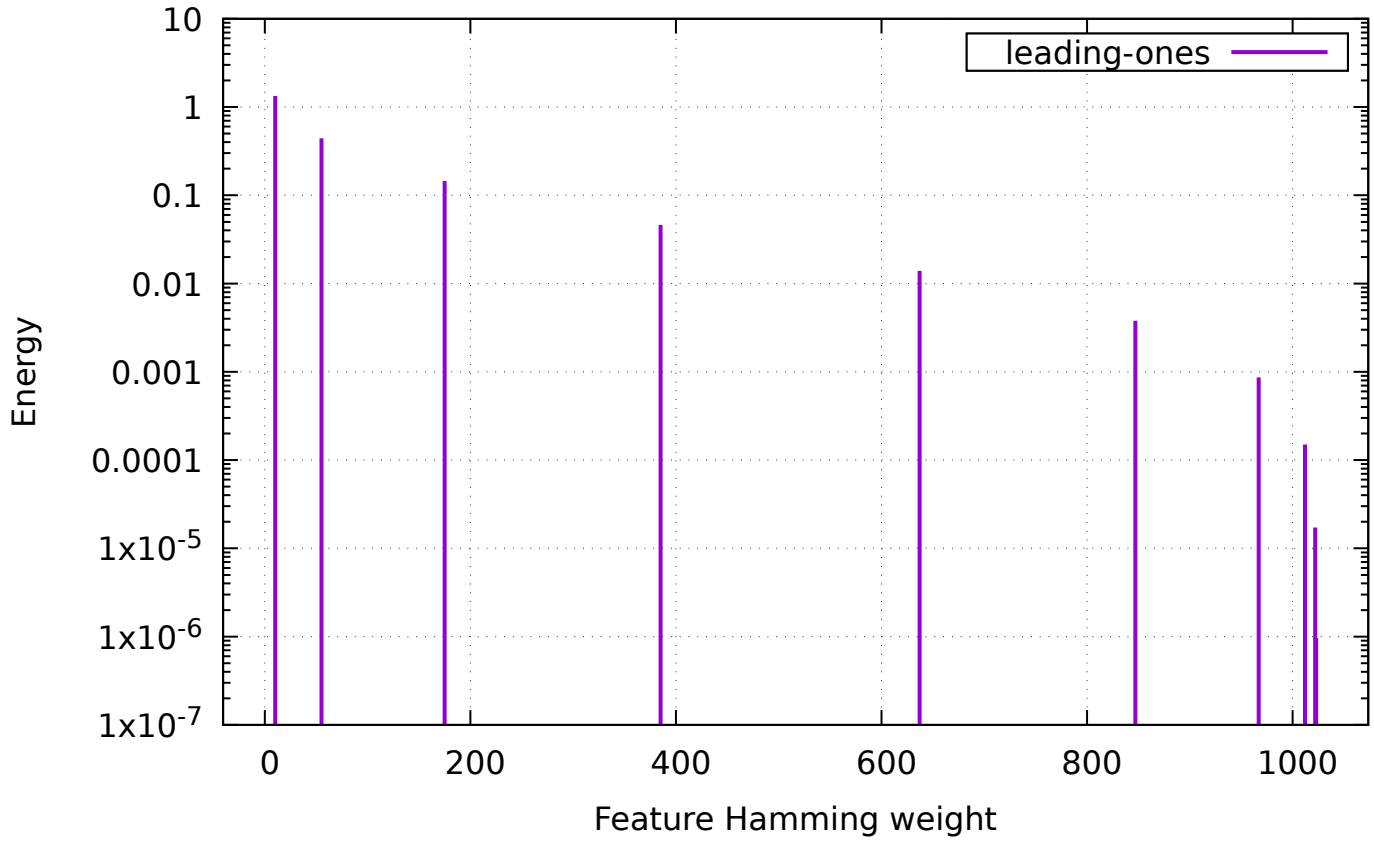
0.01
0.0001
1x10-6
1x10-8
1x10-10
1x10-12
1x10-14
1x10-16
1x10-18
0
100
200
300
400
500
600
700
800
900

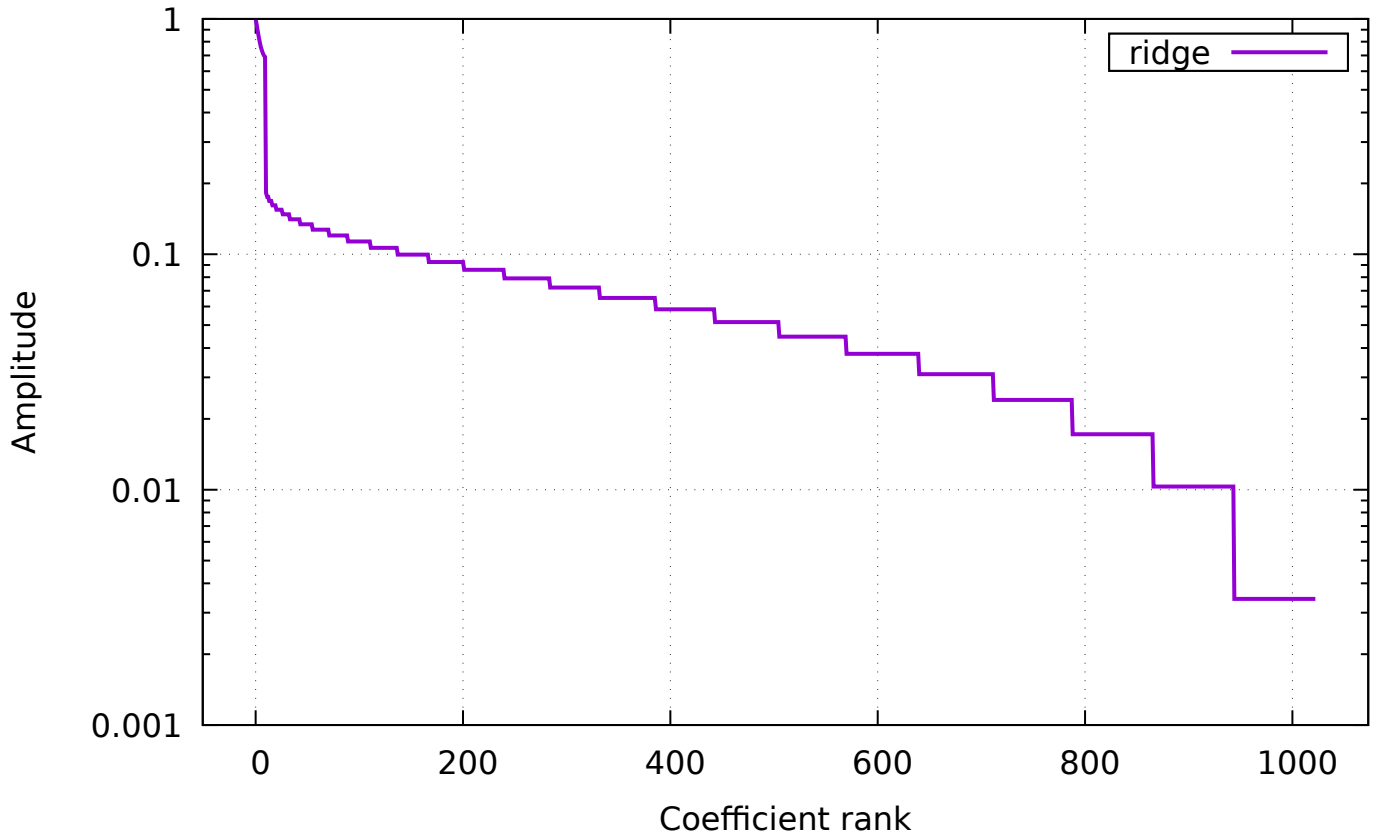

lin
Energy
Feature Hamming weight
1
1x10-5
1x10-10
1x10-15
1x10-20
1x10-25
1x10-30
1x10-35
0
100
200
300
400
500
600
700
800
900

## 6 leading-ones



## 7 ridge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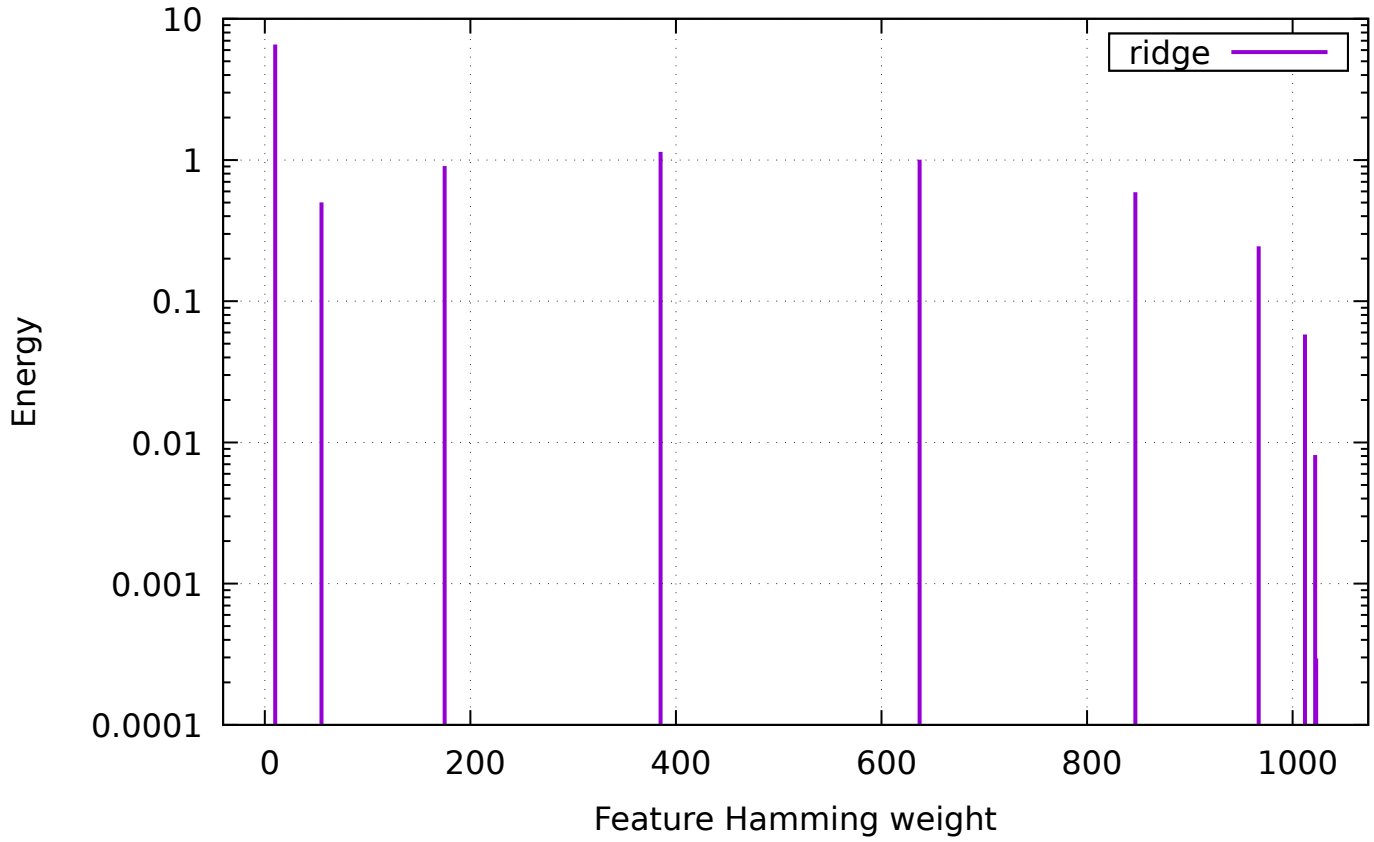
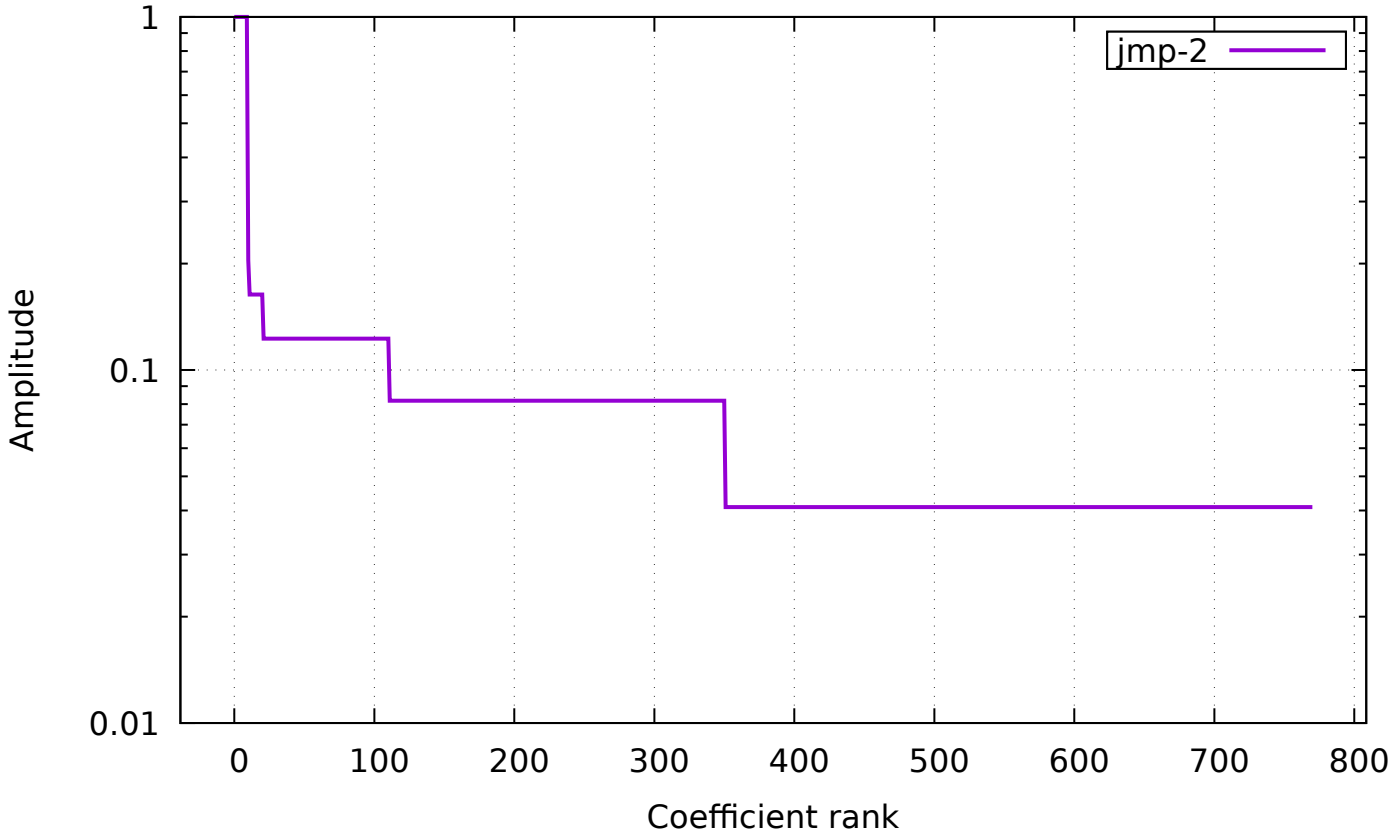
Amplitude
Coefficient rank
1
0.1
0.01
0.001
0
200
400
600
800
1000


ridge
Energy
Feature Hamming weight
10
1
0.1
0.01
0.001
0.0001
0
200
400
600
800
1000

