Comparison tables: BBOB 2009 function testbed in 40-D

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2009, see `http://coco.gforge.inria.fr/doku.php?id=bbob-2009`. More than 30 algorithms have been tested on 24 benchmark functions in dimensions between 2 and 40. A description of the used objective functions can be found in [9, 5]. The experimental set-up is described in [8].

The performance measure provided in the following tables is the expected number of objective function evaluations to reach a given target function value (ERT, expected running time), divided by the respective value for the best algorithm. Consequently, the best (smallest) value is 1 and the value 1 appears in each column at least once. See [8] for details on how ERT is obtained. All numbers are computed with no more than two digits of precision.

Table 1: 40-D, running time excess ERT/ERT_{best} on f_1, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

1 Sphere

Δftarget ERT_{best}/D	1e+03 0.025	1e+02 2.07	1e+01 2.08	1e+00 2.08	1e-01 2.08	1e-02 2.08	1e-03 2.08	1e-04 2.08	1e-05 2.08	1e-07 2.08	Δftarget ERT_{best}/D
ALPS	**1**	46	220	420	640	870	1100	1400	1700	2800	ALPS [12]
AMaLGaM IDEA	**1**	46	150	290	430	560	690	810	970	1200	AMaLGaM IDEA [4]
avg NEWUOA	**1**	3.2	**3.2**	**3.2**	**3.2**	**3.2**	**3.2**	**3.2**	**3.2**	**3.2**	avg NEWUOA [17]
BayEDAcG	**1**	60	210	350	500	650	790	940	*64e-6/2e3*	.	BayEDAcG [6]
BFGS	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BFGS [16]
BIPOP-CMA-ES	**1**	3.1	9.6	15	21	28	34	40	45	58	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**3**	7	11	15	19	23	27	31	39	(1+1)-CMA-ES [2]
DASA	**1**	13	33	57	94	130	180	220	260	340	DASA [13]
DEPSO	**1**	12	65	360	1.4e4	*15e-2/2e3*	.	.	.	.	DEPSO [7]
simple GA	**1**	400	1500	3e3	2.3e4	6.8e5	*45e-3/1e5*	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	17	73	130	180	240	290	350	410	520	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	3.9	13	21	28	35	42	49	55	67	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1**	**2.5**	5.8	9.2	13	16	19	23	26	33	(1+1)-ES [1]
Monte Carlo	**1**	*13e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	3	8.7	14	19	25	30	35	41	51	IPOP-SEP-CMA-ES [15]

Table 2: 40-D, running time excess ERT/ERT$_{\text{best}}$ on f_2, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

2 Ellipsoid separable

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	74.3	96.6	118	137	155	172	190	208	221	256	ERT$_{\text{best}}$/D
ALPS	14	15	17	19	20	23	26	32	46	140	ALPS [12]
AMaLGaM IDEA	14	14	14	14	14	14	14	14	14	14	AMaLGaM IDEA [4]
avg NEWUOA	**2**	4.7	6	9	10	12	12	13	13	14	avg NEWUOA [17]
BayEDAcG	13	13	13	14	*33e-2/2e3*	.	.	.	.	.	BayEDAcG [6]
BFGS	4.3	5.5	6	6.1	5.9	5.6	5.4	5	4.8	4.4	BFGS [16]
BIPOP-CMA-ES	7.7	9.8	11	10	10	9.5	9	8.4	8	7.1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	6	8.1	9.3	9.5	9.5	9.3	8.7	8.2	7.8	6.8	(1+1)-CMA-ES [2]
DASA	**1.7**	**2.1**	**2.5**	**2.8**	**3**	**3.3**	**3.4**	**3.5**	**3.7**	**3.8**	DASA [13]
DEPSO	28	310	*65e+1/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	610	2200	*24e+1/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	6.2	7.4	7.7	7.7	7.7	7.6	7.4	7.3	7.4	7.3	iAMaLGaM IDEA [4]
NELDER (Han)	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Han) [11]
NEWUOA	**1**	**2.6**	4.4	6.4	8.8	9.9	11	12	13	13	NEWUOA [17]
(1+1)-ES	140	630	1500	2500	3400	4400	8900	1.4e4	6.8e4	*93e-5/1e6*	(1+1)-ES [1]
Monte Carlo	*12e+5/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1.4**	**1.5**	**1.5**	**1.4**	**1.3**	**1.3**	**1.2**	**1.2**	**1.2**	**1.1**	IPOP-SEP-CMA-ES [15]

