HNCO
Comparison of black box optimization algorithms
Cache lookup ratio

August 7, 2020

Contents

1 Ranking

algorithm	rank distribution									
	1	2	3	4	5	6	7	8	9	10
sa	12	6	0	1	0	0	0	0	0	0
umda	7	7	1	2	2	0	0	0	0	0
ea-1c10	0	4	0	1	5	9	0	0	0	0
ea-1p1	0	1	12	1	1	2	2	0	0	0
pbil	0	1	4	0	8	4	1	1	0	0
ea-1p10	0	0	2	12	2	3	0	0	0	0
rls	0	0	0	2	0	0	3	8	5	1
ea-10p1	0	0	0	0	1	1	9	3	5	0
ga	0	0	0	0	0	0	3	0	4	12
hc	0	0	0	0	0	0	1	7	5	6

Per function rankings (ex-eaquo are grouped in parentheses):

one-max umda, sa, ea-1p1, ea-1p10, ea-1c10, pbil, ga, ea-10p1, rls, hc

lin umda, sa, ea-1p1, ea-1p10, ea-1c10, pbil, ea-10p1, rls, hc, ga

leading-ones sa, umda, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, hc, rls, ga

ridge sa, umda, ea-1p1, ea-1p10, ea-1c10, pbil, hc, ea-10p1, ga, rls

jmp-5 sa, ea-1c10, pbil, umda, ea-1p10, ea-1p1, rls, hc, ea-10p1, ga

jmp-10 sa, ea-1c10, pbil, rls, umda, ea-1p10, ea-1p1, hc, ea-10p1, ga

djmp-5 sa, ea-1c10, pbil, umda, ea-1p10, ea-1p1, rls, hc, ea-10p1, ga

djmp-10 sa, ea-1c10, pbil, rls, umda, ea-1p10, ea-1p1, hc, ea-10p1, ga

fp-5 sa, umda, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, hc, rls, ga

fp-10 sa, umda, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, hc, rls, ga

nk umda, sa, ea-1p10, ea-1p1, pbil, ea-1c10, ea-10p1, rls, ga, hc

max-sat sa, umda, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, rls, ga, hc

labs sa, umda, ea-1p1, ea-1p10, ea-10p1, ea-1c10, pbil, rls, hc, ga

ep umda, ea-1p1, ea-1p10, sa, ea-1c10, ea-10p1, rls, pbil, hc, ga

cancel umda, sa, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, rls, hc, ga

**trap** umda, sa, ea-1p1, ea-1p10, ea-1c10, pbil, ga, ea-10p1, rls, hc

hiff sa, umda, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, rls, hc, ga

plateau sa, pbil, umda, ea-1c10, ea-1p1, ea-1p10, ga, rls, ea-10p1, hc

**walsh2** umda, sa, ea-1p1, ea-1p10, pbil, ea-1c10, ea-10p1, rls, ga, hc

2 Function one-max

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.135	0.139	0.140	0.141	0.144	9
hc	0.046	0.046	0.047	0.047	0.048	10
sa	0.897	0.899	0.901	0.902	0.904	2
ea-1p1	0.864	0.864	0.865	0.865	0.865	3
ea-1p10	0.863	0.864	0.864	0.864	0.866	4
ea-10p1	0.143	0.145	0.145	0.146	0.147	8
ea-1c10	0.847	0.854	0.857	0.859	0.865	5
ga	0.367	0.370	0.373	0.376	0.381	7
pbil	0.855	0.855	0.855	0.856	0.856	6
umda	0.903	0.904	0.904	0.904	0.906	1
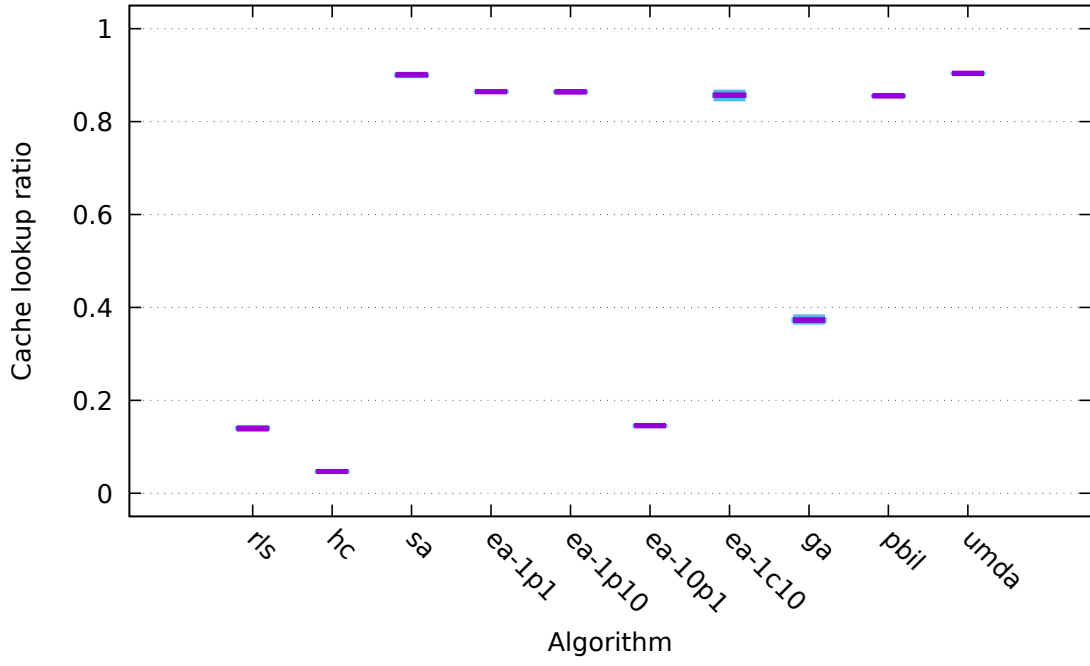
3 Function lin

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.136	0.138	0.140	0.141	0.143	8
hc	0.081	0.084	0.087	0.089	0.091	9
sa	0.868	0.870	0.872	0.873	0.880	2
ea-1p1	0.864	0.864	0.865	0.865	0.866	3
ea-1p10	0.863	0.863	0.864	0.864	0.865	4
ea-10p1	0.732	0.736	0.737	0.739	0.742	7
ea-1c10	0.849	0.854	0.855	0.858	0.863	5
ga	0.061	0.068	0.070	0.072	0.077	10
pbil	0.836	0.837	0.837	0.838	0.839	6
umda	0.902	0.903	0.903	0.903	0.904	1
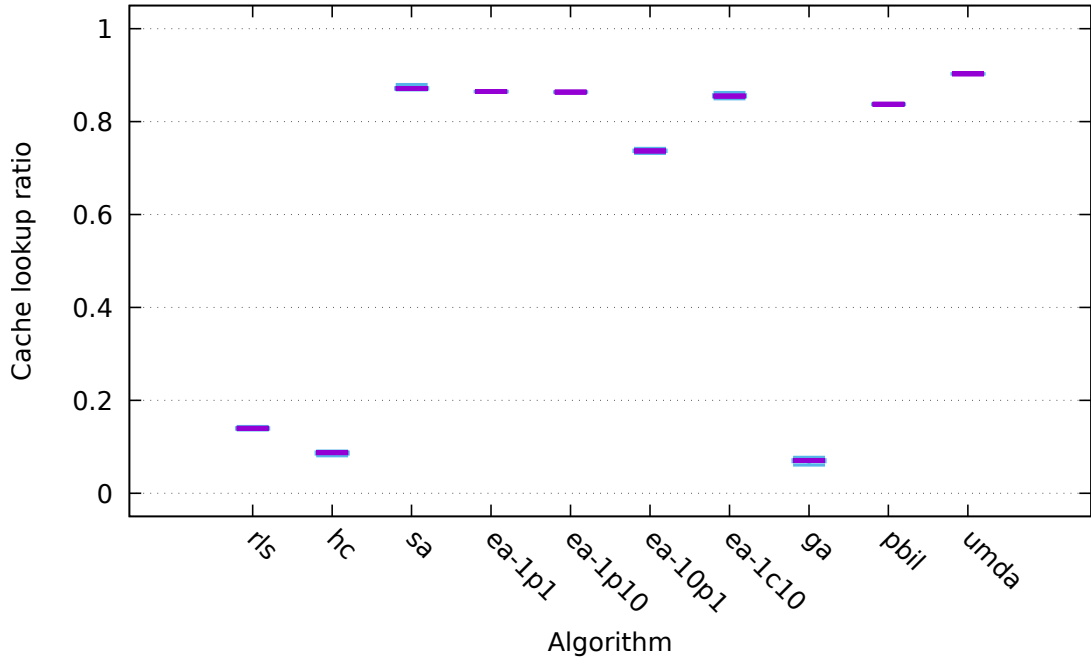
4   Function leading-ones