## 8 jmp-2


jmp-2
Amplitude
Coefficient rank
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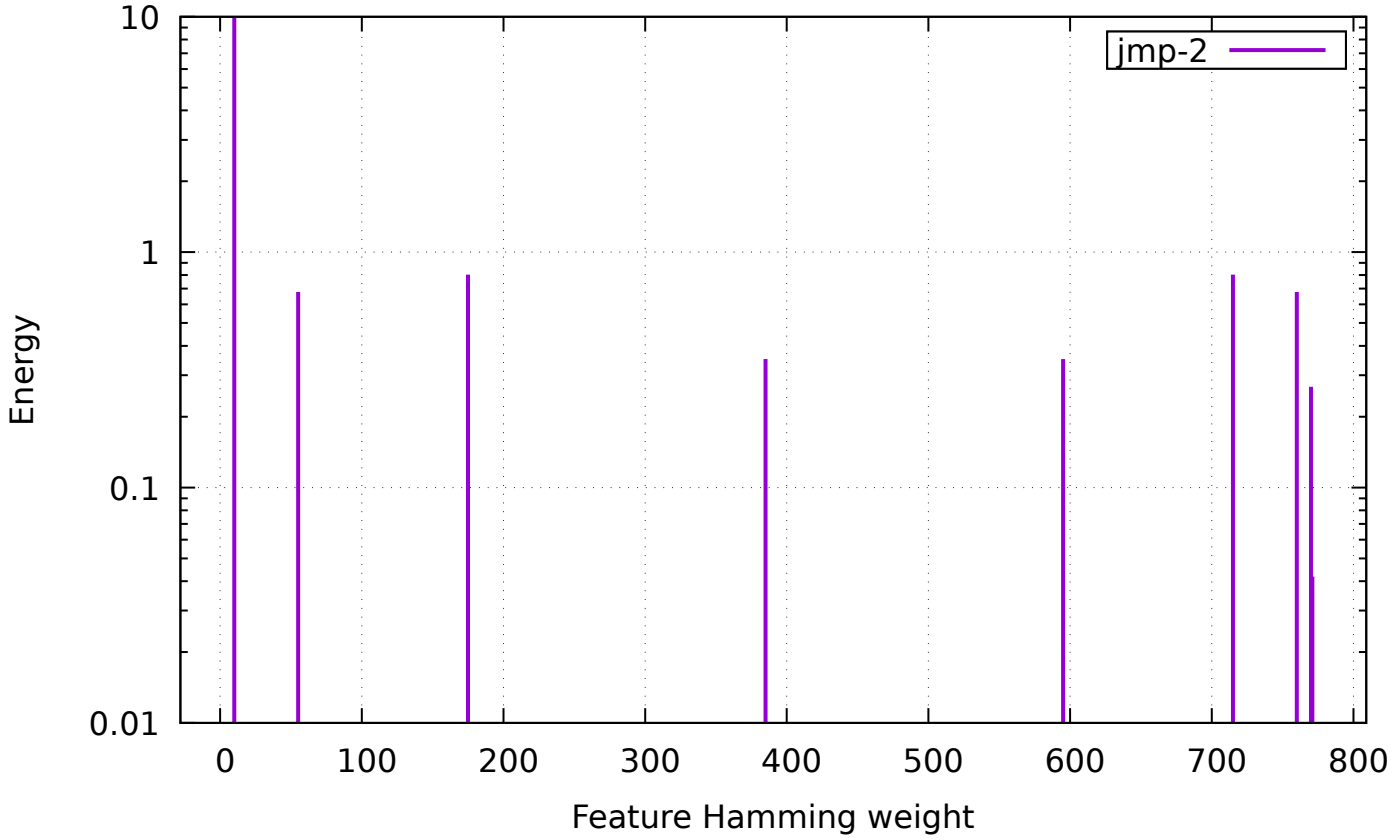
0.1
0.01
0
100
200
300
400
500
600
700
800


jmp-2
Energy
Feature Hamming weight
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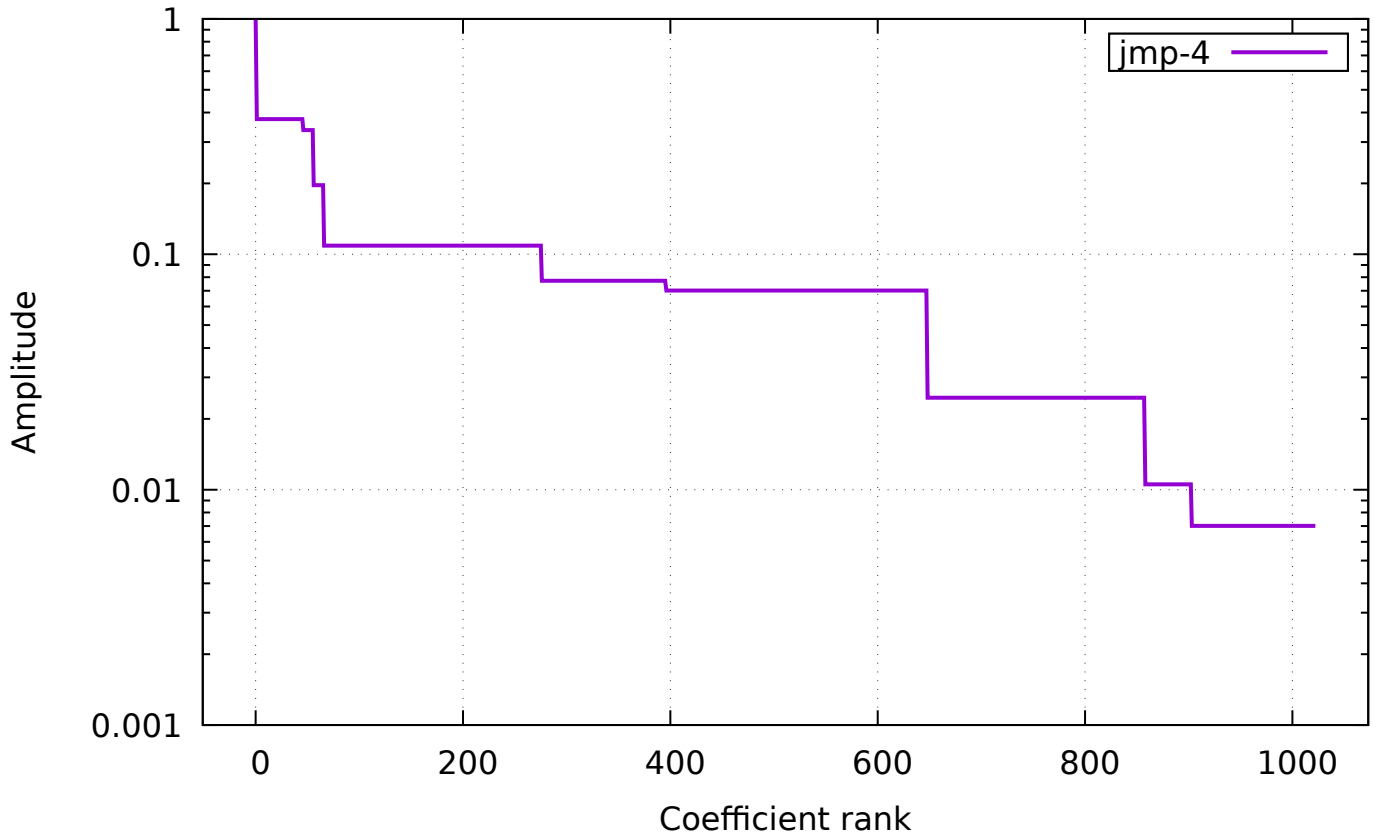
1
0.1
0.01
0
100
200
300
400
500
600
700
800

## 9 jmp-4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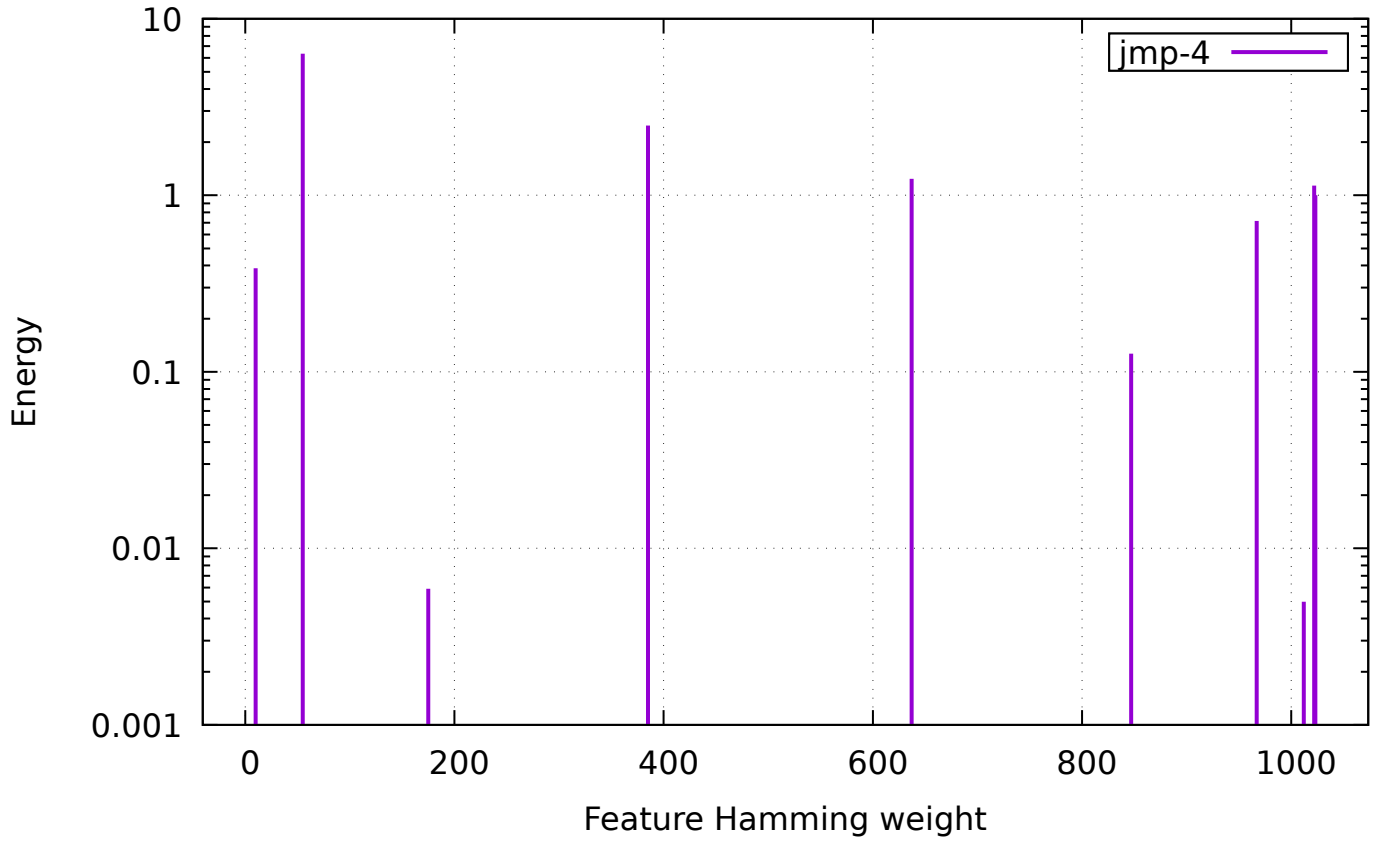
Amplitude
Coefficient rank
1
0.1
0.01
0.001
0
200
400
600
800
1000


jmp-4
Energy
Feature Hamming weight
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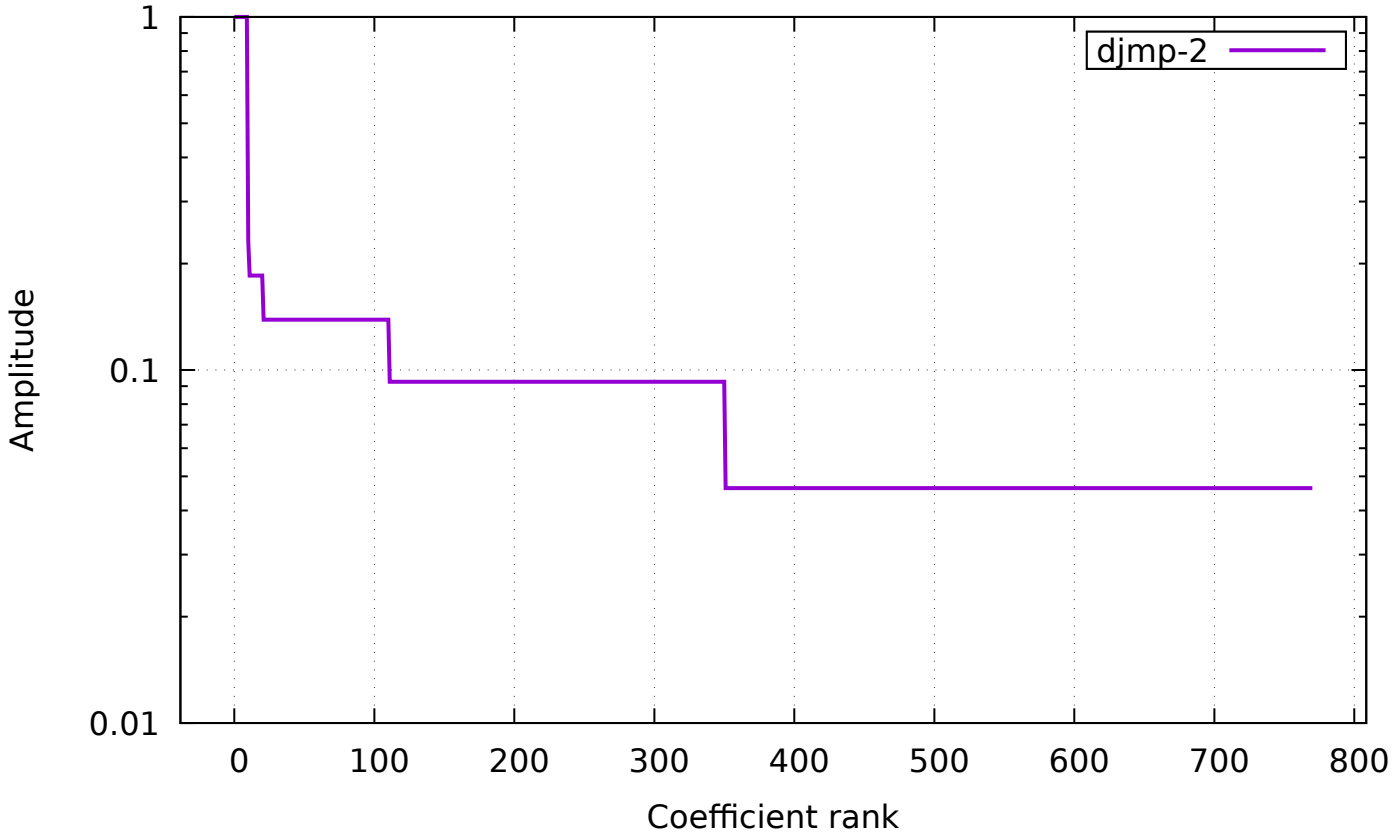
0.1
0.01
0.001
0
200
400
600
800
1000