Table 3: 40-D, running time excess ERT/ERT_{best} on f_3, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

3 Rastrigin separable

Δftarget ERT_{best}/D	1e+03 5.56	1e+02 116	1e+01 440	1e+00 24600	1e-01 1.59e5	1e-02 1.59e5	1e-03 1.59e5	1e-04 1.59e5	1e-05 1.59e5	1e-07 1.59e5	Δftarget ERT_{best}/D
ALPS	11	32	*16e+0/1e5*	.	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	13	16	2800	***11e+0/1e6***	.	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	21	*38e+1/1e4*	.	.	.	.	.	.	.	.	avg NEWUOA [17]
BayEDAcG	19	*24e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	110	*64e+1/8e3*	.	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1**	**1.1**	*12e+0/3e5*	.	.	.	.	.	.	.	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	4.1	*33e+1/1e4*	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	3.5	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	DASA [13]
DEPSO	3.1	*28e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	92	39	**420**	***11e+0/1e5***	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	4	4.6	**770**	***90e-1/1e6***	.	.	.	.	.	.	iAMaLGaM IDEA [4]
NELDER (Han)	**1.9**	*38e+1/1e4*	.	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	7.7	*46e+1/7e3*	.	.	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	300	*42e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	1.5e4	*87e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1.2**	*16e+0/1e4*	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 4: 40-D, running time excess ERT/ERT_{best} on f_4, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

4 Skew Rastrigin-Bueche separable

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	11	134	574	1.7e6	nan	nan	nan	nan	nan	nan	ERT_{best}/D
ALPS	12	66	***26e+0/1e5***	.	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	24	18	***32e+0/1e6***	.	.	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	7.5	*36e+1/3e4*	.	.	.	.	.	.	.	.	avg NEWUOA [17]
BayEDAcG	27	*25e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	1200	*97e+1/1e4*	.	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1.1**	**3.9**	***27e+0/3e5***	.	.	.	.	.	.	.	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	16	*54e+1/1e4*	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**2.5**	**1**	**1**	**1**	***20e-1/1e6***	.	.	.	.	.	DASA [13]
DEPSO	3.4	*33e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	85	39	**2500**	***17e+0/1e5***	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	6.4	**4.3**	***34e+0/1e6***	.	.	.	.	.	.	.	iAMaLGaM IDEA [4]
NELDER (Han)	110	*63e+1/1e4*	.	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	14	*54e+1/2e4*	.	.	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	2900	*67e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	6.3e5	*11e+2/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	5.3	***30e+0/1e4***	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 5: 40-D, running time excess ERT/ERT$_{\text{best}}$ on f_5, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

5 Linear slope

Δftarget ERT$_{\text{best}}$/D	1e+03 0.025	1e+02 2.13	1e+01 2.45	1e+00 2.89	1e-01 3	1e-02 3.01	1e-03 3.01	1e-04 3.01	1e-05 3.01	1e-07 3.01	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	81	140	160	180	200	210	220	230	230	ALPS [12]
AMaLGaM IDEA	**1**	97	120	100	100	100	100	100	100	100	AMaLGaM IDEA [4]
avg NEWUOA	**1**	3.1	3.1	3.2	3.4	3.4	3.4	3.4	3.4	3.4	avg NEWUOA [17]
BayEDAcG	**1**	140	210	220	220	220	220	220	220	220	BayEDAcG [6]
BFGS	**1**	**1.4**	**2.1**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	BFGS [16]
BIPOP-CMA-ES	**1**	3.2	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1.9**	3	**3**	**2.9**	**3**	**3**	**3**	**3**	**3**	(1+1)-CMA-ES [2]
DASA	**1**	12	17	19	23	27	34	41	50	69	DASA [13]
DEPSO	**1**	18	29	30	30	31	31	31	31	31	DEPSO [7]
simple GA	**1**	1100	3e3	4800	7e3	9500	1.2e4	1.5e4	1.9e4	*19e-8/1e5*	simple GA [14]
iAMaLGaM IDEA	**1**	5.6	8.1	7.4	7.2	7.1	7.1	7.1	7.1	7.1	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	9.1	14	13	13	13	13	13	13	13	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1**	**1.8**	**2.9**	**3**	**2.9**	**2.9**	**2.9**	**2.9**	**2.9**	**2.9**	(1+1)-ES [1]
Monte Carlo	**1**	*36e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	3.3	5.2	5.4	5.3	5.2	5.3	5.3	5.3	5.3	IPOP-SEP-CMA-ES [15]