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.042	0.043	0.045	0.046	0.047	9
hc	0.080	0.086	0.087	0.088	0.092	8
sa	0.758	0.980	0.984	0.987	0.990	1
ea-1p1	0.846	0.850	0.851	0.853	0.856	3
ea-1p10	0.842	0.848	0.849	0.853	0.854	4
ea-10p1	0.499	0.506	0.513	0.522	0.531	7
ea-1c10	0.584	0.605	0.626	0.631	0.651	6
ga	0.007	0.007	0.007	0.007	0.008	10
pbil	0.649	0.668	0.676	0.682	0.690	5
umda	0.872	0.875	0.877	0.879	0.887	2
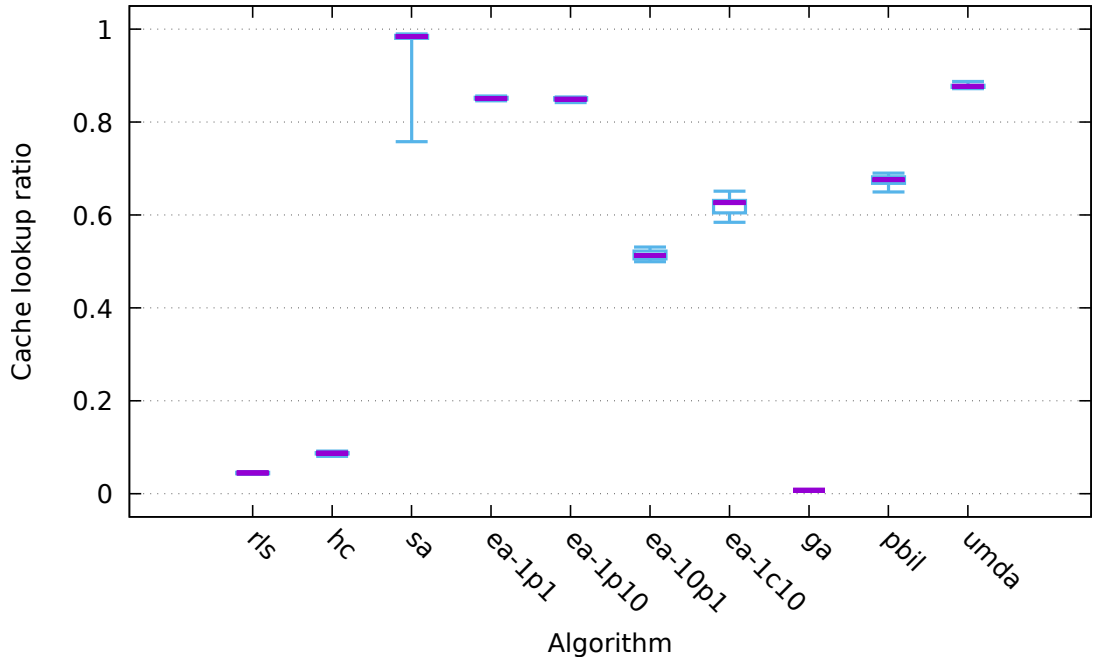
5 Function ridge

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.139	0.142	0.144	0.146	0.150	10
hc	0.625	0.638	0.642	0.647	0.648	7
sa	0.924	0.928	0.932	0.937	0.946	1
ea-1p1	0.826	0.831	0.832	0.833	0.833	3
ea-1p10	0.826	0.828	0.828	0.831	0.835	4
ea-10p1	0.551	0.569	0.582	0.587	0.596	8
ea-1c10	0.714	0.717	0.720	0.722	0.725	5
ga	0.367	0.370	0.374	0.376	0.380	9
pbil	0.692	0.693	0.694	0.694	0.697	6
umda	0.845	0.848	0.849	0.850	0.852	2
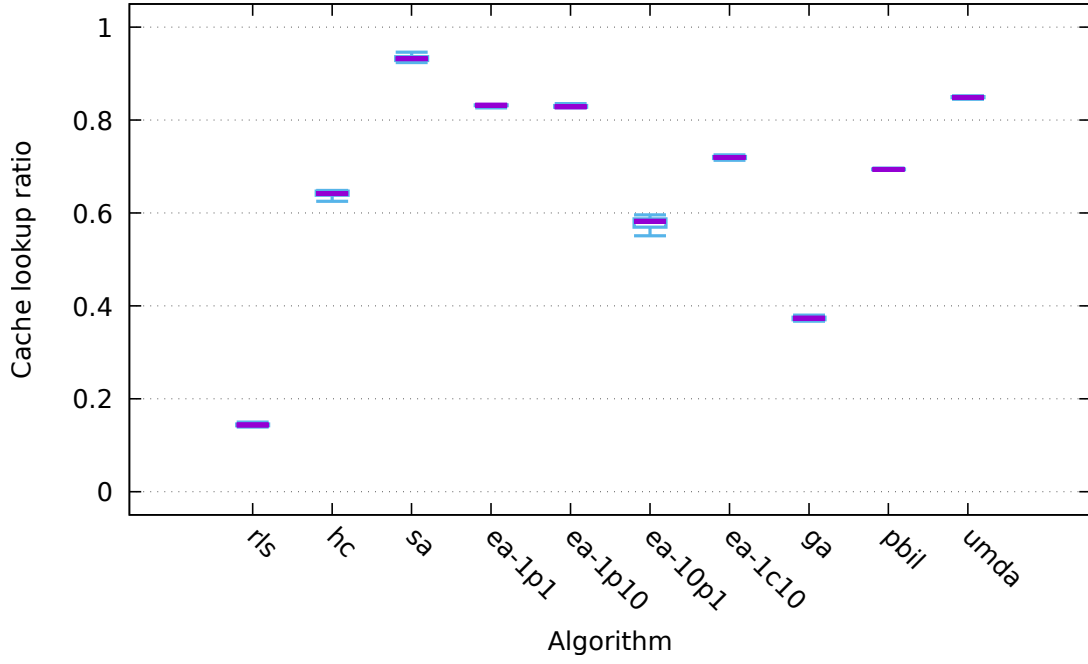
6 Function jmp-5