## 10 djmp-2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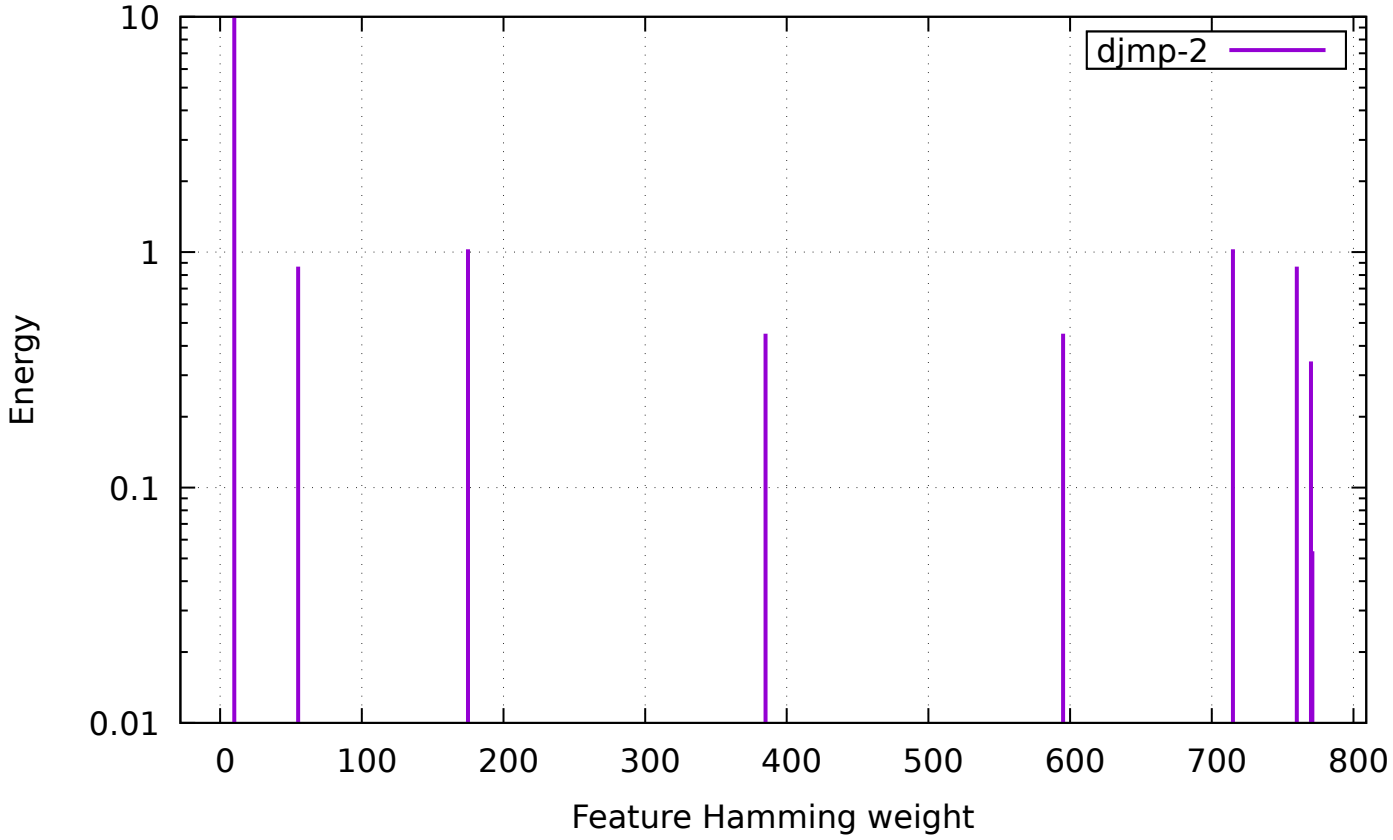
0.1
0.01
0
100
200
300
400
500
600
700
800
Coefficient rank


djmp-2
Energy
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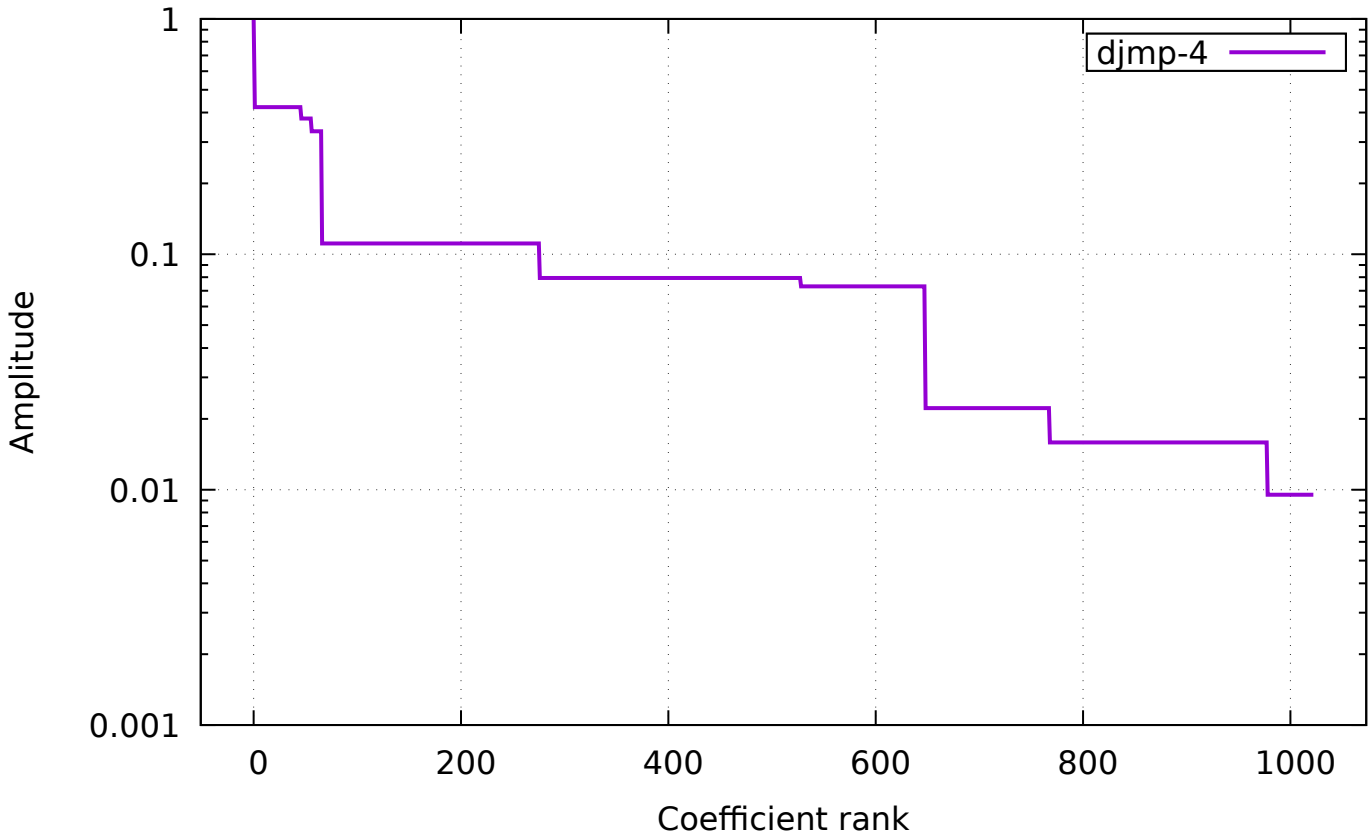
1
0.1
0.01
0
100
200
300
400
500
600
700
800
Feature Hamming weight

## 11 djmp-4


djmp-4
Amplitude
Coefficient rank
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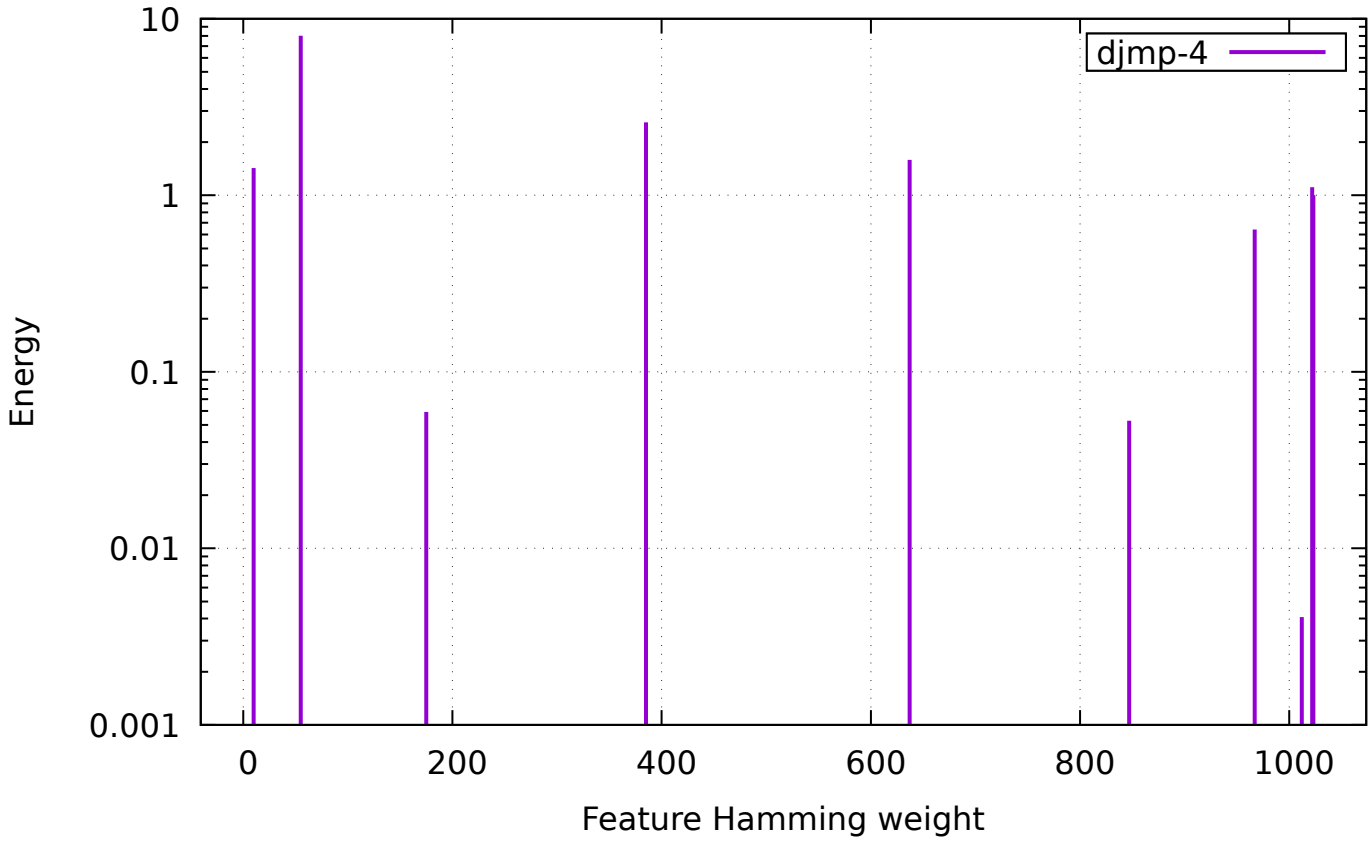
0.1
0.01
0.001
0
200
400
600
800
1000


djmp-4
Energy
Feature Hamming weight
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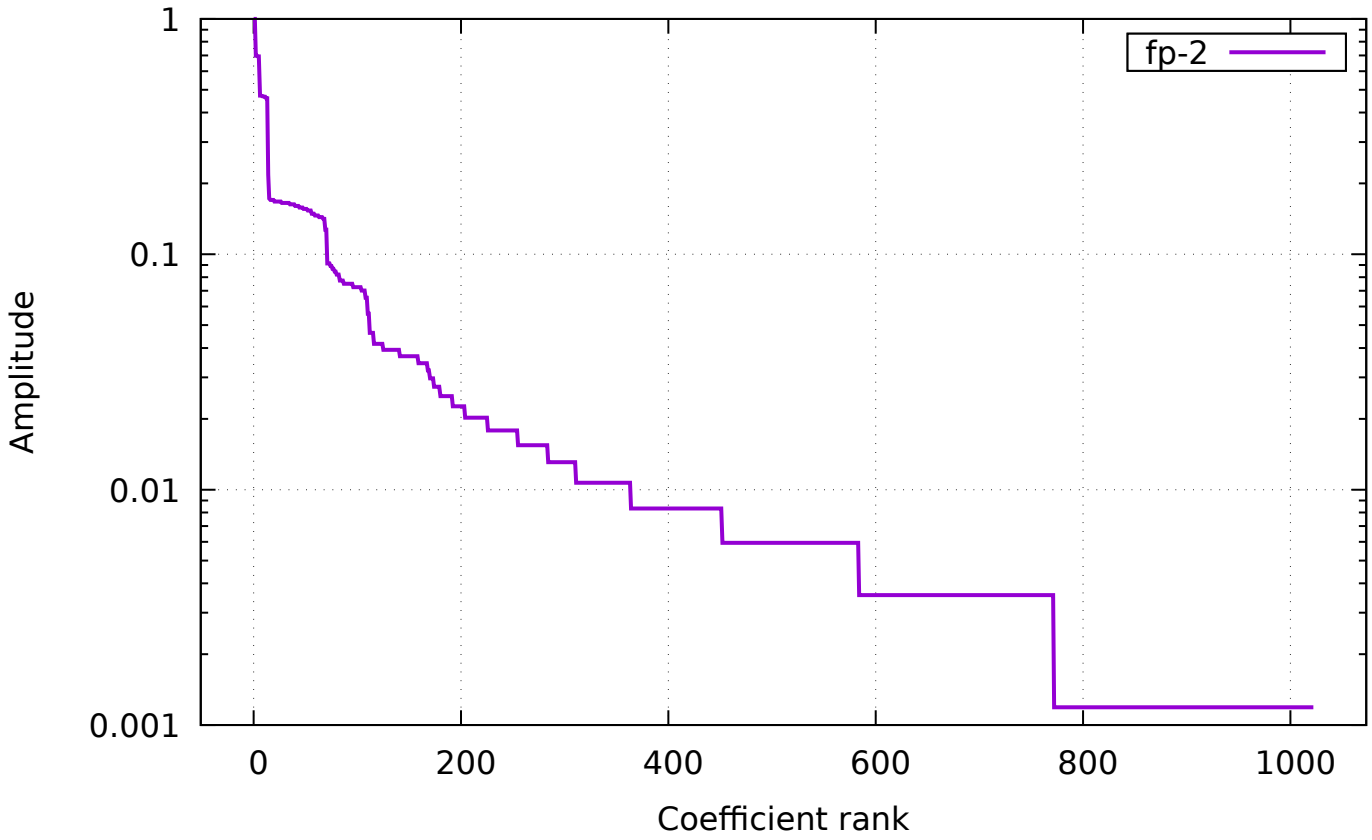
0.1
0.01
0.001
0
200
400
600
800
1000

## 12 fp-2


fp-2
Amplitude
Coefficient rank
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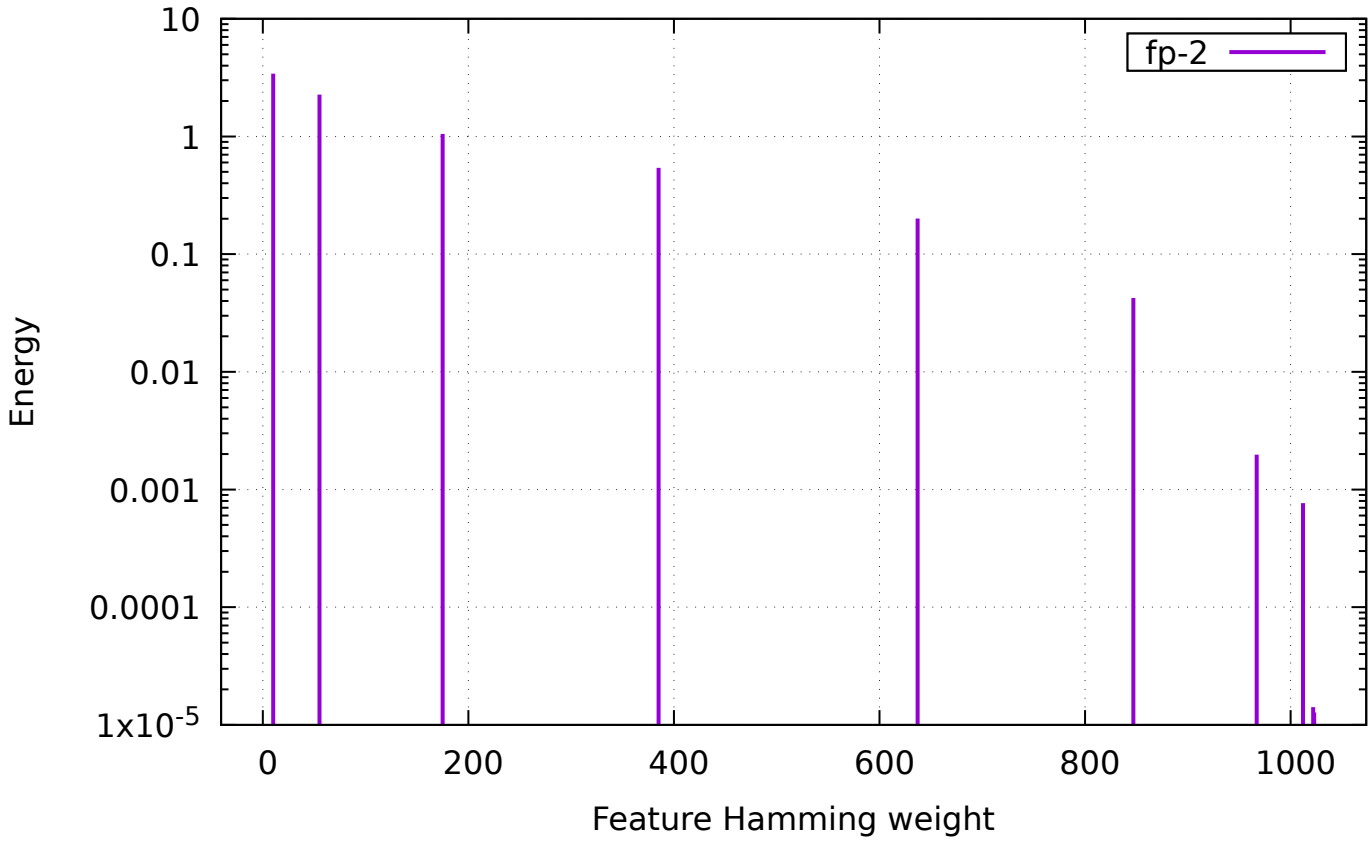
0.1
0.01
0.001
0
200
400
600
800
1000