Table 6: 40-D, running time excess ERT/ERT$_{\text{best}}$ on f_6, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

6 Attractive sector

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	4.87	46	87.7	138	179	237	288	332	375	481	ERT$_{\text{best}}$/D
ALPS	56	28	53	93	330	*24e-3/1e5*	.	.	.	.	ALPS [12]
AMaLGaM IDEA	280	67	56	48	47	43	42	41	41	40	AMaLGaM IDEA [4]
avg NEWUOA	4.7	**1.5**	**1.3**	**1.3**	**1.2**	**1.2**	**1.1**	**1.2**	**1.1**	**1.1**	avg NEWUOA [17]
BayEDAcG	70	160	*13e+1/2e3*	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1.9**	3.3	4.2	4.4	4.6	4.5	4.5	4.6	4.9	18	BFGS [16]
BIPOP-CMA-ES	6.1	**1.9**	**1.6**	**1.5**	**1.5**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	3.6	6.6	360	*12e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	9	8.8	18	25	36	41	46	52	56	59	DASA [13]
DEPSO	12	19	*38e+0/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	350	730	*65e+0/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	26	9.4	10	9.9	11	10	10	11	11	11	iAMaLGaM IDEA [4]
NELDER (Han)	3.3	**2.7**	**2.7**	**2.5**	**2.6**	**2.8**	3.5	5.5	16	68	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**3.1**	**1.9**	3.2	4.6	6.1	6.8	7.4	8.1	8.6	9	(1+1)-ES [1]
Monte Carlo	*12e+4/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	6.5	**1.9**	**1.9**	**1.8**	**1.9**	**1.8**	**1.8**	**2**	**2**	**2**	IPOP-SEP-CMA-ES [15]

Table 7: 40-D, running time excess ERT/ERT_{best} on f_7, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

7 Step-ellipsoid

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	2.64	30.6	267	446	1030	1660	1660	1660	1660	1700	ERT_{best}/D
ALPS	14	14	2e3	*13e+0/1e5*	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	14	12	**2.5**	**2.2**	**1.3**	**1**	**1**	**1**	**1**	**1**	AMaLGaM IDEA [4]
avg NEWUOA	**2.6**	5.4	*24e+0/4e4*	.	.	.	.	.	.	.	avg NEWUOA [17]
BayEDAcG	24	23	*26e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	*20e+2/100*	.	.	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1.5**	**1**	**1.2**	8.3	4	**2.6**	**2.6**	**2.6**	**2.6**	**2.5**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1.8**	73	100	*12e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	6	2200	*76e+0/2e5*	.	.	.	.	.	.	.	DASA [13]
DEPSO	4.9	7.5	*27e+0/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	96	110	*36e+0/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	3.9	**4**	**1**	**1**	**1**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	iAMaLGaM IDEA [4]
NELDER (Han)	**1.8**	100	*70e+0/1e4*	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	880	*77e+0/6e4*	.	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	770	*24e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	260	*54e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1.4**	**1**	**2.3**	**5.2**	**2.5**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	IPOP-SEP-CMA-ES [15]

Table 8: 40-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_8, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