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.088	0.089	0.089	0.089	0.090	7
hc	0.019	0.019	0.019	0.019	0.019	8
sa	0.783	0.786	0.790	0.791	0.999	1
ea-1p1	0.100	0.102	0.103	0.103	0.106	6
ea-1p10	0.102	0.103	0.103	0.104	0.105	5
ea-10p1	0.012	0.013	0.013	0.013	0.013	9
ea-1c10	0.510	0.514	0.515	0.516	0.521	2
ga	0.004	0.004	0.004	0.004	0.004	10
pbil	0.264	0.289	0.325	0.383	0.503	3
umda	0.172	0.178	0.185	0.191	0.200	4
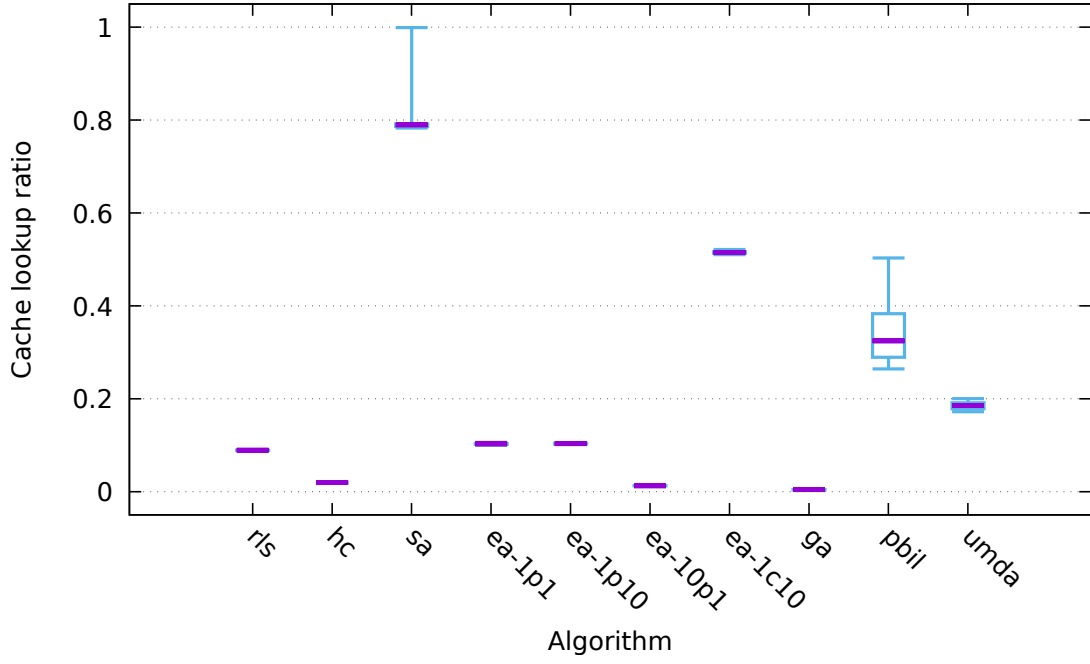
7   Function jmp-10

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.086	0.086	0.086	0.087	0.087	4
hc	0.019	0.019	0.019	0.019	0.019	8
sa	0.782	0.787	0.788	0.790	0.794	1
ea-1p1	0.057	0.058	0.058	0.058	0.059	7
ea-1p10	0.058	0.058	0.059	0.060	0.060	6
ea-10p1	0.010	0.010	0.010	0.010	0.010	9
ea-1c10	0.467	0.468	0.470	0.471	0.473	2
ga	0.003	0.003	0.003	0.004	0.004	10
pbil	0.214	0.243	0.274	0.303	0.370	3
umda	0.061	0.068	0.072	0.076	0.087	5
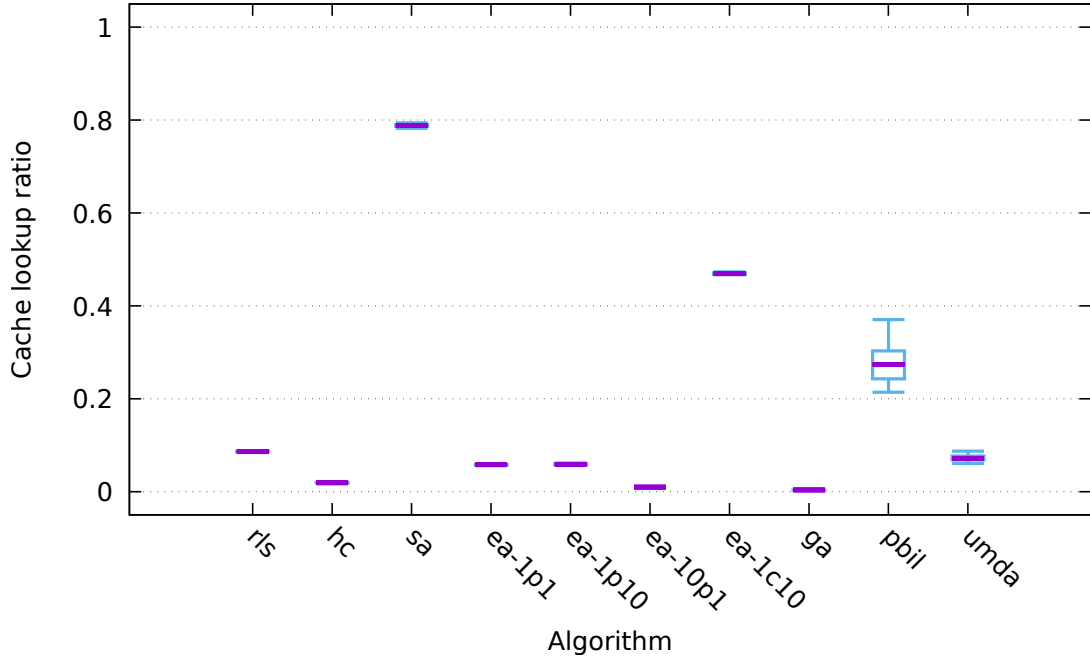
8 Function djmp-5

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.088	0.089	0.089	0.090	0.090	7
hc	0.019	0.019	0.019	0.019	0.019	8
sa	0.784	0.786	0.788	0.789	0.793	1
ea-1p1	0.101	0.102	0.103	0.104	0.106	6
ea-1p10	0.101	0.102	0.104	0.105	0.105	5
ea-10p1	0.012	0.013	0.013	0.013	0.013	9
ea-1c10	0.509	0.514	0.515	0.516	0.518	2
ga	0.004	0.004	0.004	0.004	0.004	10
pbil	0.249	0.284	0.343	0.388	0.447	3
umda	0.165	0.176	0.181	0.185	0.203	4
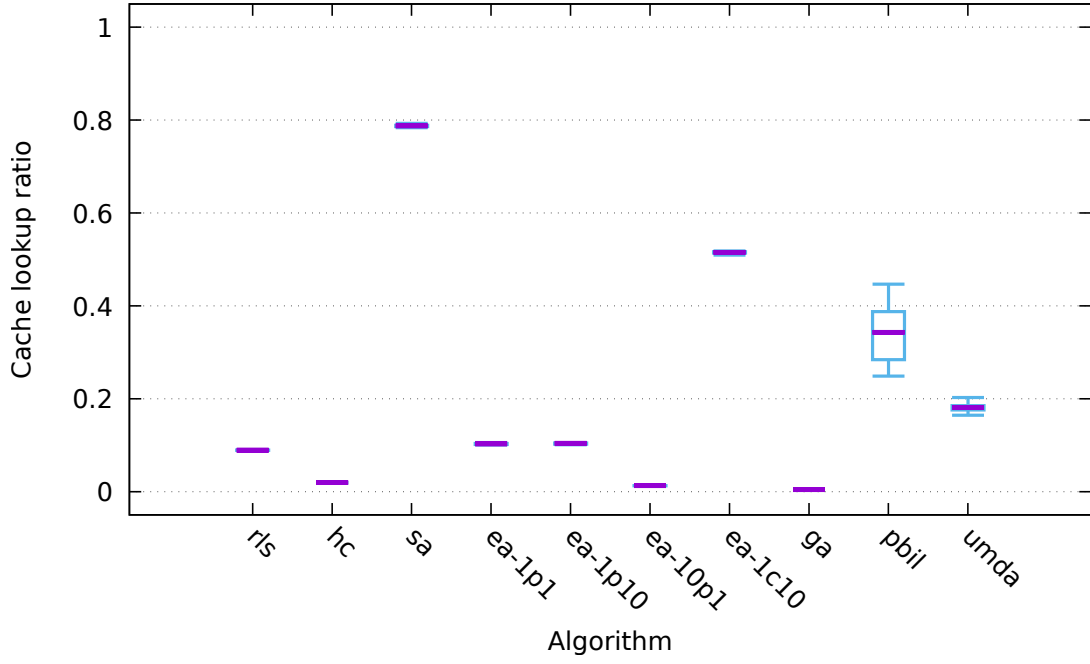
9 Function djmp-10