fp-2
Energy
Feature Hamming weight
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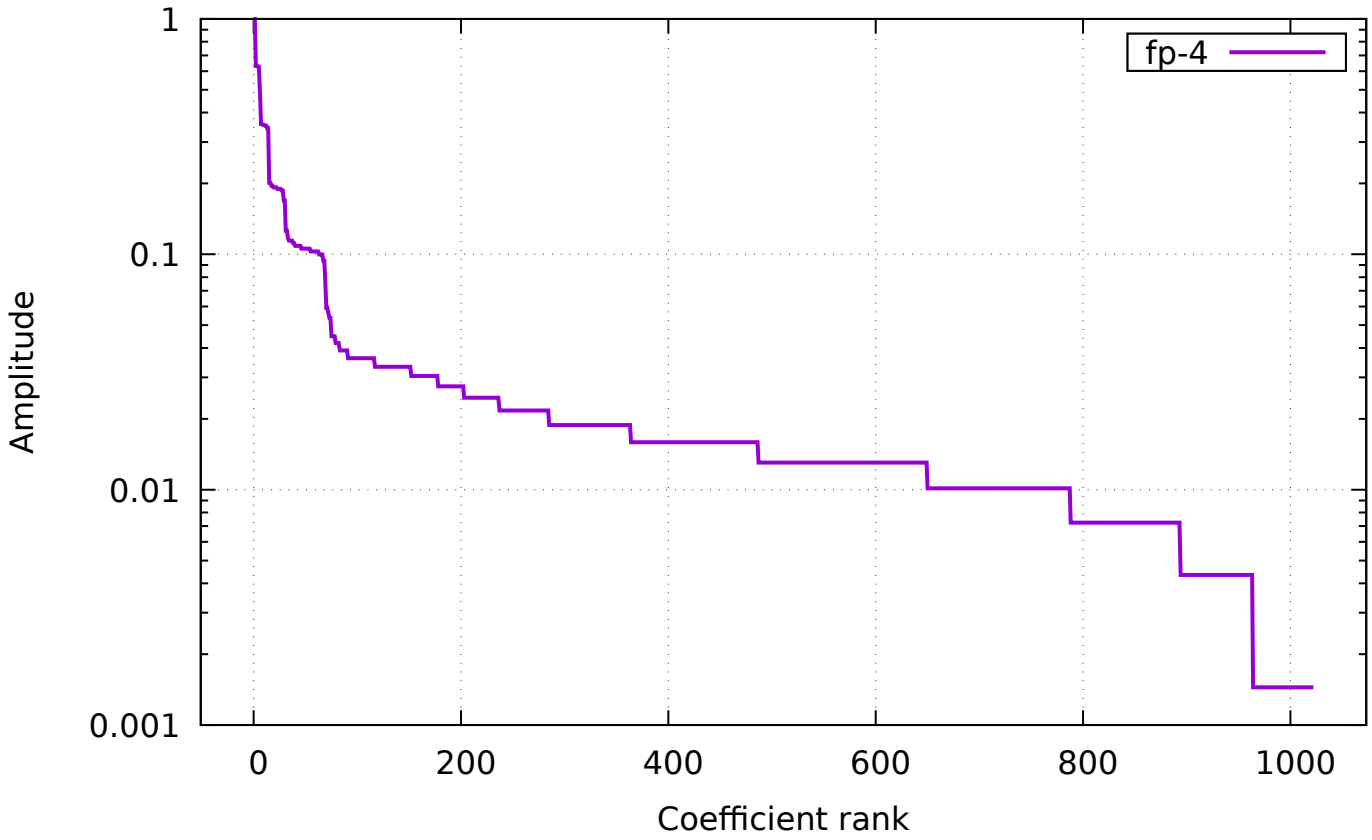
0.1
0.01
0.001
0.0001
1x10-5
0
200
400
600
800
1000

## 13 fp-4


fp-4
Amplitude
Coefficient rank
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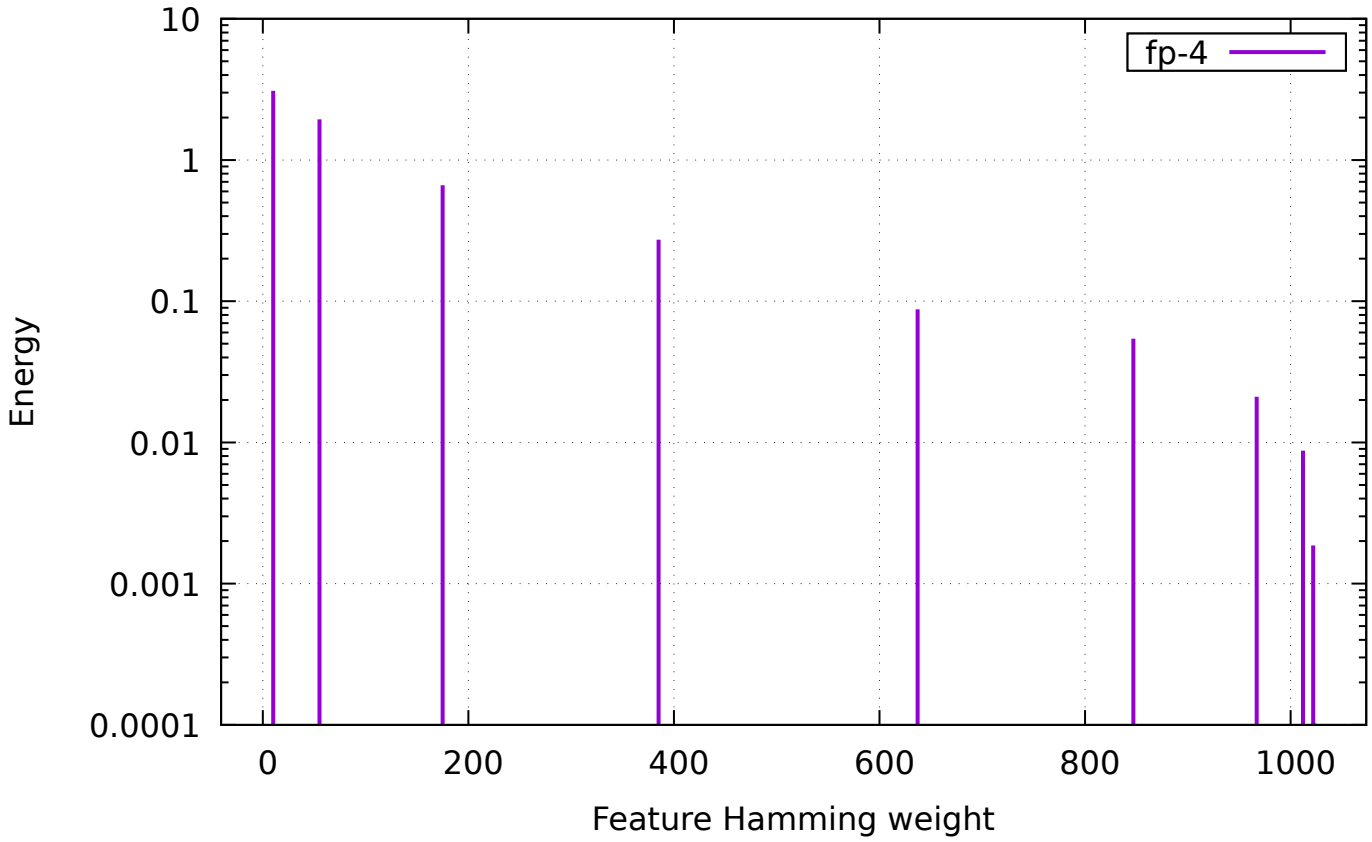
0.1
0.01
0.001
0
200
400
600
800
1000


fp-4
Energy
Feature Hamming weight
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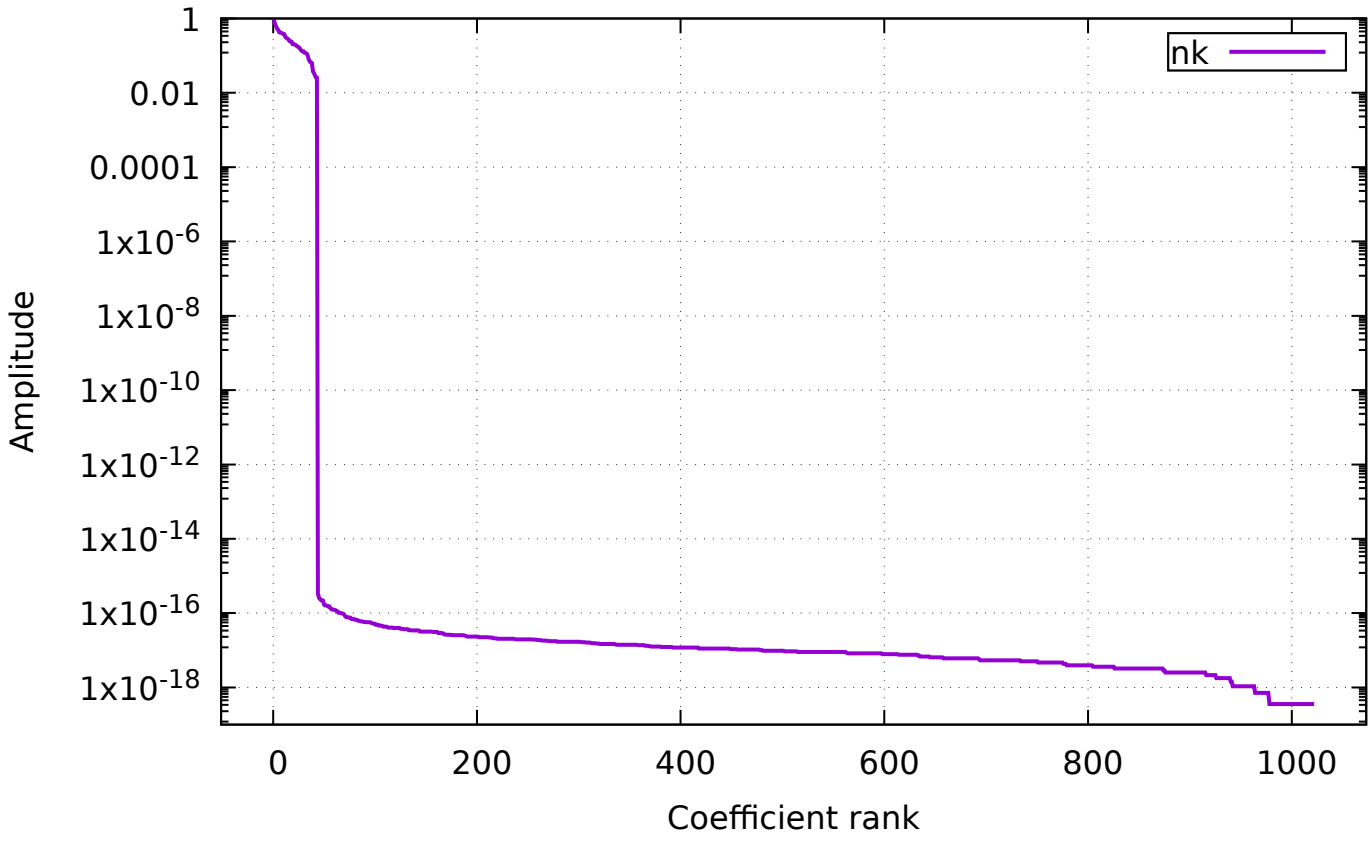
1
0.1
0.01
0.001
0.0001
0
200
400
600
800
1000