8 Rosenbrock original

Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D	1e+03 15.2	1e+02 40.4	1e+01 177	1e+00 266	1e-01 275	1e-02 282	1e-03 286	1e-04 289	1e-05 293	1e-07 299	Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	40	84	530	1100	1900	2e3	3200	*14e-1/1e5*	.	.	ALPS [12]
AMaLGaM IDEA	27	20	47	40	41	42	43	43	43	44	AMaLGaM IDEA [4]
avg NEWUOA	**1.6**	**1.7**	**1.2**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	avg NEWUOA [17]
BayEDAcG	38	50	*87e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1.1**	**1.7**	**2.4**	**2.3**	**2.3**	**2.3**	**2.3**	**2.2**	**2.2**	**2.2**	BFGS [16]
BIPOP-CMA-ES	**1.8**	**1.7**	7.3	7.7	7.9	7.9	7.9	7.9	7.9	7.8	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1.2**	**1**	8.3	8.3	8.6	8.7	8.8	8.8	8.8	8.9	(1+1)-CMA-ES [2]
DASA	6.6	27	55	61	85	120	150	190	220	290	DASA [13]
DEPSO	16	130	*13e+1/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	270	1200	*91e+0/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	11	7.5	17	15	15	15	16	16	16	16	iAMaLGaM IDEA [4]
NELDER (Han)	**2.4**	4	150	280	550	540	530	530	520	510	NELDER (Han) [11]
NEWUOA	**1**	**1.4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1**	5.5	27	67	73	85	100	120	130	170	(1+1)-ES [1]
Monte Carlo	*87e+3/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1.6**	**2**	9.7	9.1	9.2	9.1	9.1	9.1	9.1	9	IPOP-SEP-CMA-ES [15]

Table 9: 40-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_9, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

9 Rosenbrock rotated

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	12.7	34.9	153	325	333	337	341	345	348	354	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	21	36	*28e+0/1e5*	.	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	28	18	54	32	34	35	35	36	36	37	AMaLGaM IDEA [4]
avg NEWUOA	**1.7**	**1.3**	**1.4**	**1.1**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	avg NEWUOA [17]
BayEDAcG	38	26	*38e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1.1**	**1.4**	**2.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	BFGS [16]
BIPOP-CMA-ES	**1.8**	**1.5**	8.2	6.2	6.4	6.5	6.5	6.5	6.5	6.5	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1.2**	**1.2**	9.7	9.7	10	10	10	10	10	10	(1+1)-CMA-ES [2]
DASA	7.7	12	410	420	520	650	820	980	1100	1600	DASA [13]
DEPSO	14	110	*11e+1/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	270	3500	*11e+1/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	13	8.5	20	12	13	13	13	13	13	14	iAMaLGaM IDEA [4]
NELDER (Han)	**1.6**	**2.3**	160	230	460	450	440	440	*14e+0/1e4*	.	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1.2**	**1.4**	33	91	95	110	120	130	150	170	(1+1)-ES [1]
Monte Carlo	*83e+3/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1.6**	**1.2**	10	6.9	7.1	7.1	7.1	7.1	7.1	7.1	IPOP-SEP-CMA-ES [15]

Table 10: 40-D, running time excess ERT/$\mathrm{ERT_{best}}$ on f_{10}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

10 Ellipsoid

Δftarget $\mathrm{ERT_{best}}$/D	1e+03 165	1e+02 402	1e+01 647	1e+00 759	1e-01 920	1e-02 1290	1e-03 1400	1e-04 1520	1e-05 1630	1e-07 1770	Δftarget $\mathrm{ERT_{best}}$/D
ALPS	*28e+2/1e5*	.	.	.	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	6.3	3.2	**2.4**	**2.4**	**2.2**	**1.8**	**1.9**	**1.9**	**1.9**	**2.1**	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	**1.6**	**1.4**	**1.9**	**1.8**	**1.7**	**1.8**	**1.9**	**1.9**	**2.1**	avg NEWUOA [17]
BayEDAcG	*16e+4/2e3*	.	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1.7**	**1.2**	**1**	**1**	**1**	**2.1**	7.8	34	220	*40e-6/1e5*	BFGS [16]
BIPOP-CMA-ES	3.6	**2.3**	**1.9**	**1.9**	**1.7**	**1.3**	**1.2**	**1.2**	**1.1**	**1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**2.8**	**2**	**1.7**	**1.7**	**1.6**	**1.3**	**1.2**	**1.1**	**1.1**	**1**	(1+1)-CMA-ES [2]
DASA	290	1e3	2.3e4	*23e+0/1e6*	.	.	.	.	.	.	DASA [13]
DEPSO	*14e+4/2e3*	.	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	*83e+3/1e5*	.	.	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**2.9**	**1.9**	**1.4**	**1.4**	**1.3**	**1**	**1**	**1**	**1**	**1.1**	iAMaLGaM IDEA [4]
NELDER (Han)	5.9	*35e+1/1e4*	.	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1.2**	**1.6**	**1.8**	**1.5**	**1.7**	**1.8**	**1.9**	**2.1**	NEWUOA [17]
(1+1)-ES	46	130	260	430	580	620	1e3	1600	*33e-5/1e6*	.	(1+1)-ES [1]
Monte Carlo	*13e+5/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	6.2	3.8	**2.9**	**2.7**	**2.4**	**1.8**	**1.7**	**1.5**	**1.5**	**1.4**	IPOP-SEP-CMA-ES [15]