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.086	0.086	0.086	0.087	0.088	4
hc	0.019	0.019	0.019	0.019	0.019	8
sa	0.781	0.786	0.791	0.793	0.797	1
ea-1p1	0.057	0.058	0.059	0.059	0.060	7
ea-1p10	0.057	0.058	0.059	0.060	0.060	6
ea-10p1	0.009	0.010	0.010	0.010	0.010	9
ea-1c10	0.465	0.469	0.470	0.472	0.476	2
ga	0.003	0.003	0.004	0.004	0.004	10
pbil	0.156	0.217	0.250	0.277	0.415	3
umda	0.058	0.067	0.072	0.076	0.085	5
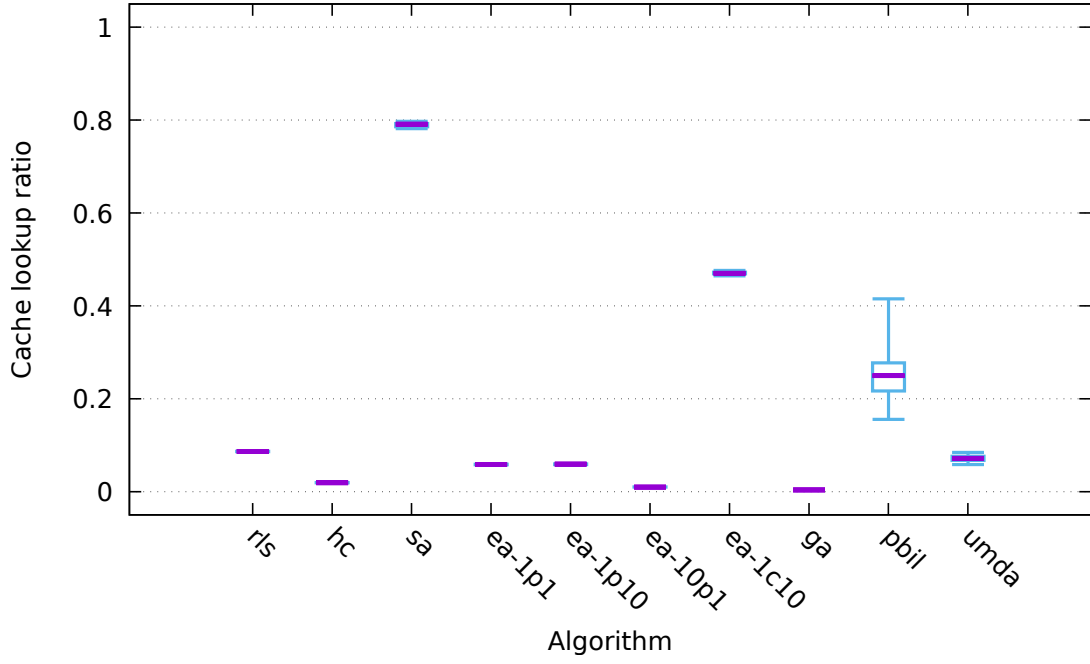
10 Function fp-5

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.039	0.041	0.042	0.043	0.044	9
hc	0.066	0.068	0.070	0.071	0.077	8
sa	0.617	0.810	0.983	0.986	0.989	1
ea-1p1	0.848	0.850	0.852	0.852	0.856	3
ea-1p10	0.845	0.849	0.850	0.853	0.854	4
ea-10p1	0.487	0.512	0.516	0.530	0.535	7
ea-1c10	0.589	0.609	0.622	0.634	0.664	6
ga	0.007	0.007	0.007	0.008	0.008	10
pbil	0.642	0.659	0.670	0.675	0.688	5
umda	0.874	0.875	0.878	0.882	0.885	2
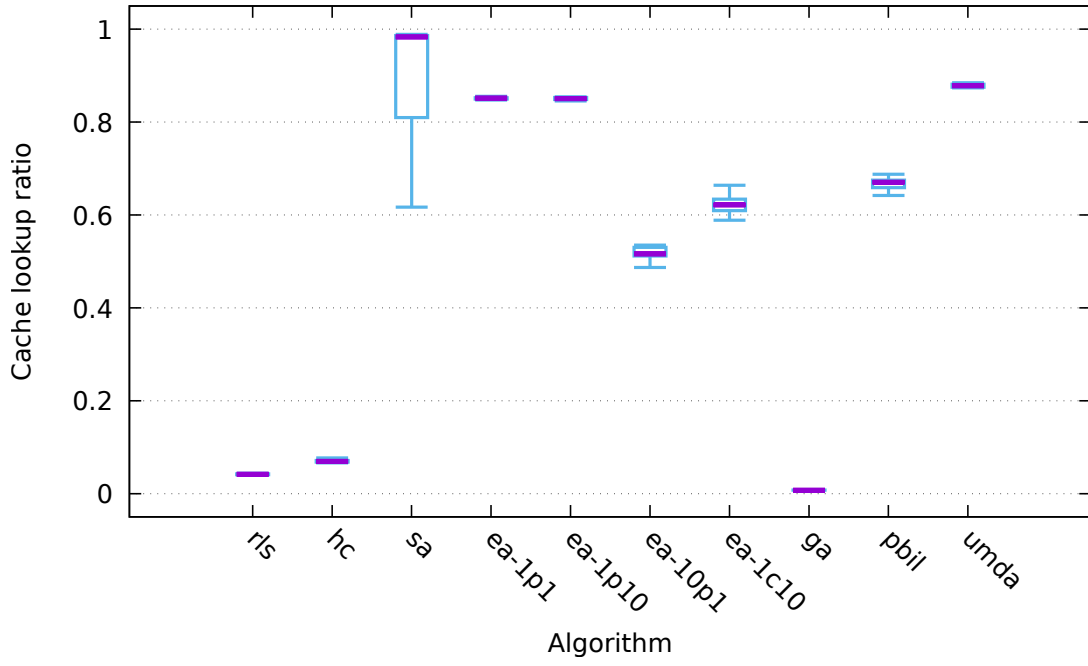
11   Function fp-10