## 14 nk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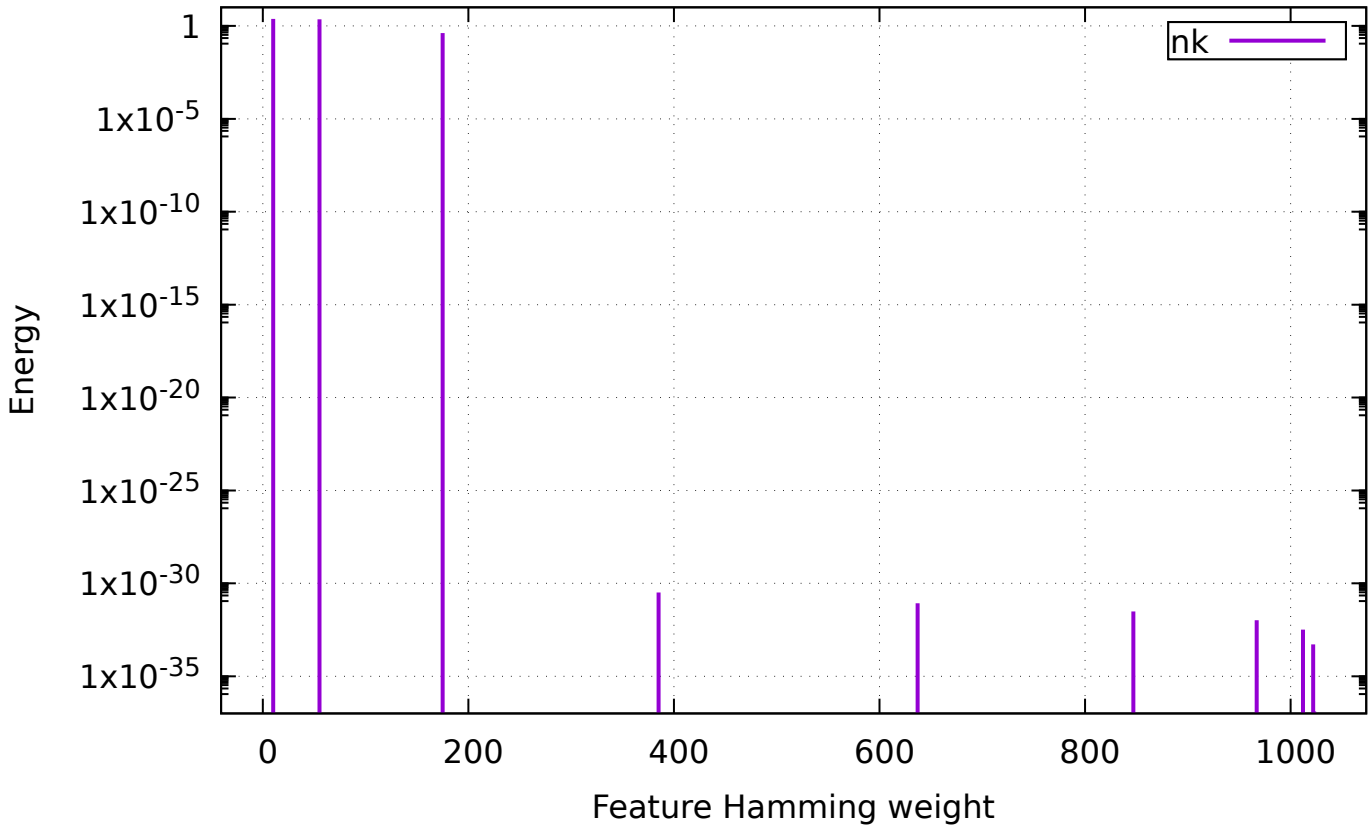
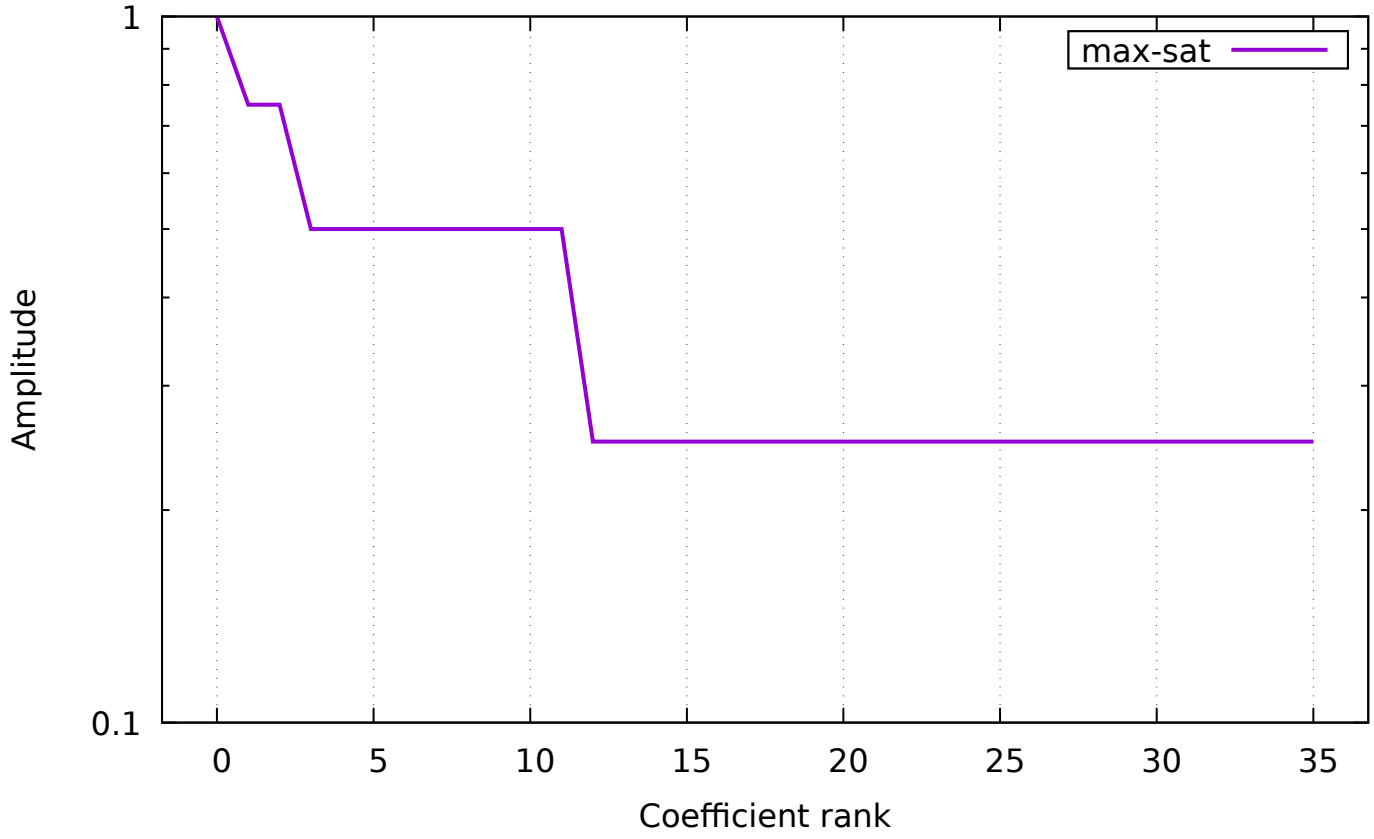
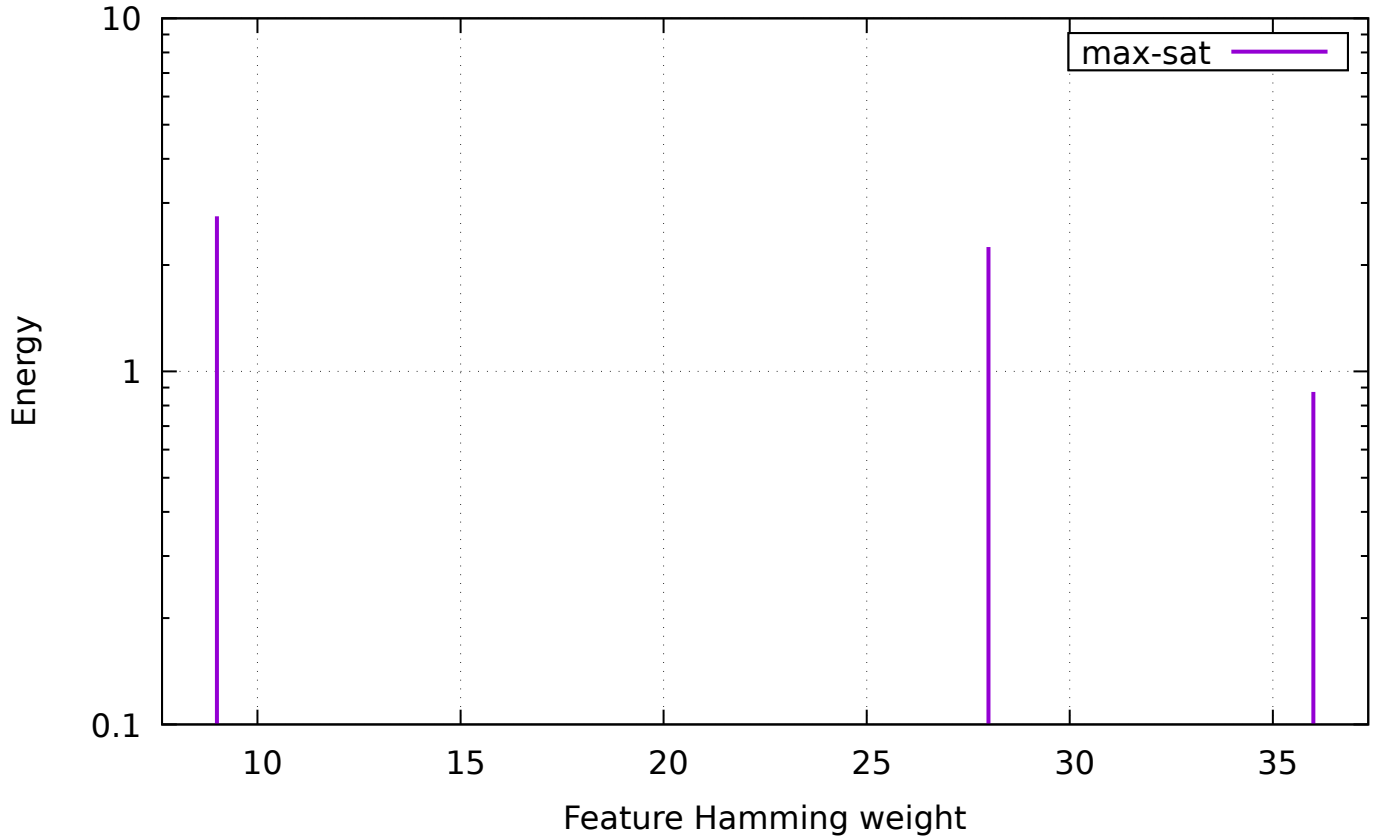
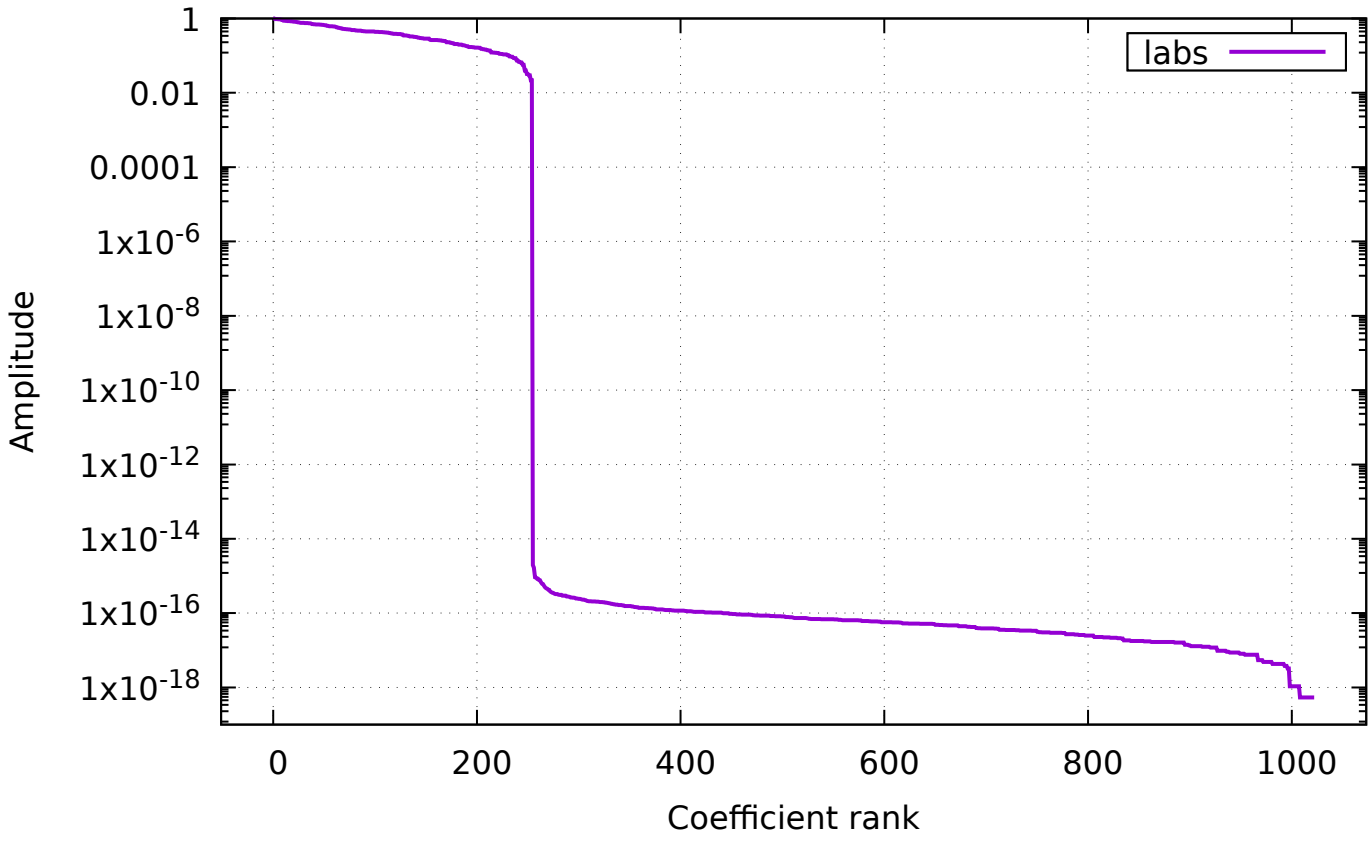
Amplitude
1
0.01
0.0001
1x10-6
1x10-8
1x10-10
1x10-12
1x10-14
1x10-16
1x10-18
0
200
400
600
800
1000
Coefficient rank


nk
Energy
1
1x10-5
1x10-10
1x10-15
1x10-20
1x10-25
1x10-30
1x10-35
0
200
400
600
800
1000
Feature Hamming weight