Table 11: 40-D, running time excess ERT/ERT_{best} on f_{11}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

11 Discus

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	1.78	22.6	59.2	121	292	562	674	769	888	1090	ERT_{best}/D
ALPS	**2.7**	240	970	*33e-1/1e5*	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	**2.6**	11	9.5	6.8	3.8	**2.5**	**2.4**	**2.5**	**2.5**	**2.5**	AMaLGaM IDEA [4]
avg NEWUOA	3.4	**5.5**	**3.9**	**2.8**	**1.5**	**1**	**1**	**1**	**1**	**1**	avg NEWUOA [17]
BayEDAcG	**2.3**	*26e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**2.8**	**1**	**1**	**1**	**1**	**2.5**	72	*29e-4/1e4*	.	.	BFGS [16]
BIPOP-CMA-ES	99	35	15	8	3.5	**1.9**	**1.6**	**1.5**	**1.3**	**1.1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	21	9.8	7.1	5.5	3.1	**2.1**	**2.2**	**2.3**	**2.4**	**2.6**	(1+1)-CMA-ES [2]
DASA	**1**	230	590	790	500	440	490	540	630	1e3	DASA [13]
DEPSO	6	*24e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	3.5	820	*43e+0/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1.8**	**8.5**	**5**	**3.3**	**1.8**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	iAMaLGaM IDEA [4]
NELDER (Han)	**1.6**	88	*53e+0/1e4*	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	18	13	9.9	4.9	3.2	3	**3**	**3**	**3**	NEWUOA [17]
(1+1)-ES	2300	1100	870	650	350	240	240	240	240	250	(1+1)-ES [1]
Monte Carlo	**2.4**	*20e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	130	57	25	13	5.7	3	**2.6**	**2.3**	**2.1**	**1.7**	IPOP-SEP-CMA-ES [15]

Table 12: 40-D, running time excess ERT/ERT$_{\text{best}}$ on f_{12}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

12 Bent cigar

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	36	39.9	104	186	229	269	329	526	569	630	ERT$_{\text{best}}$/D
ALPS	67	81	180	690	8100	*83e-2/1e5*	.	.	.	.	ALPS [12]
AMaLGaM IDEA	46	48	21	13	14	16	17	13	14	15	AMaLGaM IDEA [4]
avg NEWUOA	**1.5**	6.5	21	24	31	38	42	32	39	86	avg NEWUOA [17]
BayEDAcG	66	*44e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	**1.1**	**1**	**1**	**1**	**1**	**1**	4.6	15	660	BFGS [16]
BIPOP-CMA-ES	**2.1**	**2.8**	**2.2**	**2.3**	**2.5**	**2.5**	**2.5**	**1.8**	**1.9**	**1.9**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1.4**	**1.7**	**2.1**	3.1	4.1	4.4	4.6	3.4	3.6	4.1	(1+1)-CMA-ES [2]
DASA	20	27	3.8e4	3.5e4	*22e+0/1e6*	.	.	.	.	.	DASA [13]
DEPSO	*12e+4/2e3*	.	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	*40e+3/1e5*	.	.	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	17	18	8.6	6.4	7	7.3	7.2	5.2	5.4	5.7	iAMaLGaM IDEA [4]
NELDER (Han)	**2.4**	**2.5**	15	24	52	190	*42e-3/1e4*	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1.4**	**1.4**	**1.4**	**1.5**	**1.4**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1.2**	1300	4800	7700	*14e-1/1e6*	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	*16e+7/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1.8**	**2.8**	**2.8**	3.6	4.2	4.2	3.9	**2.7**	**2.7**	**2.7**	IPOP-SEP-CMA-ES [15]