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.037	0.038	0.038	0.040	0.043	9
hc	0.067	0.069	0.071	0.073	0.077	8
sa	0.511	0.981	0.984	0.985	0.989	1
ea-1p1	0.847	0.850	0.853	0.854	0.856	3
ea-1p10	0.842	0.848	0.850	0.852	0.857	4
ea-10p1	0.480	0.508	0.513	0.520	0.536	7
ea-1c10	0.583	0.598	0.611	0.622	0.643	6
ga	0.007	0.007	0.008	0.008	0.008	10
pbil	0.657	0.669	0.680	0.689	0.698	5
umda	0.868	0.873	0.877	0.879	0.883	2
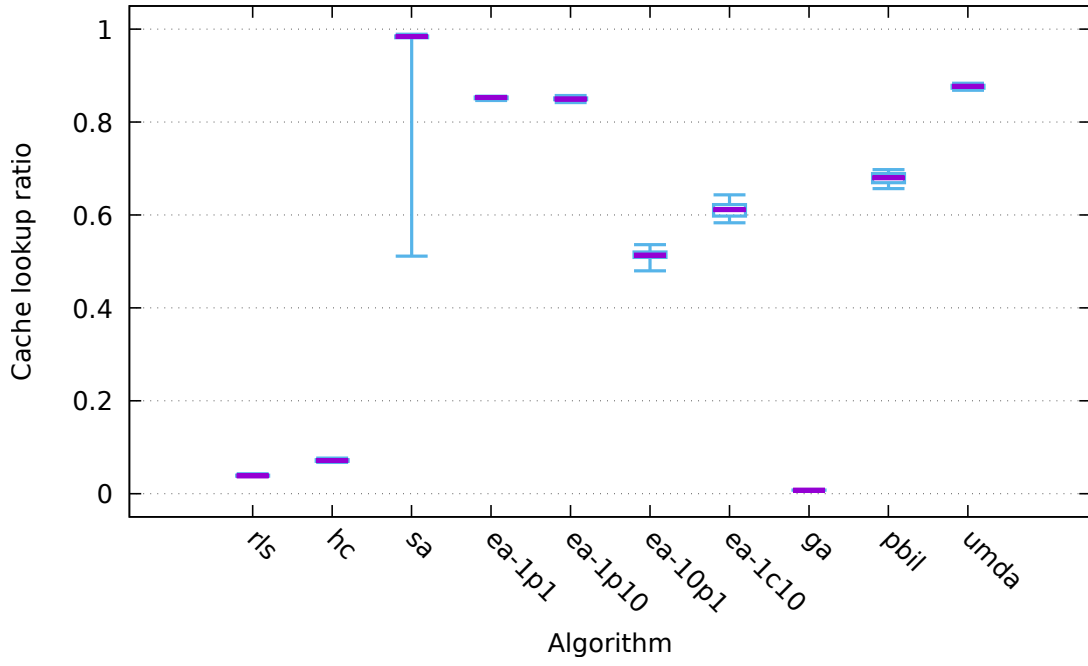
12 Function nk

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.102	0.102	0.103	0.103	0.104	8
hc	0.019	0.019	0.019	0.019	0.019	10
sa	0.855	0.865	0.875	0.888	0.915	2
ea-1p1	0.795	0.823	0.837	0.850	0.863	4
ea-1p10	0.765	0.822	0.841	0.853	0.863	3
ea-10p1	0.581	0.661	0.692	0.714	0.736	7
ea-1c10	0.689	0.710	0.725	0.748	0.774	6
ga	0.018	0.024	0.030	0.050	0.060	9
pbil	0.761	0.778	0.783	0.786	0.796	5
umda	0.848	0.873	0.885	0.900	0.901	1
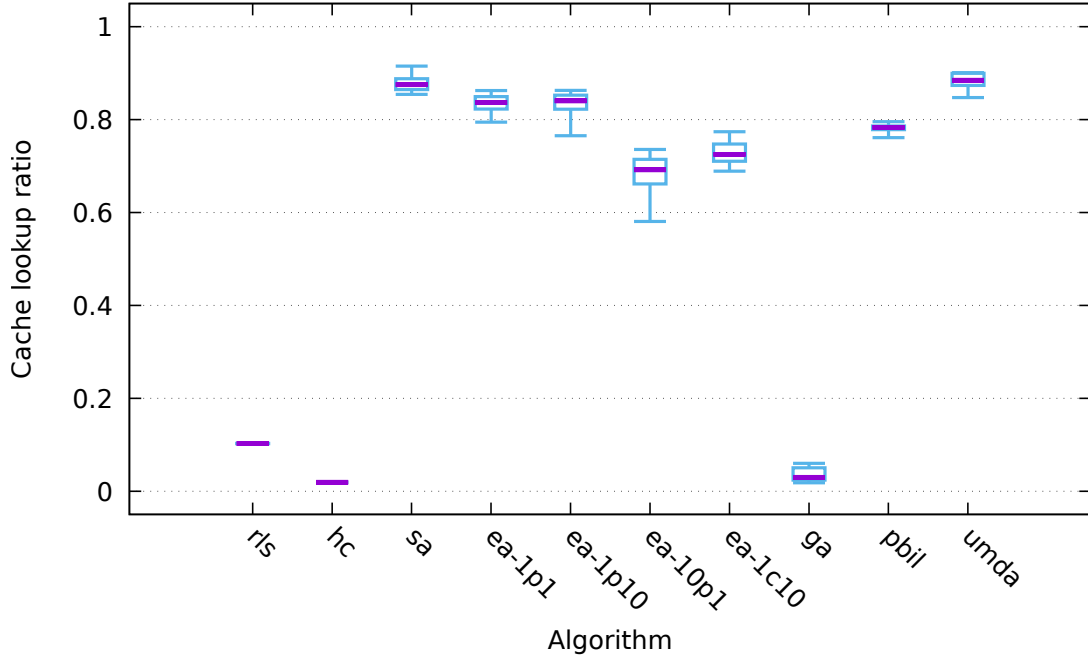
13 Function max-sat

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.096	0.097	0.097	0.098	0.100	8
hc	0.019	0.019	0.019	0.019	0.019	10
sa	0.505	0.694	0.775	0.791	0.803	1
ea-1p1	0.483	0.703	0.768	0.802	0.830	3
ea-1p10	0.508	0.657	0.747	0.790	0.812	4
ea-10p1	0.049	0.061	0.119	0.185	0.201	7
ea-1c10	0.601	0.648	0.683	0.704	0.765	6
ga	0.020	0.030	0.053	0.066	0.086	9
pbil	0.716	0.721	0.739	0.748	0.784	5
umda	0.701	0.746	0.774	0.810	0.828	2
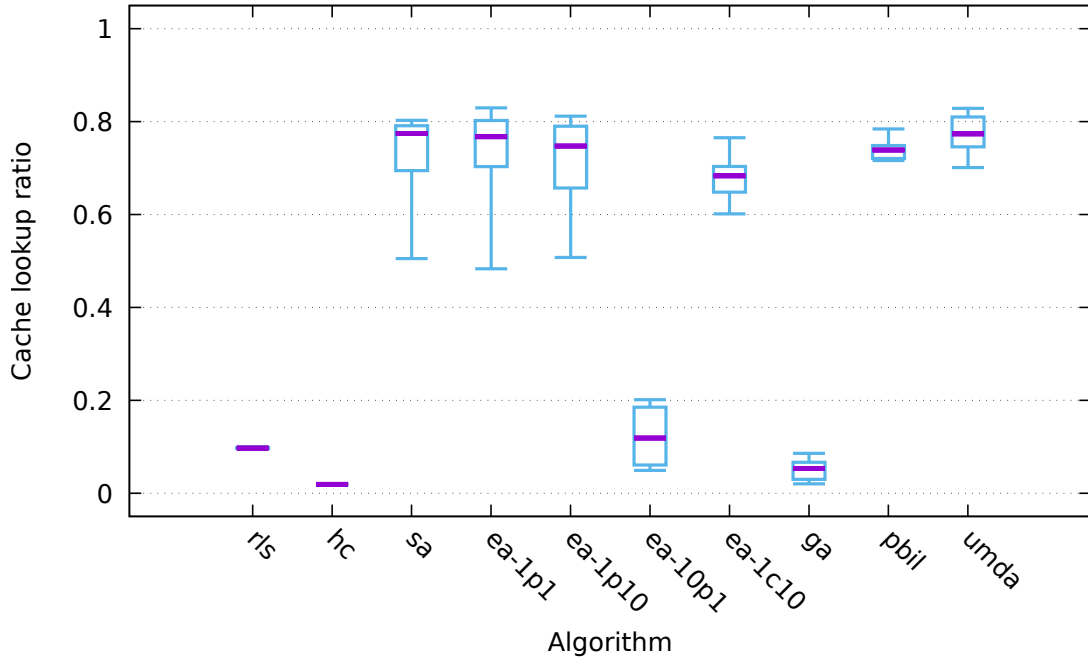
14   Function labs