## 15 max-sat


max-sat
Amplitude
Coefficient rank
1
0.1
0
5
10
15
20
25
30
35


max-sat
Energy
Feature Hamming weight
10
1
0.1
10
15
20
25
30
35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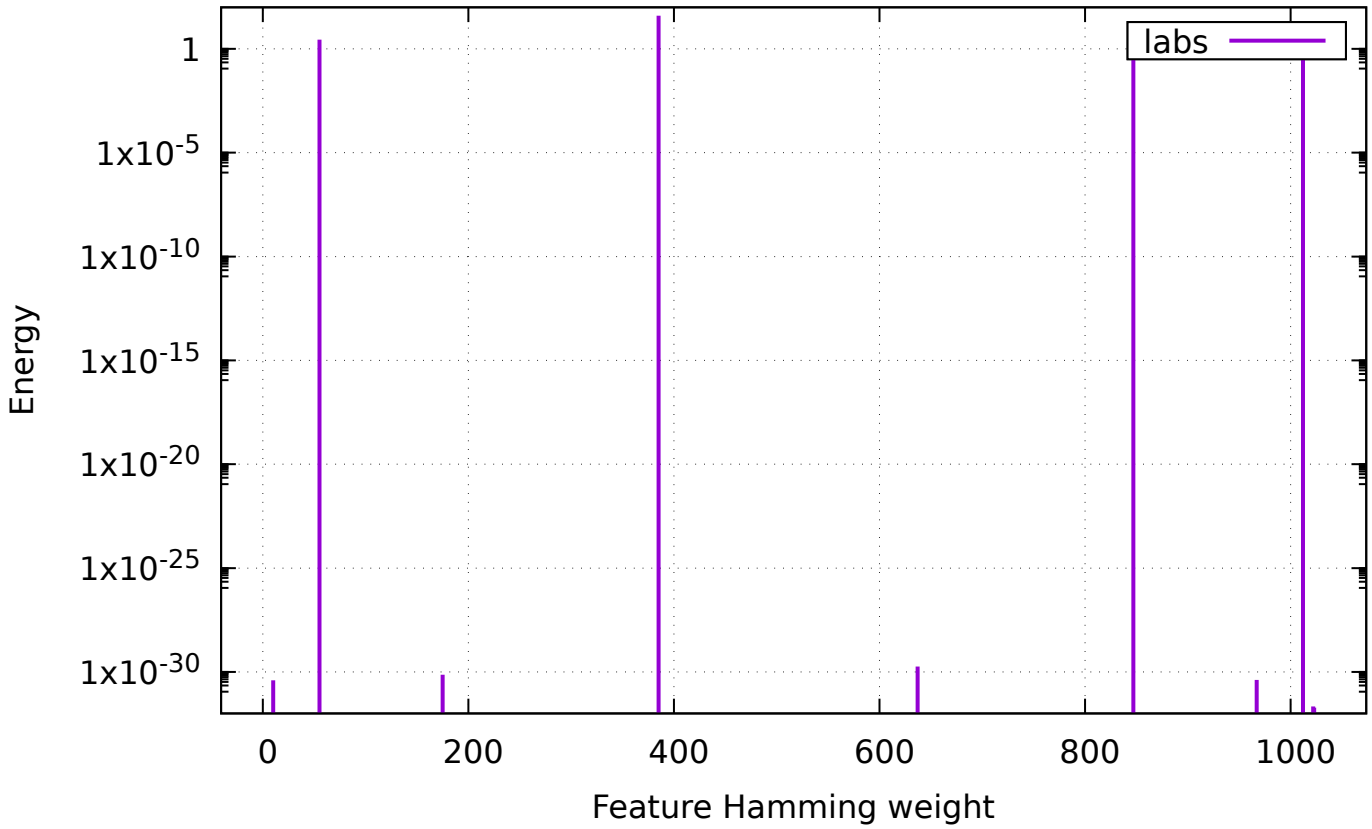
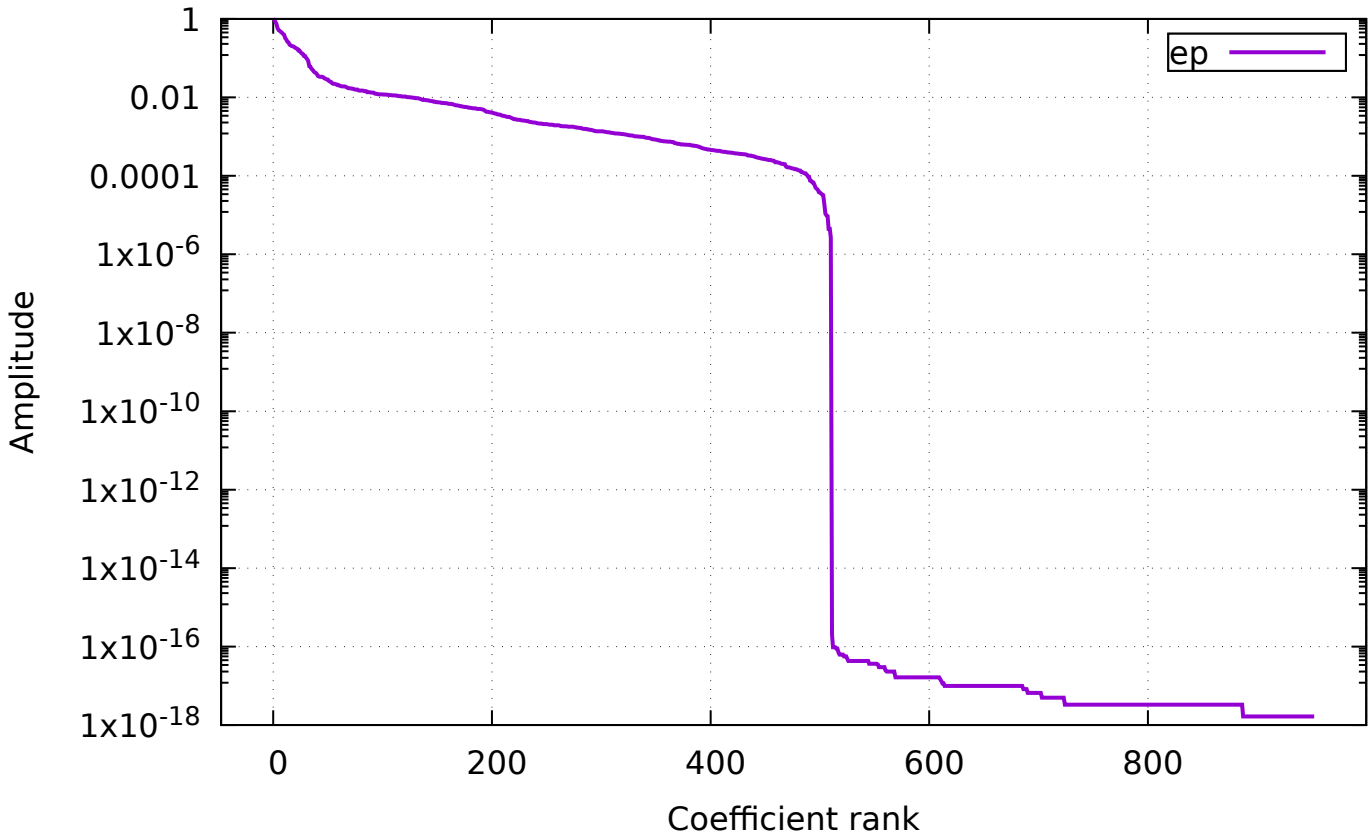
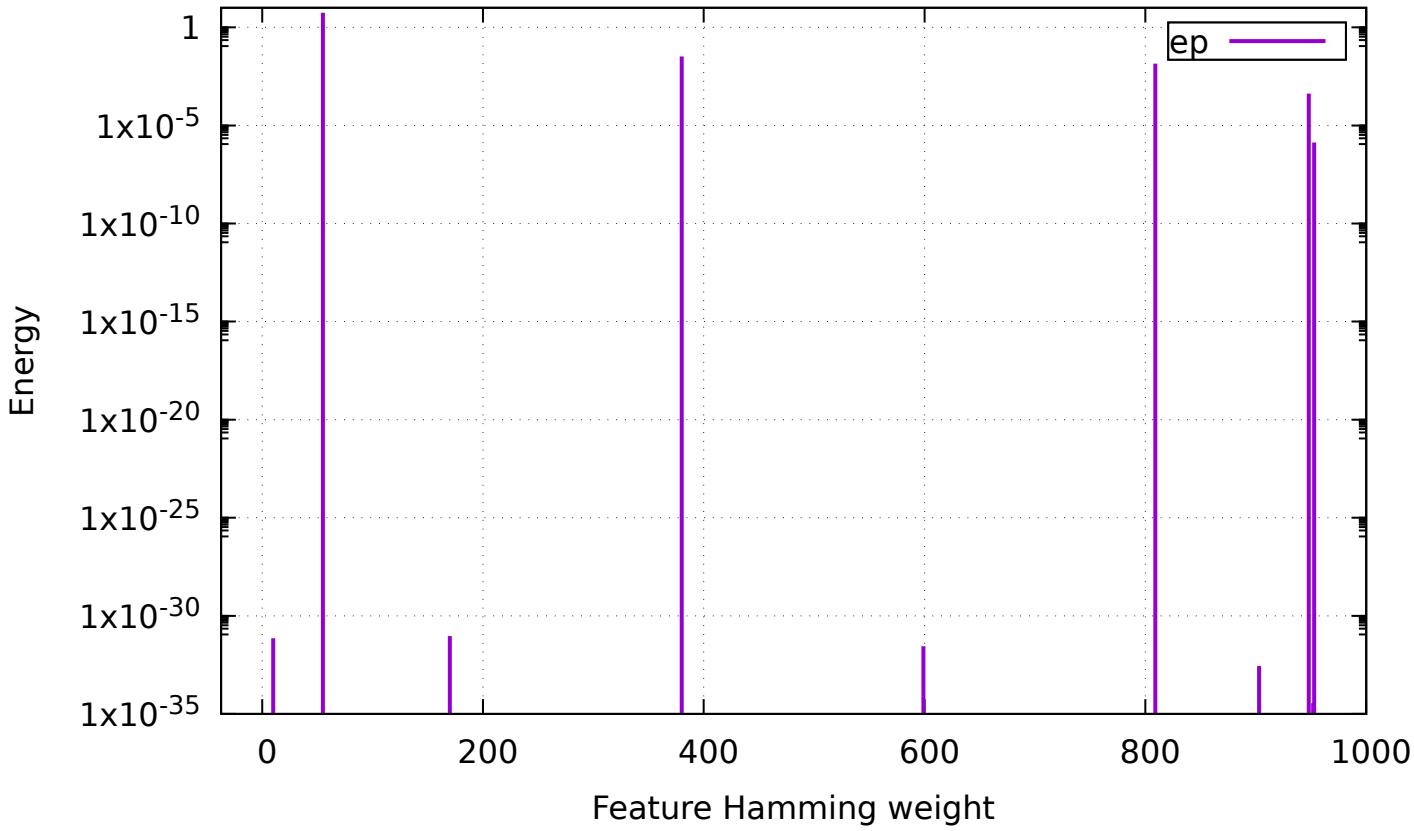
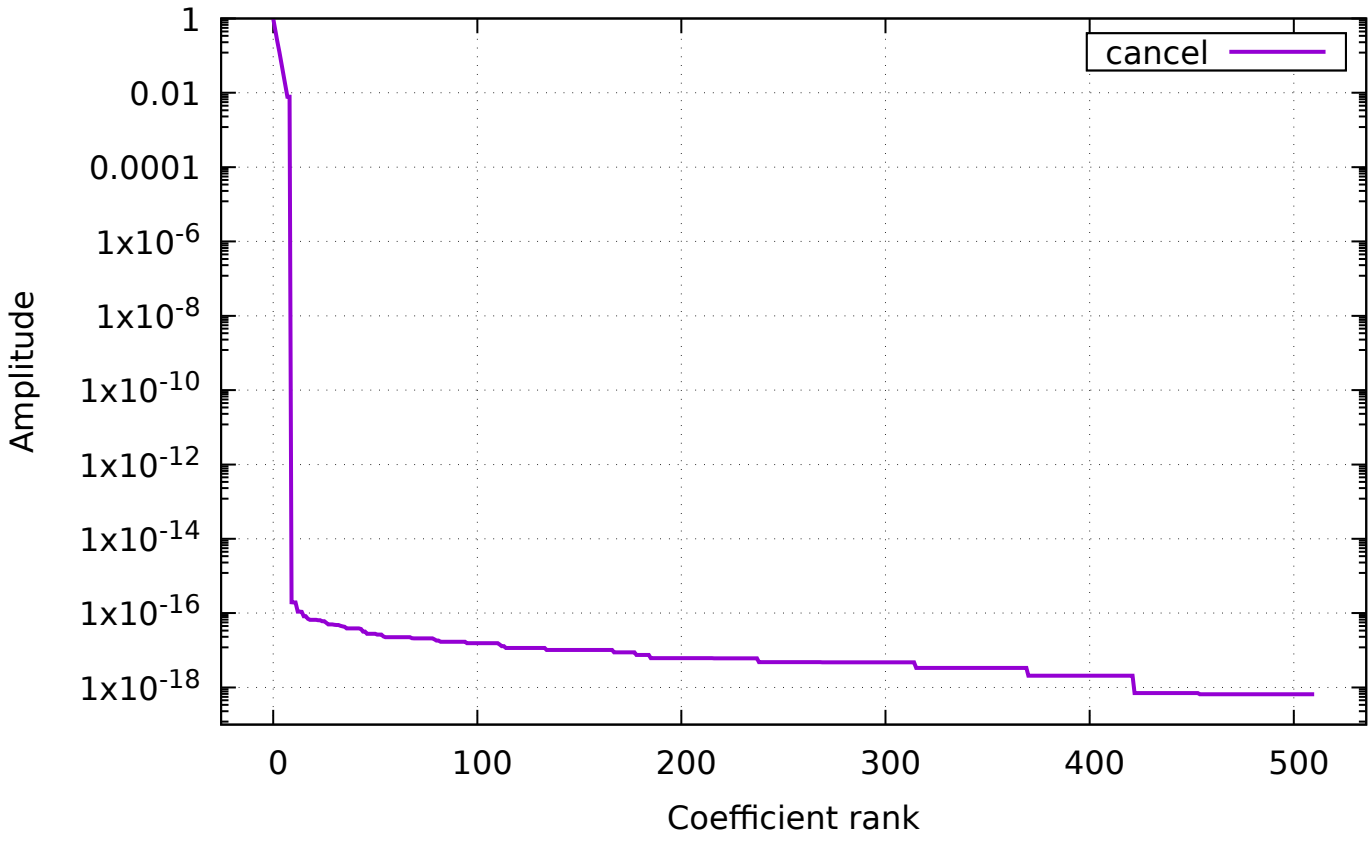
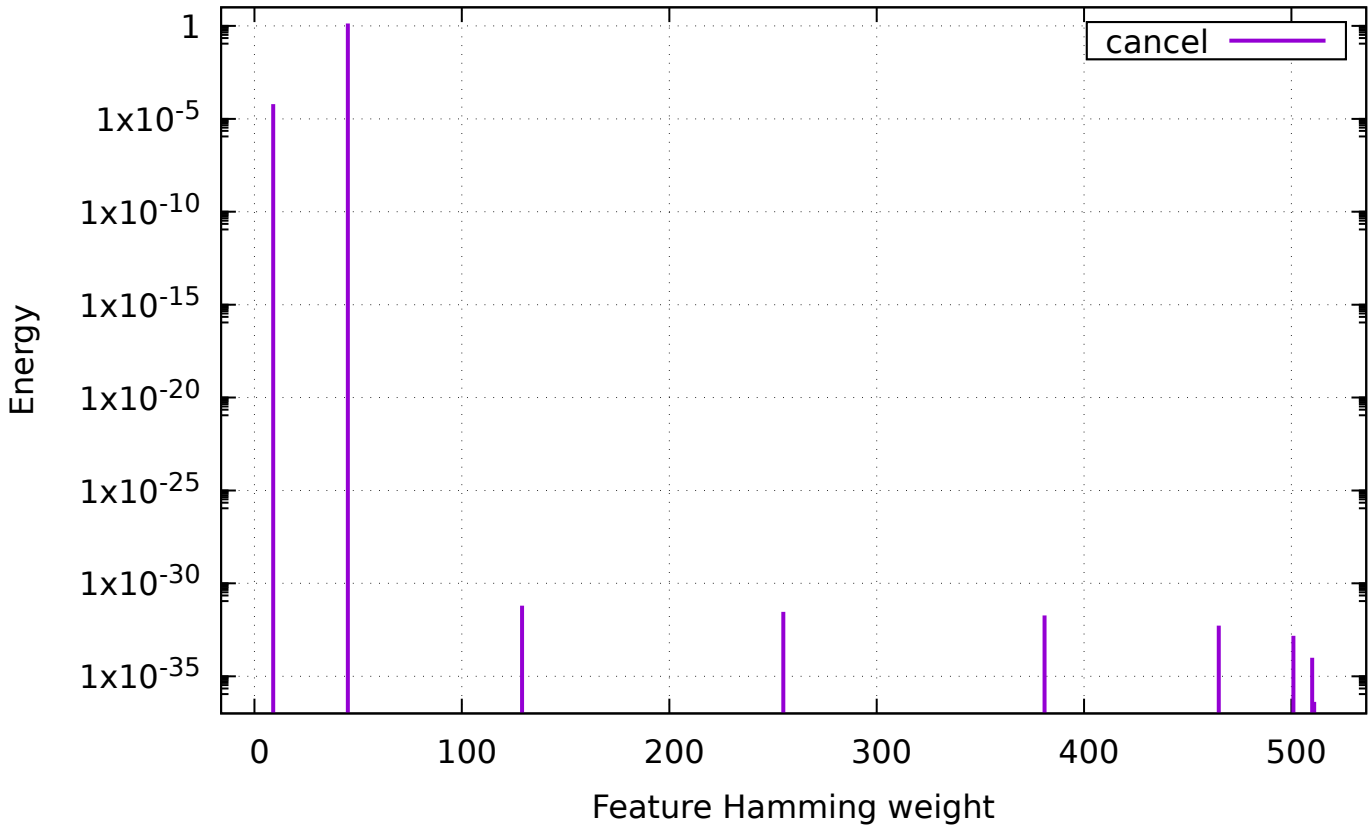
0.01
0.0001
1x10-6
1x10-8
1x10-10
1x10-12
1x10-14
1x10-16
1x10-18
0
200
400
600
800
1000
Coefficient rank


labs
Energy
1
1x10-5
1x10-10
1x10-15
1x10-20
1x10-25
1x10-30
0
200
400
600
800
1000
Feature Hamming weight

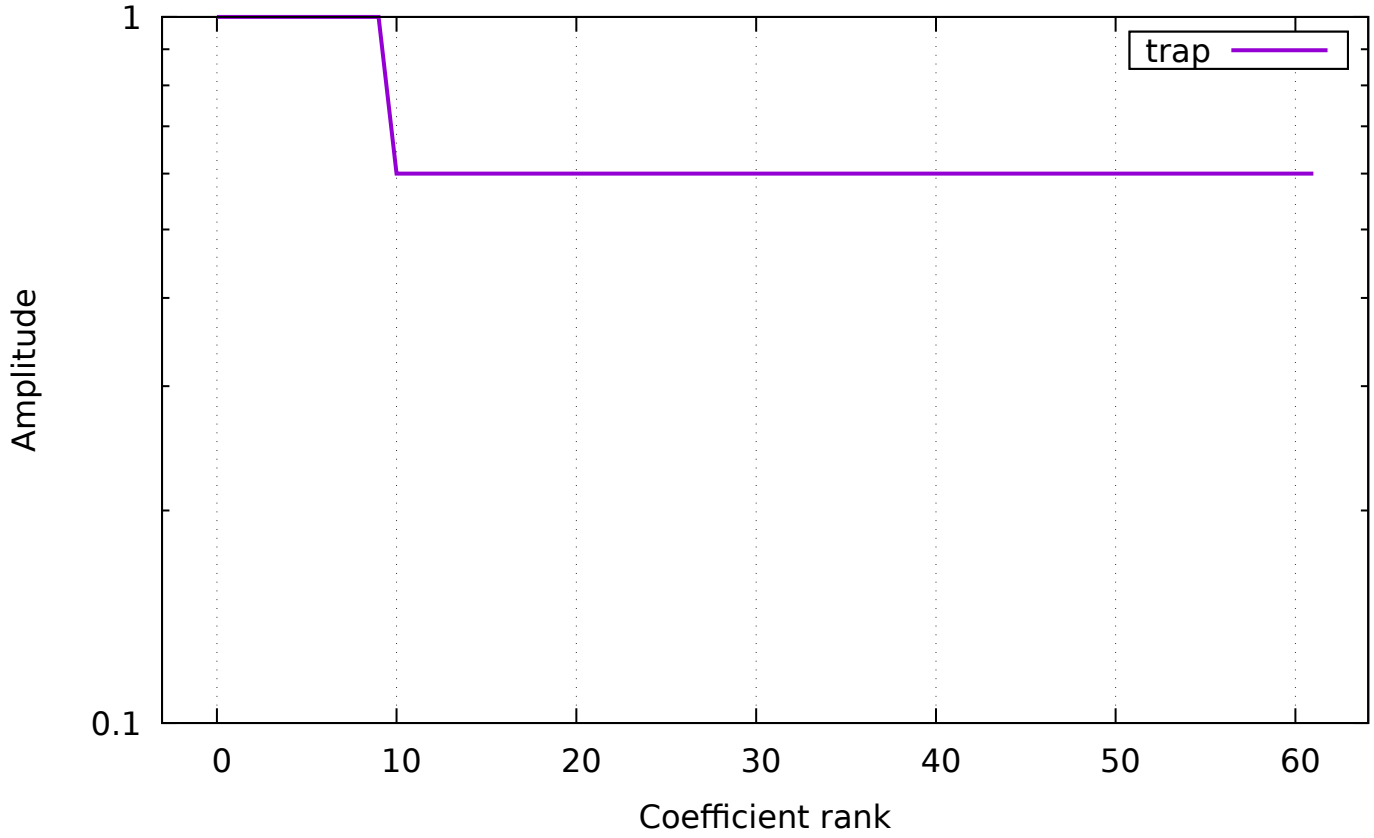

ep
Amplitude
Coefficient rank
1
0.01
0.0001
1x10-6
1x10-8
1x10-10
1x10-12
1x10-14
1x10-16
1x10-18
0
200
400
600
800