Table 13: 40-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_{13}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

13 Sharp ridge

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	3.73	9.74	50.7	173	218	297	1800	2100	2460	2990	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	80	180	130	190	860	*85e-3/1e5*	.	.	.	.	ALPS [12]
AMaLGaM IDEA	88	93	28	12	12	10	**2**	**2**	**1.9**	**1.9**	AMaLGaM IDEA [4]
BayEDAcG	100	160	*52e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1.2**	**1.8**	**1.4**	**1**	**1**	**1**	46	73	*16e-4/4e4*	.	BFGS [16]
BIPOP-CMA-ES	4.6	5.1	**2.6**	**2.6**	5	17	4.4	5.2	5.3	5.9	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	3.3	3.3	**1.7**	4.2	9.5	20	5.6	9.7	18	48	(1+1)-CMA-ES [2]
DASA	15	24	40	73	150	540	220	940	2900	*21e-5/1e6*	DASA [13]
DEPSO	21	1500	*12e+1/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	540	6800	*91e+0/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	25	33	11	4.5	**4.7**	**4.8**	**1**	**1**	**1**	**1**	iAMaLGaM IDEA [4]
NELDER (Han)	4.8	5.9	9.8	20	71	160	41	*13e-2/1e4*	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	**2**	**3**	13	7.3	15	28	*88e-5/1e4*	NEWUOA [17]
(1+1)-ES	**2.9**	**3.3**	4.7	4.5	18	36	11	37	100	1400	(1+1)-ES [1]
Monte Carlo	*21e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	4.4	4.6	**2.1**	**2.8**	6.3	**8.2**	**2.6**	**2.8**	**2.8**	**2.9**	IPOP-SEP-CMA-ES [15]

Table 14: 40-D, running time excess ERT/ERT_{best} on f_{14}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

14 Sum of different powers

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.025	1.01	7.61	15.7	19.4	27.6	55.2	90.6	121	1440	ERT_{best}/D
ALPS	**1**	**2.4**	38	59	80	140	510	*27e-5/1e5*	.	.	ALPS [12]
AMaLGaM IDEA	**1.1**	**2.2**	44	46	53	50	30	22	20	**2.1**	AMaLGaM IDEA [4]
BayEDAcG	**1**	3.3	74	89	180	*63e-3/2e3*	.	.	.	.	BayEDAcG [6]
BFGS	**1**	**2.4**	**1.7**	**1.6**	**1.8**	**1.7**	**1.2**	**1**	**1**	*29e-7/2e4*	BFGS [16]
BIPOP-CMA-ES	**1**	**1.1**	**2.7**	**2.5**	3.1	3.9	4.4	5.4	**6.6**	**1.1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**2.3**	**2.1**	**1.7**	**2**	**2.2**	**2.2**	**3.2**	**5.3**	**1**	(1+1)-CMA-ES [2]
DASA	**1**	4.8	8.7	8.6	13	22	71	500	4600	*58e-7/1e6*	DASA [13]
DEPSO	**1.1**	**1.7**	11	28	300	*11e-2/2e3*	.	.	.	.	DEPSO [7]
simple GA	**1**	3.3	280	390	1.1e4	*17e-2/1e5*	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1**	13	15	19	19	12	9.2	8.6	**1**	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**2.9**	**2.5**	**2.8**	3	3.4	3.4	11	*40e-6/1e4*	.	NELDER (Han) [11]
NEWUOA	**1.2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	8.6	24	NEWUOA [17]
(1+1)-ES	**1.2**	**2**	**1.9**	**1.6**	**1.8**	**2.2**	5.2	37	400	*81e-8/1e6*	(1+1)-ES [1]
Monte Carlo	**1.1**	**1.9**	*29e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1.1**	**2.4**	**2.3**	**2.9**	3.7	6.8	8.8	10	**1.5**	IPOP-SEP-CMA-ES [15]