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.117	0.118	0.119	0.119	0.119	8
hc	0.018	0.018	0.018	0.018	0.018	9
sa	0.934	0.944	0.959	0.973	0.987	1
ea-1p1	0.809	0.847	0.852	0.861	0.865	3
ea-1p10	0.783	0.838	0.852	0.860	0.865	4
ea-10p1	0.621	0.681	0.700	0.708	0.724	5
ea-1c10	0.652	0.659	0.668	0.672	0.688	6
ga	0.013	0.013	0.015	0.017	0.026	10
pbil	0.494	0.523	0.549	0.556	0.572	7
umda	0.879	0.883	0.897	0.900	0.903	2
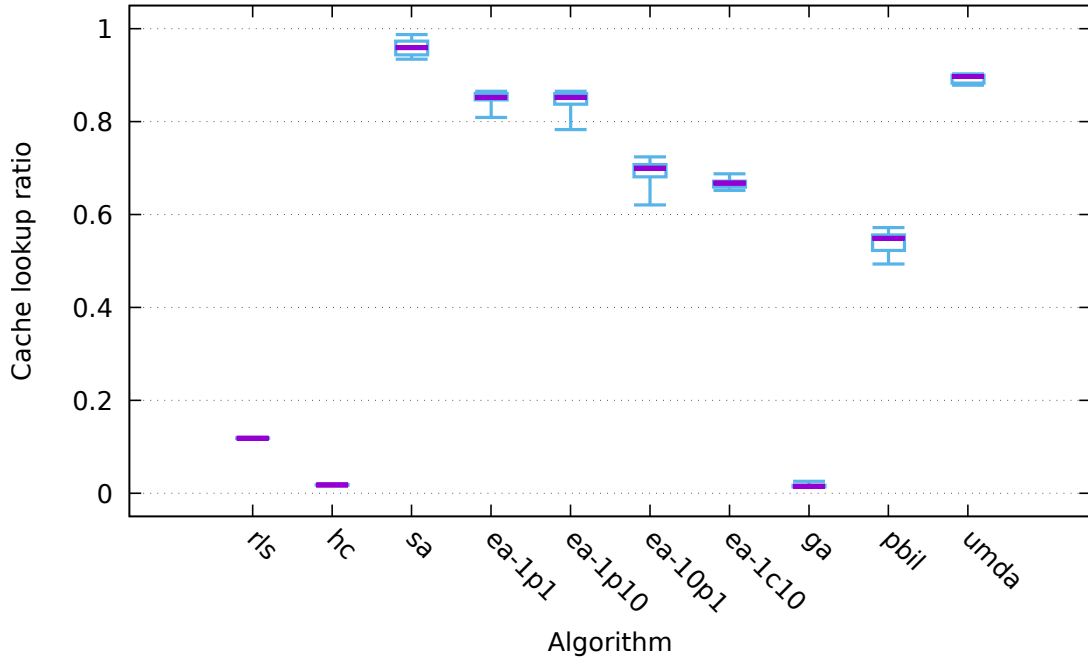
15 Function ep

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.152	0.152	0.153	0.153	0.155	7
hc	0.013	0.013	0.013	0.013	0.013	9
sa	0.594	0.629	0.650	0.666	0.699	4
ea-1p1	0.811	0.834	0.844	0.855	0.864	2
ea-1p10	0.804	0.824	0.843	0.851	0.864	3
ea-10p1	0.565	0.594	0.600	0.606	0.618	6
ea-1c10	0.604	0.611	0.613	0.619	0.625	5
ga	0.005	0.005	0.005	0.005	0.005	10
pbil	0.014	0.055	0.082	0.123	0.163	8
umda	0.834	0.864	0.874	0.881	0.887	1
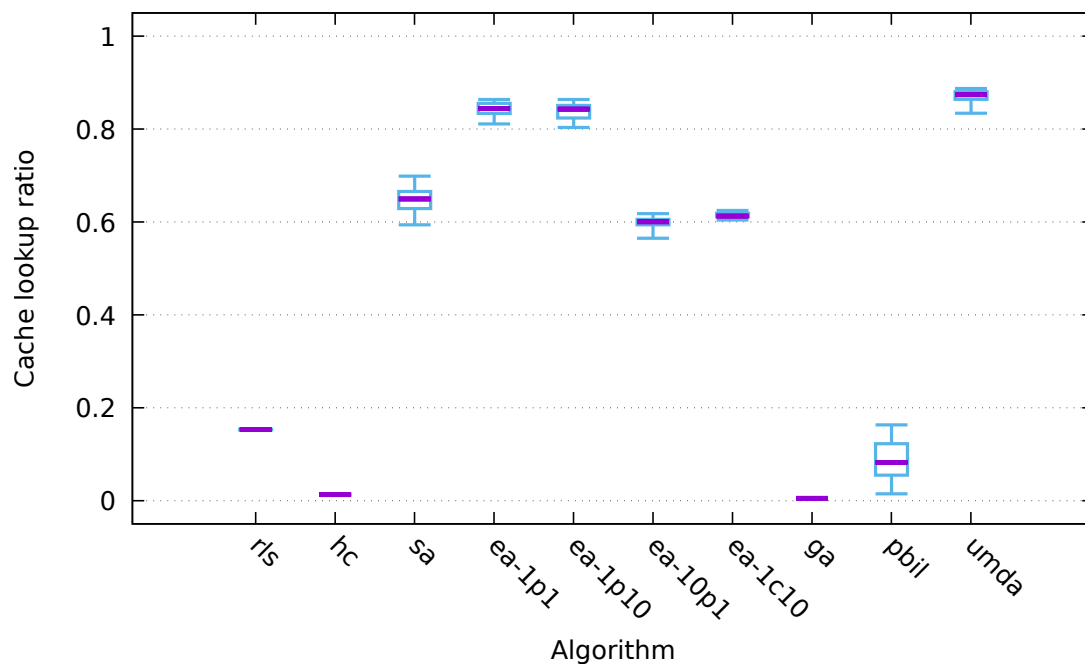
16 Function cancel

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.092	0.093	0.094	0.094	0.097	8
hc	0.018	0.018	0.018	0.018	0.018	9
sa	0.649	0.687	0.708	0.720	0.743	2
ea-1p1	0.576	0.678	0.705	0.747	0.785	3
ea-1p10	0.579	0.632	0.666	0.737	0.826	4
ea-10p1	0.208	0.393	0.489	0.509	0.626	7
ea-1c10	0.584	0.597	0.604	0.609	0.620	6
ga	0.006	0.006	0.006	0.007	0.007	10
pbil	0.572	0.610	0.614	0.626	0.653	5
umda	0.808	0.834	0.846	0.867	0.896	1
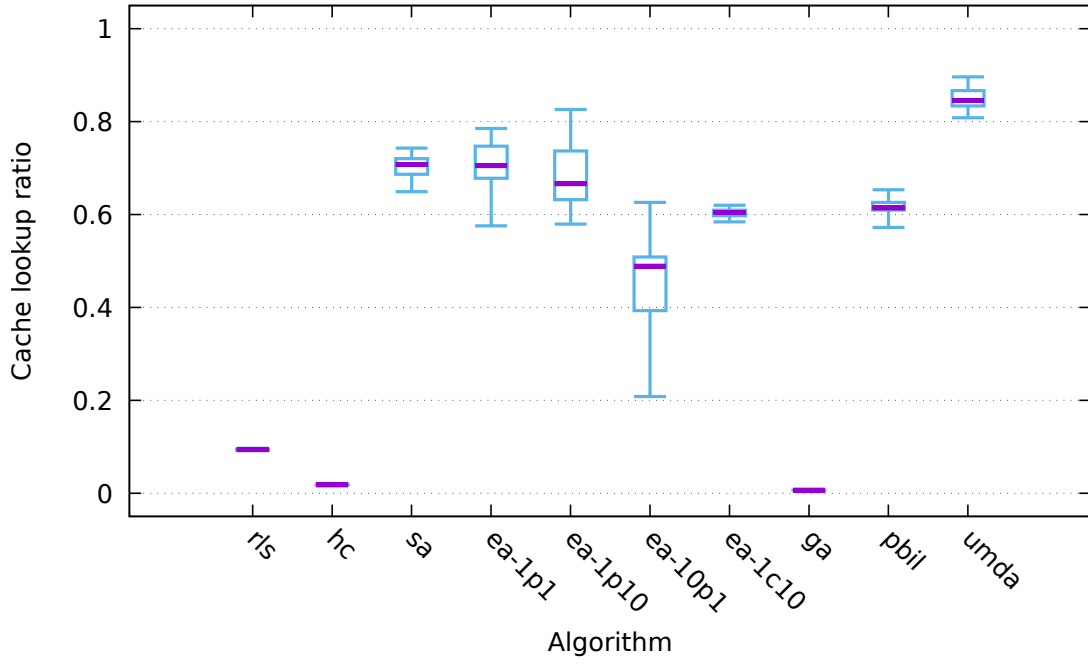
17 Function trap