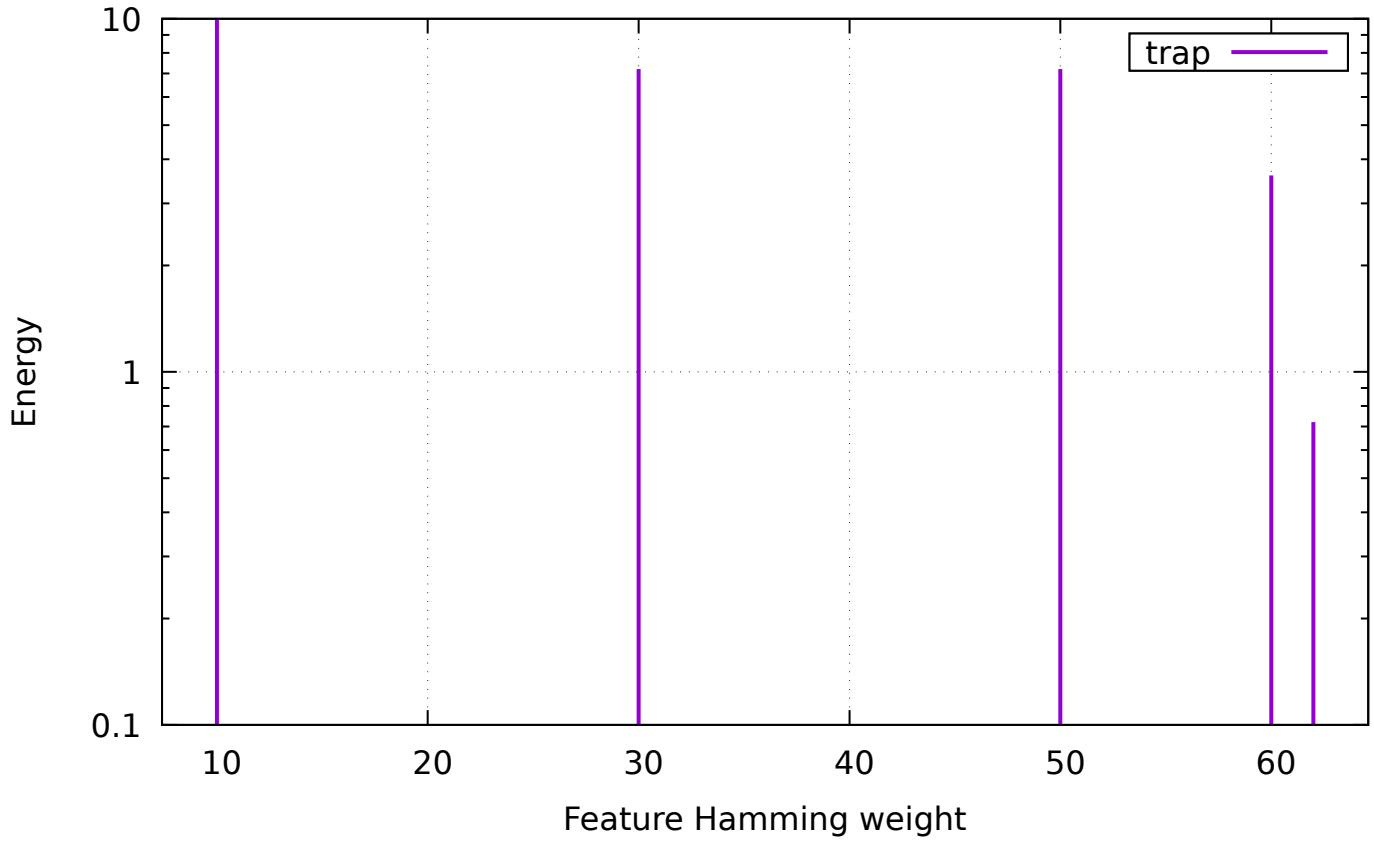

ep
Energy
Feature Hamming weight
1
1x10-5
1x10-10
1x10-15
1x10-20
1x10-25
1x10-30
1x10-35
0
200
400
600
800
1000

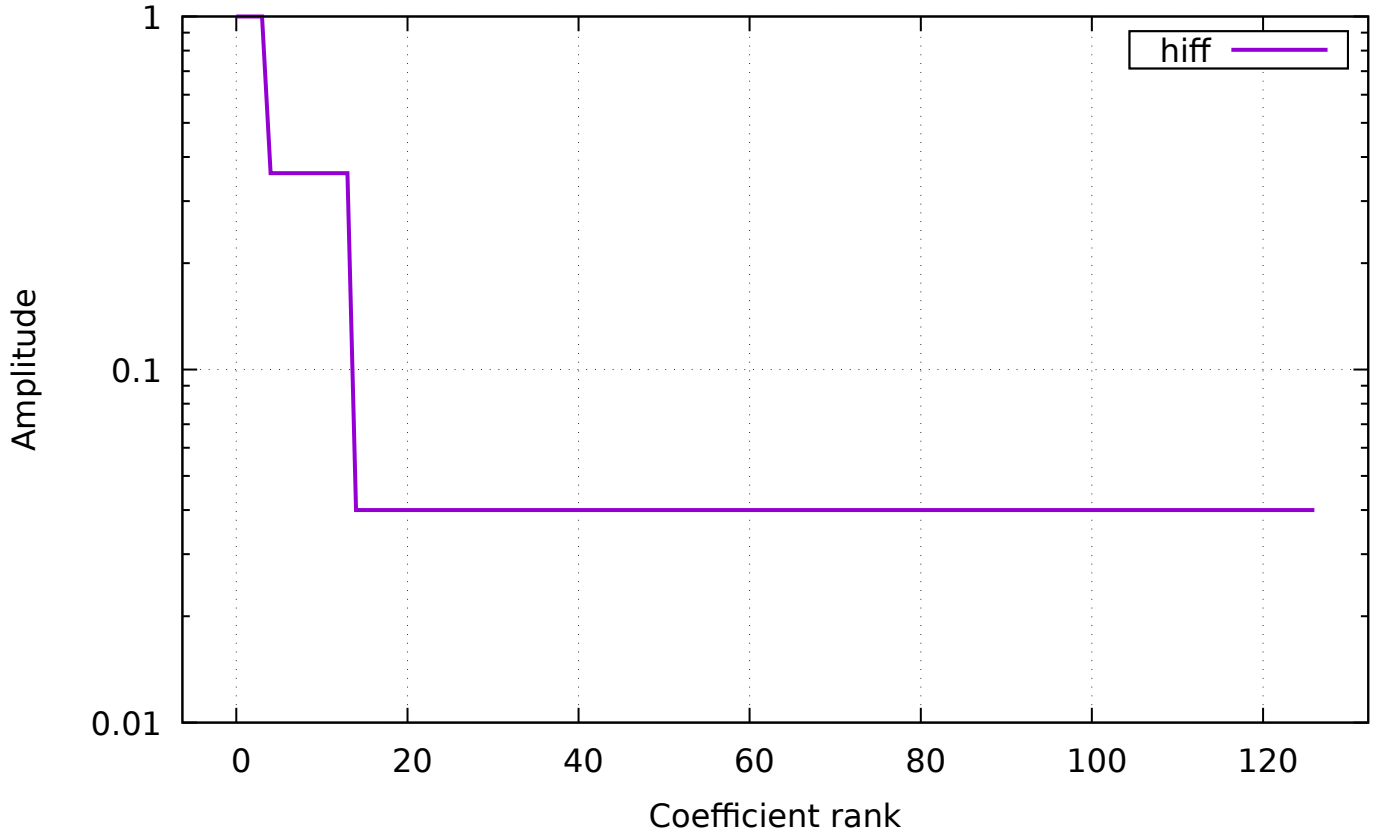

cancel
Amplitude
1
0.01
0.0001
1x10-6
1x10-8
1x10-10
1x10-12
1x10-14
1x10-16
1x10-18
0
100
200
300
400
500
Coefficient rank

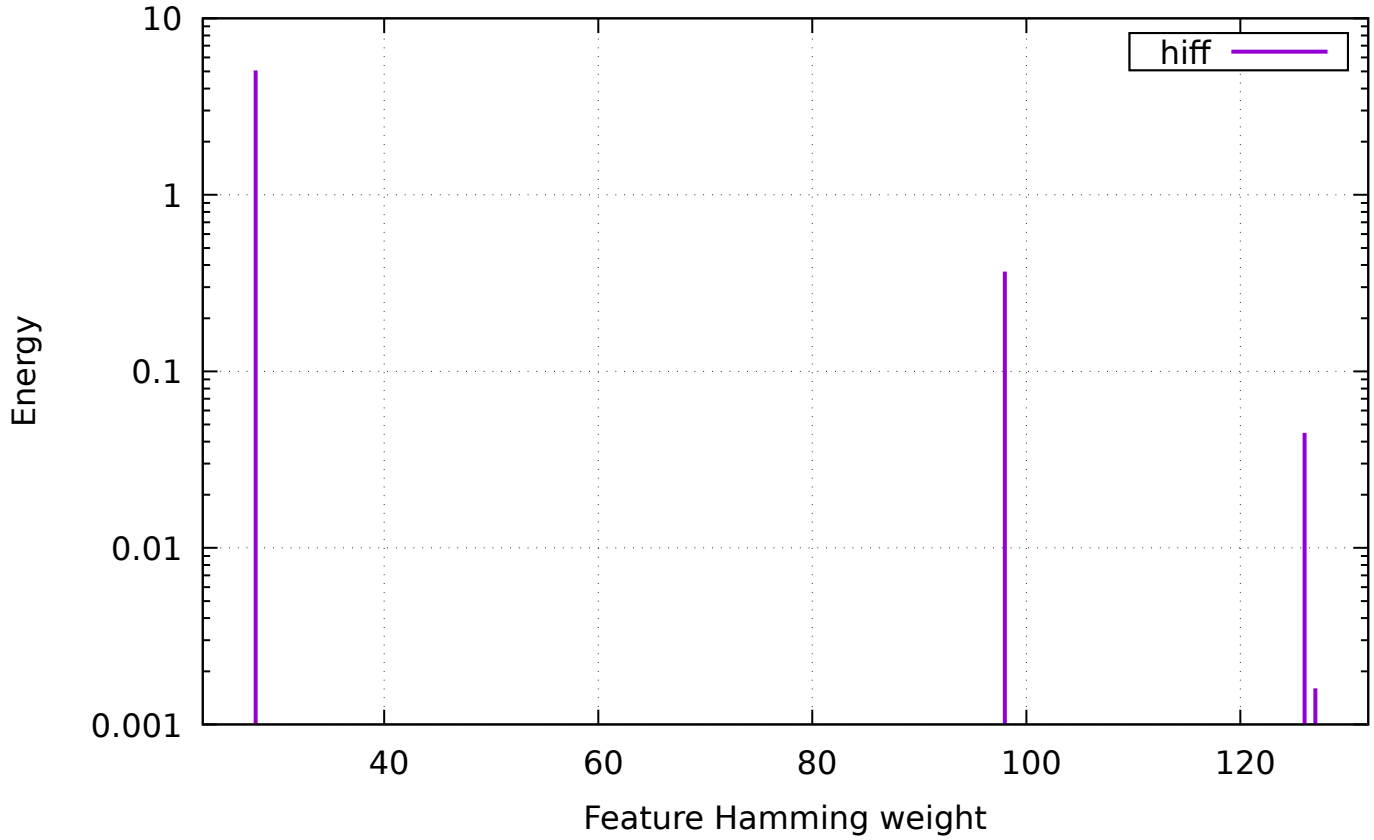

cancel
Energy
1
1x10-5
1x10-10
1x10-15
1x10-20
1x10-25
1x10-30
1x10-35
0
100
200
300
400
500
Feature Hamming weight