Table 15: 40-D, running time excess ERT/ERT_{best} on f_{15}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

15 Rastrigin

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	4.79	190	4700	19700	26200	26600	27000	27300	27700	28400	ERT_{best}/D
ALPS	12	1100	*10e+1/1e5*	.	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	13	9.6	**1.9**	**1.5**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.7**	AMaLGaM IDEA [4]
BayEDAcG	23	*24e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	28	*53e+1/9e3*	.	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1.2**	**1**	**1.4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	5.1	*34e+1/1e4*	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	640	*39e+1/1e6*	.	.	.	.	.	.	.	.	DASA [13]
DEPSO	3.7	*35e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	100	2200	*11e+1/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	3.9	**2.9**	9.8	14	**11**	**11**	**11**	**11**	**10**	**10**	iAMaLGaM IDEA [4]
NELDER (Han)	**1.6**	*33e+1/1e4*	.	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	7.4	*37e+1/7e3*	.	.	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	450	*42e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	3.6e4	*91e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1.3**	**1**	**3.6**	*40e-1/1e4*	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 16: 40-D, running time excess ERT/ERT_{best} on f_{16}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

16 Weierstrass

Δftarget ERT_{best}/D	1e+03 0.025	1e+02 0.025	1e+01 131	1e+00 1800	1e-01 8040	1e-02 17800	1e-03 35200	1e-04 49300	1e-05 49700	1e-07 50500	Δftarget ERT_{best}/D
ALPS	**1**	**1.1**	11	*38e-1/1e5*	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	**1**	**1.1**	17	**3.4**	**3.6**	**4.8**	**3.4**	**3.1**	**3.1**	**3.8**	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1.3**	*31e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	3.7	*41e+0/2e4*	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1**	**1.1**	**1**	**1**	**1**	**1.3**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1.1**	550	*12e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1.2**	1.1e5	*13e+0/1e6*	.	.	.	.	.	.	DASA [13]
DEPSO	**1**	**1.2**	*35e+0/2e3*	.	.	.	.	.	.	.	DEPSO [7]
simple GA	**1**	**1.1**	260	*79e-1/1e5*	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1.1**	**3.1**	4.3	24	27	17	23	**27**	**27**	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**1.1**	95	*10e+0/1e4*	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1.2**	17	*78e-1/1e4*	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	**1**	**1**	*15e+0/1e6*	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	**1**	**1.1**	*22e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1.1**	**1.8**	**1.5**	**1**	**1**	**1.4**	**3**	*30e-3/1e4*	.	IPOP-SEP-CMA-ES [15]

Table 17: 40-D, running time excess ERT/ERT_{best} on f_{17}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

17 Schaffer F7, condition 10

Δftarget ERT_{best}/D	1e+03 0.025	1e+02 0.025	1e+01 9.98	1e+00 106	1e-01 354	1e-02 874	1e-03 1300	1e-04 2220	1e-05 3330	1e-07 6640	Δftarget ERT_{best}/D
ALPS	**1**	**1.1**	7	3800	*12e-1/1e5*	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	**1**	**1.3**	13	9.3	4.9	**3**	**2.6**	**1.9**	**1.6**	**4.5**	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1.1**	22	14	*47e-2/2e3*	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	5.6	410	*68e-1/3e4*	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.4**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1**	67	*68e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	4.2	9.4e4	*98e-1/1e6*	.	.	.	.	.	.	DASA [13]
DEPSO	**1**	**1.2**	**4**	31	*97e-2/2e3*	.	.	.	.	.	DEPSO [7]
simple GA	**1**	**1.3**	63	230	*89e-2/1e5*	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1.4**	5.2	**2.6**	**1.5**	**1**	54	110	100	62	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**1.7**	310	*77e-1/1e4*	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1.9**	38	*54e-1/1e5*	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	**1**	7.4	5.6e4	*80e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	**1**	**1.1**	2.2e4	*91e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1.2**	**1**	**2.1**	**2.4**	**1.6**	**1.6**	**1.3**	**1.3**	**1**	IPOP-SEP-CMA-ES [15]