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.135	0.137	0.138	0.141	0.142	9
hc	0.042	0.043	0.044	0.045	0.046	10
sa	0.893	0.898	0.900	0.901	0.903	2
ea-1p1	0.863	0.864	0.864	0.865	0.866	3
ea-1p10	0.863	0.864	0.864	0.864	0.865	4
ea-10p1	0.143	0.145	0.146	0.146	0.147	8
ea-1c10	0.849	0.856	0.858	0.861	0.863	5
ga	0.355	0.372	0.374	0.375	0.384	7
pbil	0.854	0.855	0.855	0.856	0.857	6
umda	0.903	0.904	0.904	0.905	0.905	1
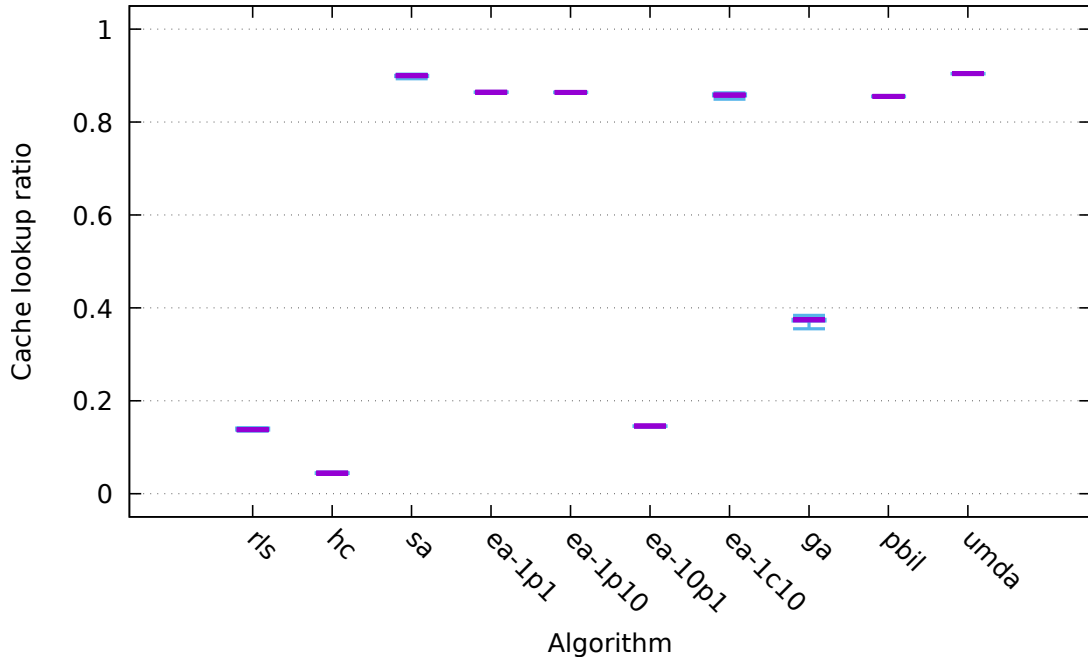
18 Function hiff

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.084	0.084	0.085	0.085	0.086	8
hc	0.015	0.015	0.015	0.015	0.015	9
sa	0.940	0.958	0.962	0.967	0.984	1
ea-1p1	0.800	0.810	0.820	0.822	0.836	3
ea-1p10	0.790	0.813	0.819	0.826	0.832	4
ea-10p1	0.234	0.276	0.298	0.325	0.383	7
ea-1c10	0.625	0.634	0.638	0.644	0.650	6
ga	0.005	0.006	0.006	0.007	0.021	10
pbil	0.754	0.760	0.765	0.771	0.781	5
umda	0.828	0.853	0.865	0.874	0.890	2
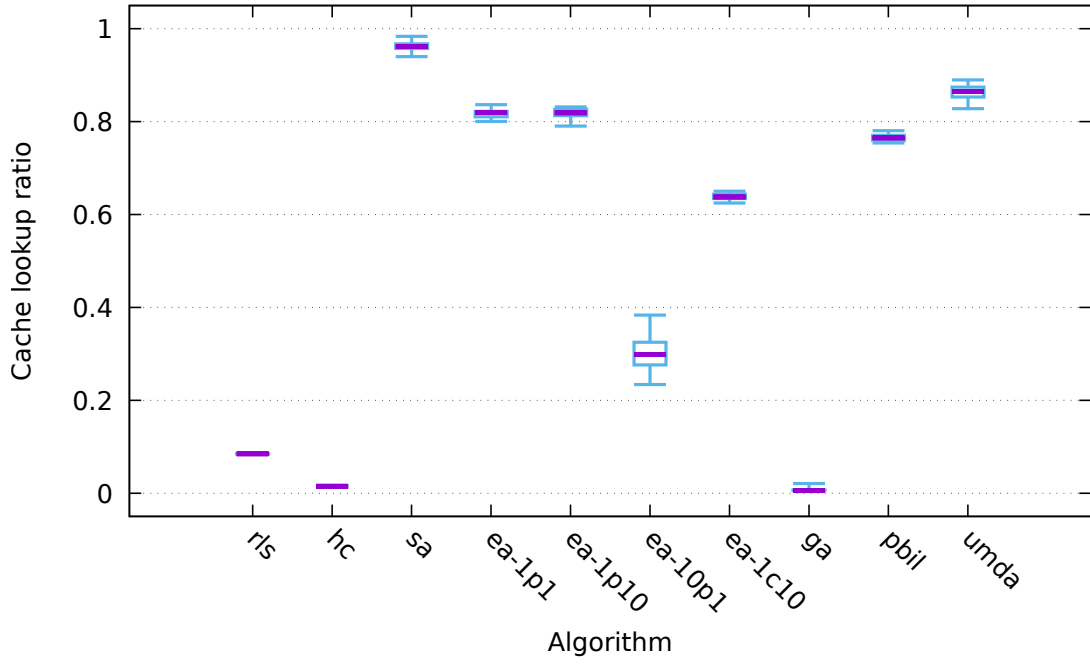
19 Function plateau