## 19 trap

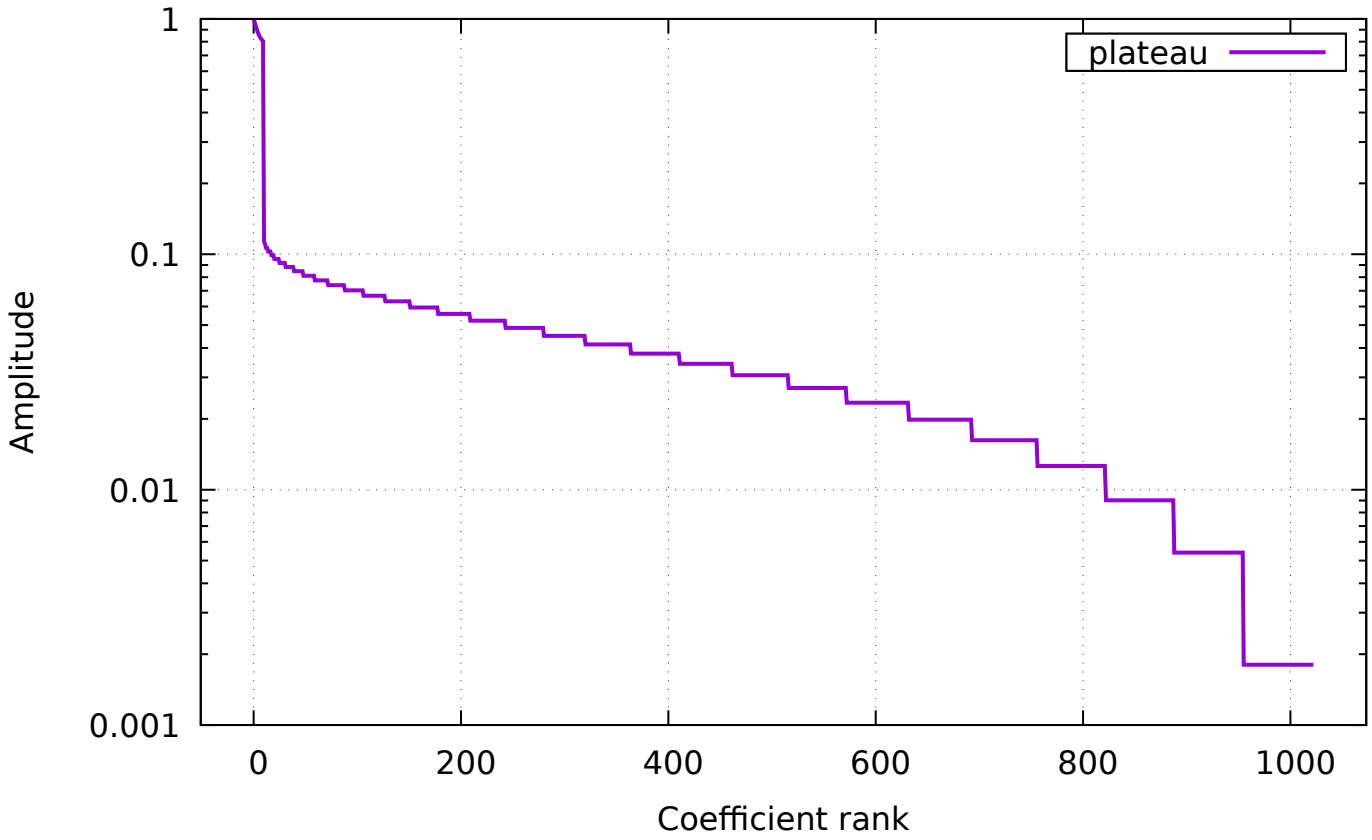

trap
Amplitude
Coefficient rank
1
0.1
0
10
20
30
40
50
60

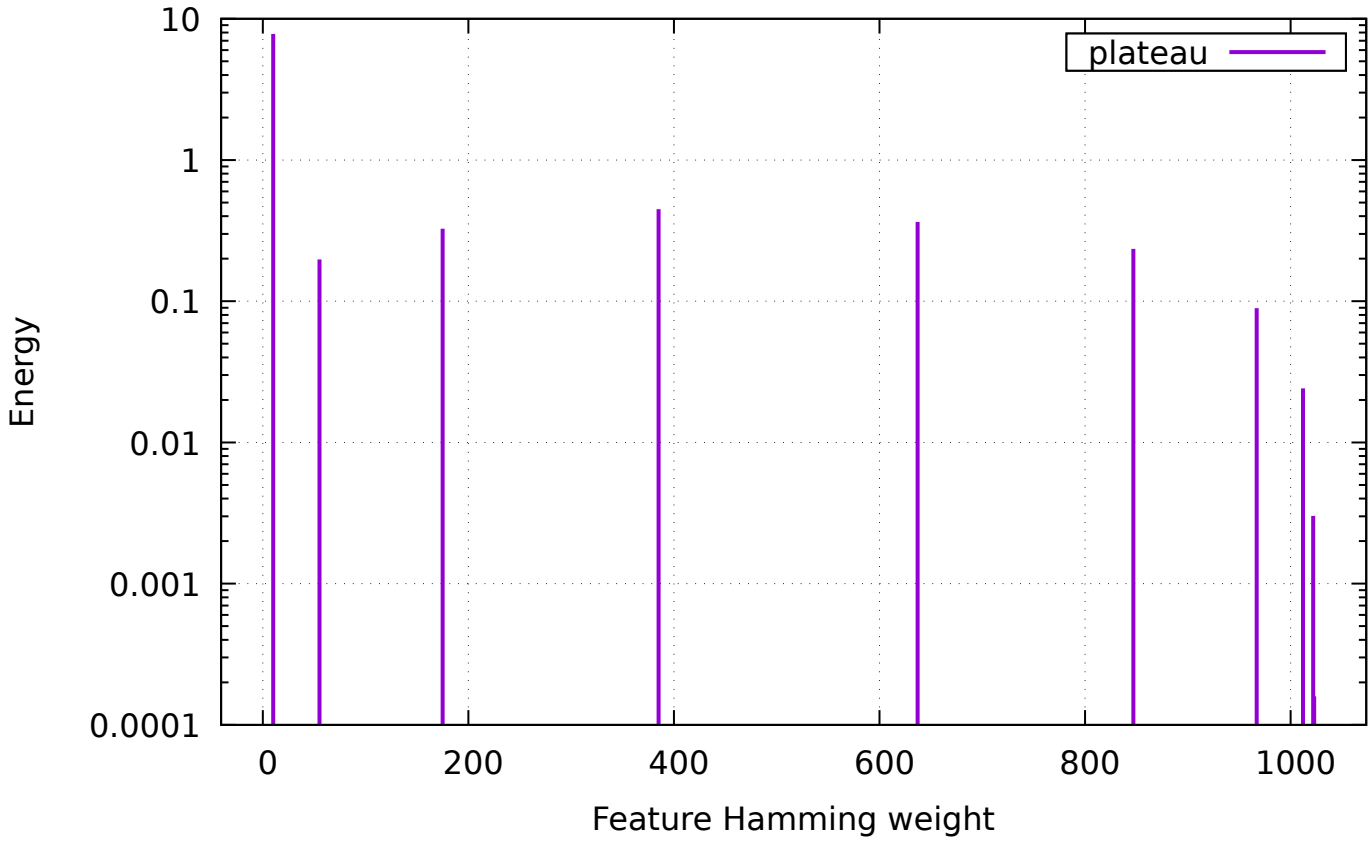

trap
Energy
Feature Hamming weight
10
1
0.1
10
20
30
40
50
60


hiff
Amplitude
1
0.1
0.01
0
20
40
60
80
100
120
Coefficient rank

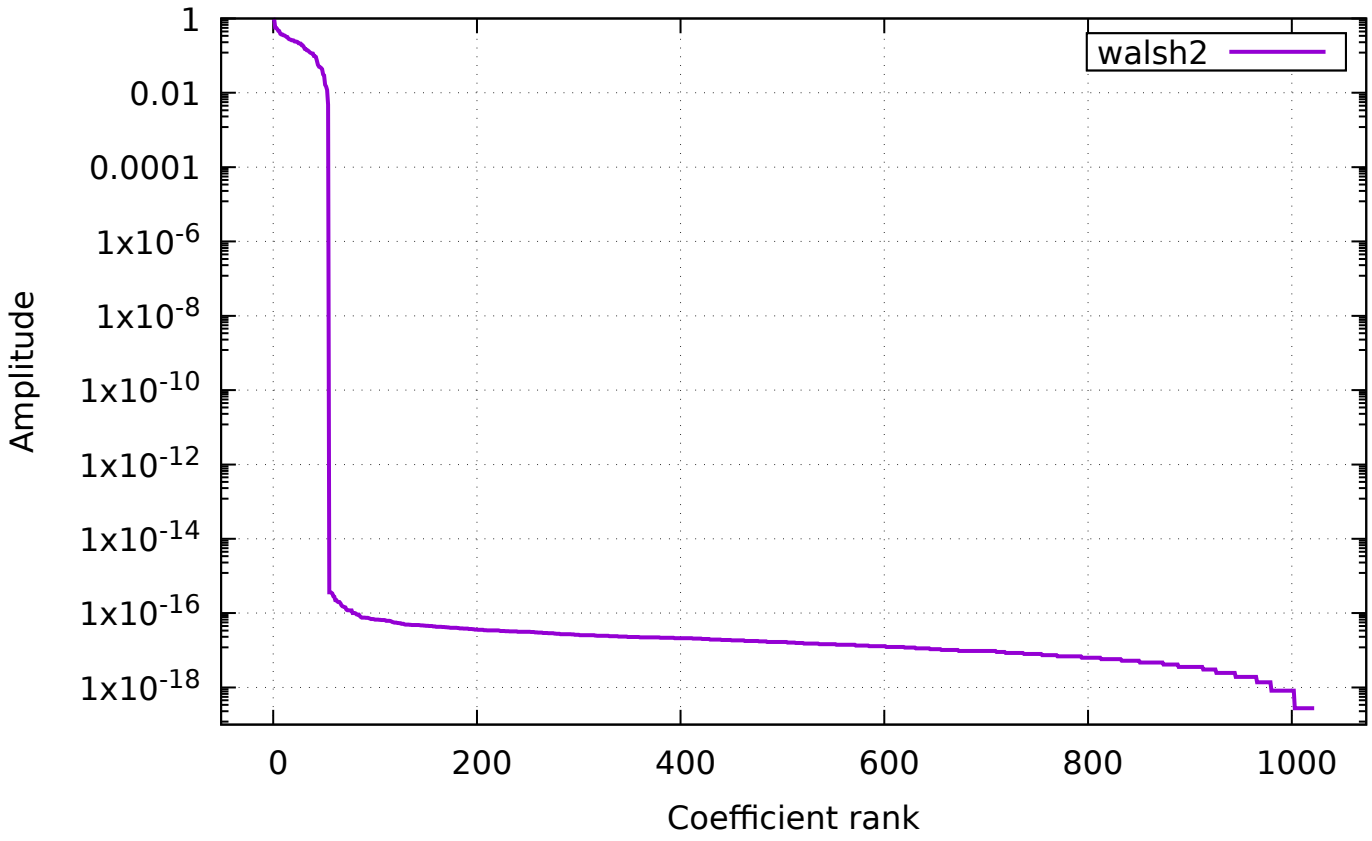

hiff
Energy
10
1
0.1
0.01
0.001
40
60
80
100
120
Feature Hamming weight

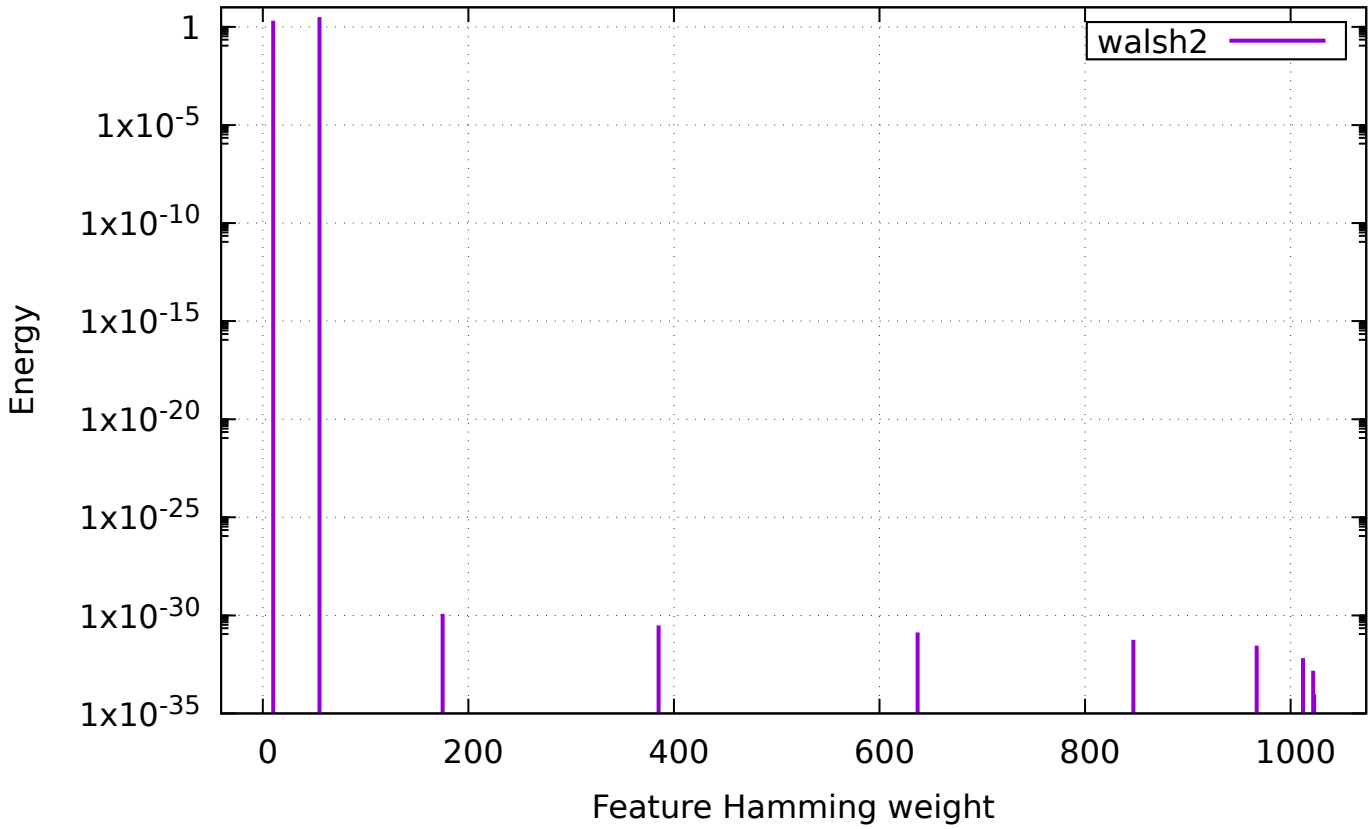
## 21 plateau


plateau
Amplitude
Coefficient rank
1
0.1
0.01
0.001
0
200
400
600
800
1000


plateau
Energy
Feature Hamming weight
10
1
0.1
0.01
0.001
0.0001
0
200
400
600
800
1000

## 22 walsh2




# A Plan

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        "col": ">{{\\nprounddigits{2}}}N{2}{2}"
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    {
        "id": "leading-ones",
        "opt": "-F 10",
        "col": ">{{\\nprounddigits{0}}}N{3}{0}"
    },
    {
        "id": "ridge",
        "opt": "-F 11",
        "col": ">{{\\nprounddigits{0}}}N{3}{0}"
    },
    {
        "id": "jmp-2",
        "opt": "-F 30 -t 2",
        "col": ">{{\\nprounddigits{0}}}N{3}{0}"
    },
    {
        "id": "jmp-4",
        "opt": "-F 30 -t 4",
        "col": ">{{\\nprounddigits{0}}}N{3}{0}"
    },
    {
        "id": "djmp-2",
        "opt": "-F 31 -t 2",
        "col": ">{{\\nprounddigits{0}}}N{3}{0}"
    },
    {
        "id": "djmp-4",
        "opt": "-F 31 -t 4",
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        "id": "fp-2",
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    {
        "id": "nk",
        "opt": "-F 60 -p instances/nk.10.2",
        "col": ">{{\\nprounddigits{2}}}N{1}{2}"
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    {
        "id": "max-sat",
        "opt": "-F 70 -p instances/ms.10.3.10",
```

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        {
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            "col": ">{{\\nprounddigits{2}}}N{1}{2}"
        },
        {
            "id": "ep",
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            "logscale": true,
            "col": ">{{\\nprounddigits{2}}}N{1}{2}"
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            "reverse": true,
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        {
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            "id": "hiff",
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        {
            "id": "plateau",
            "opt": "-F 130",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "walsh2",
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            "col": ">{{\\nprounddigits{2}}}N{3}{2}"
        }
    ],
    "groups": [
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                },
                {
                    "id": "leading-ones",
                    "opt": "-F 10",
                    "col": ">{{\\nprounddigits{0}}}N{3}{0}"
                },
                {
                    "id": "ridge",
                    "opt": "-F 11",
                    "col": ">{{\\nprounddigits{0}}}N{3}{0}"
                },
                {
                    "id": "jmp-2",
                    "opt": "-F 30 -t 2",
```

```
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
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        {
            "id": "jmp-4",
            "opt": "-F 30 -t 4",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "djmp-2",
            "opt": "-F 31 -t 2",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "djmp-4",
            "opt": "-F 31 -t 4",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "fp-2",
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            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
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        {
            "id": "fp-4",
            "opt": "-F 40 -t 4",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "max-sat",
            "opt": "-F 70 -p instances/ms.10.3.10",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "trap",
            "opt": "-F 110 --fn-num-traps 2",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "hiff",
            "opt": "-F 120 -s 8",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        },
        {
            "id": "plateau",
            "opt": "-F 130",
            "col": ">{{\\nprounddigits{0}}}N{3}{0}"
        }
    ]
},
{
    "id": "group2",
    "functions": [
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            "id": "lin",
            "opt": "-F 1 -p instances/lin.10",
            "col": ">{{\\nprounddigits{2}}}N{2}{2}"
        },
        {
            "id": "nk",
            "opt": "-F 60 -p instances/nk.10.2",
            "col": ">{{\\nprounddigits{2}}}N{1}{2}"
        },
        {
```

```
                    "id": "labs",
                    "opt": "-F 80",
                    "col": ">{{\\nprounddigits{2}}}N{1}{2}"
                },
                {
                    "id": "ep",
                    "opt": "-F 90 -p instances/ep.10",
                    "reverse": true,
                    "logscale": true,
                    "col": ">{{\\nprounddigits{2}}}N{1}{2}"
                },
                {
                    "id": "cancel",
                    "opt": "-F 100 -s 9",
                    "reverse": true,
                    "col": ">{{\\nprounddigits{2}}}N{1}{2}"
                },
                {
                    "id": "walsh2",
                    "opt": "-F 162 -p instances/walsh2.10",
                    "col": ">{{\\nprounddigits{2}}}N{3}{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
# cache_budget = 0
# ea_lambda = 100
# ea_mu = 10
# 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_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
# mutation_probability = 1
# neighborhood = 0
```

```
# neighborhood_iterator = 0
# noise_stddev = 1
# num_iterations = 0
# num_threads = 1
# path = nopath
# pn_mutation_probability = 1
# pn_neighborhood = 0
# pn_radius = 2
# population_size = 10
# pv_log_num_components = 5
# radius = 2
# 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
# target = 100
# print_defaults
# last_parameter
# exec_name = hnco
# version = 0.9
# Generated from hnco.json
```