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.141	0.145	0.147	0.148	0.155	8
hc	0.045	0.046	0.047	0.047	0.049	10
sa	0.913	0.921	0.923	0.926	0.937	1
ea-1p1	0.611	0.620	0.634	0.642	0.694	5
ea-1p10	0.596	0.612	0.627	0.652	0.736	6
ea-10p1	0.137	0.138	0.139	0.139	0.140	9
ea-1c10	0.808	0.812	0.814	0.817	0.823	4
ga	0.368	0.371	0.374	0.377	0.379	7
pbil	0.840	0.844	0.848	0.852	0.855	2
umda	0.809	0.832	0.842	0.854	0.861	3
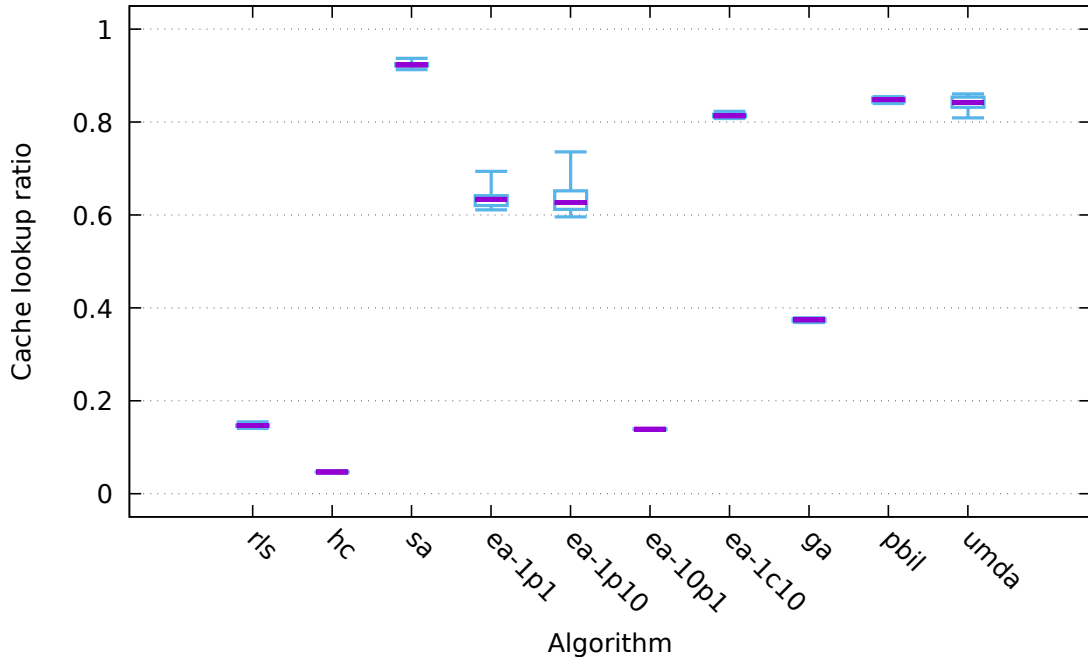
20 Function walsh2

algorithm	cache lookup ratio					
	min	Q_1	med.	Q_3	max	rk
rls	0.095	0.096	0.097	0.098	0.098	8
hc	0.019	0.019	0.019	0.019	0.020	10
sa	0.842	0.868	0.872	0.877	0.892	2
ea-1p1	0.811	0.855	0.861	0.863	0.865	3
ea-1p10	0.819	0.844	0.856	0.860	0.864	4
ea-10p1	0.653	0.709	0.719	0.726	0.733	7
ea-1c10	0.721	0.755	0.761	0.777	0.824	6
ga	0.022	0.033	0.051	0.060	0.145	9
pbil	0.756	0.778	0.783	0.795	0.800	5
umda	0.861	0.882	0.896	0.900	0.901	1
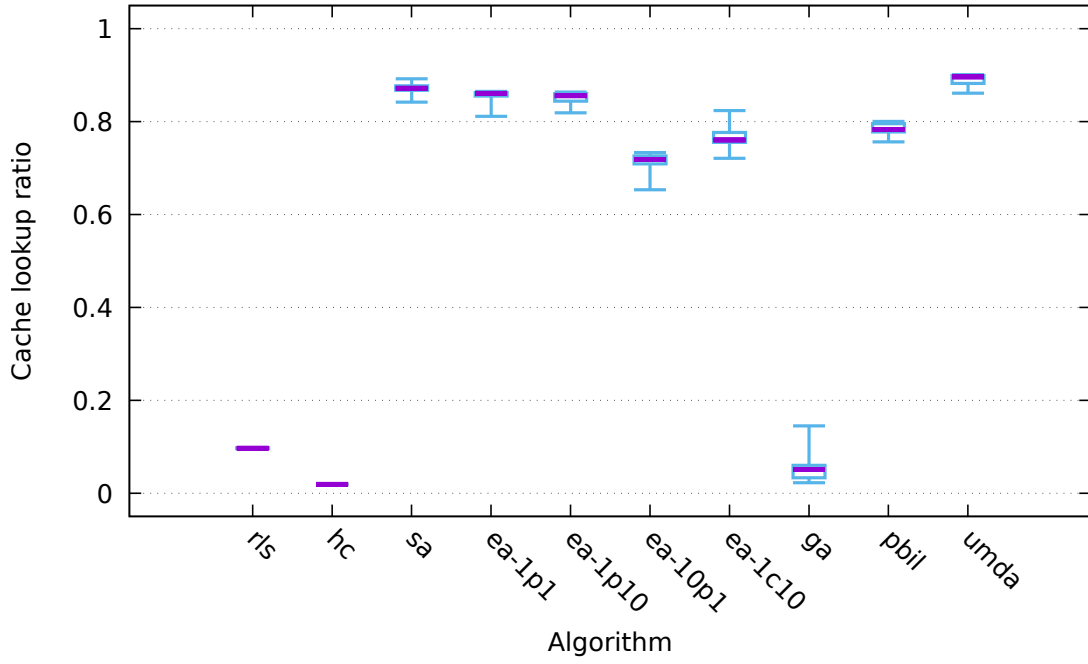
A Plan

```
{
    "exec": "hnco",
    "opt": "--print-results --map 1 --map-random -s 100 --cache --cache-budget",
    "budget": 300000,
    "num_runs": 20,
    "parallel": true,
    "functions": [
        {
            "id": "one-max",
            "opt": "-F 0",
            "rounding": {
                "value": { "before": 1, "after": 3 },
                "time": { "before": 1, "after": 2 } }
        },
        {
            "id": "lin",
            "opt": "-F 1 -p instances/lin.100",
            "rounding": {
                "value": { "before": 1, "after": 3 },
                "time": { "before": 1, "after": 2 } }
        },
        {
```

```json
        "id": "leading-ones",
        "opt": "-F 10",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "ridge",
        "opt": "-F 11",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "jmp-5",
        "opt": "-F 30 -t 5",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "jmp-10",
        "opt": "-F 30 -t 10",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "djmp-5",
        "opt": "-F 31 -t 5",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "djmp-10",
        "opt": "-F 31 -t 10",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "fp-5",
        "opt": "-F 40 -t 5",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "fp-10",
        "opt": "-F 40 -t 10",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "nk",
        "opt": "-F 60 -p instances/nk.100.4",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
```

```json
        "id": "max-sat",
        "opt": "-F 70 -p instances/ms.100.3.1000",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "labs",
        "opt": "-F 81",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "ep",
        "opt": "-F 90 -p instances/ep.100",
        "reverse": true,
        "logscale": true,
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "cancel",
        "opt": "-F 100 -s 99",
        "reverse": true,
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "trap",
        "opt": "-F 110 --fn-num-traps 10",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "hiff",
        "opt": "-F 120 -s 128",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "plateau",
        "opt": "-F 130",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    },
    {
        "id": "walsh2",
        "opt": "-F 162 -p instances/walsh2.100",
        "rounding": {
            "value": { "before": 1, "after": 3 },
            "time": { "before": 1, "after": 2 } }
    }
],
"algorithms": [
    {
        "id": "rls",
        "opt": "-A 100 --restart"
```

```
        },
        {
            "id": "hc",
            "opt": "-A 150 --restart"
        },
        {

            "id": "sa",
            "opt": "-A 200 --sa-beta-ratio 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 --allow-no-mutation"
        },
        {
            "id": "ga",
            "opt": "-A 400 --ea-mu 100"
        },
        {

            "id": "pbil",
            "opt": "-A 500 -l 5e-3"
        },
        {

            "id": "umda",
            "opt": "-A 600 -x 100 -y 10"
        }
    ]
}
```

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_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
# 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 = 0.15
# Generated from hnco.json
```