Table 18: 40-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_{18}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

18 Schaffer F7, condition 1000

Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D	1e+03 0.025	1e+02 0.403	1e+01 36.1	1e+00 425	1e-01 1180	1e-02 3180	1e-03 4690	1e-04 6420	1e-05 16800	1e-07 23700	Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	38	*39e-1/1e5*	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	**1**	**1.1**	18	3.3	**1.9**	**1**	**2.2**	**3**	**2.6**	**5**	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1.1**	23	35	*16e-1/2e3*	.	.	.	.	.	BayEDAcG [6]
BFGS	3.7	620	*28e+0/3e4*	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1.1**	**2.9**	**1.1**	**1.1**	**1.4**	**1.1**	**1.1**	**1.2**	**1.2**	**1.1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	3.1	*25e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	13	*41e+0/1e6*	.	.	.	.	.	.	.	DASA [13]
DEPSO	**1.1**	**1.5**	25	*57e-1/2e3*	.	.	.	.	.	.	DEPSO [7]
simple GA	**1.1**	**1.3**	100	*46e-1/1e5*	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1.1**	**1.1**	**4.6**	**1**	**1**	9	52	54	44	43	iAMaLGaM IDEA [4]
NELDER (Han)	**1.1**	12	*29e+0/1e4*	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1.1**	4.2	*20e+0/1e5*	.	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	**1**	100	*35e+0/1e6*	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	**1**	**1**	*32e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**2.2**	**1**	**1.3**	**1.7**	**1.1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [15]

Table 19: 40-D, running time excess ERT/ERT_{best} on f_{19}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

19 Griewank-Rosenbrock F8F2

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.025	0.025	8.79	1410	34800	4.21e5	6.38e5	1.13e6	1.13e6	1.14e6	ERT_{best}/D
ALPS	**1**	**1.2**	6.5	620	*16e-1/1e5*	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	**1**	**1**	11	**2.4**	**1**	**2.6**	**7.4**	**4.2**	**4.2**	**4.2**	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1.1**	18	*57e-1/2e3*	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	**1**	*19e+0/2e4*	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1**	**1**	**1.1**	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1**	16	*38e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	1.6e6	*16e+0/1e6*	.	.	.	.	.	.	DASA [13]
DEPSO	**1**	**1.1**	3.9	*67e-1/2e3*	.	.	.	.	.	.	DEPSO [7]
simple GA	**1**	**1.1**	130	1e3	*24e-1/1e5*	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1.1**	7	11	**46**	***10e-2/1e6***	.	.	.	.	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**1**	12	*40e-1/1e4*	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1.2**	**1**	*28e-1/1e5*	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	**1**	**1.4**	7.7e5	*16e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	**1**	**1.1**	*14e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	**1.1**	**4.6**	*84e-2/1e4*	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 20: 40-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{20}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

20 Schwefel x*sin(x)

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	3.12	4.33	5.54	3280	4.03e6	nan	nan	nan	nan	nan	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	45	44	40	*13e-1/1e5*	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	74	62	52	1400	***11e-1/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
BayEDAcG	85	75	64	*34e-1/2e3*	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1.6**	**1.5**	**1.5**	33	***11e-1/3e4***	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	5.4	4.6	4.1	**22**	**1**	***17e-2/6e5***	.	.	.	.	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	3.6	3.1	**2.7**	*14e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	18	16	14	**1**	***57e-2/1e6***	.	.	.	.	.	DASA [13]
DEPSO	20	21	22	*30e-1/2e3*	.	.	.	.	.	.	DEPSO [7]
simple GA	630	570	510	**2.9**	***65e-2/1e5***	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	31	28	23	*15e-1/1e6*	.	.	.	.	.	.	iAMaLGaM IDEA [4]
NELDER (Han)	4.8	4.6	4.1	*14e-1/1e4*	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	310	***11e-1/3e4***	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	**3.4**	**3**	**2.6**	1400	***12e-1/1e6***	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	*28e+3/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	4.6	4	3.5	*16e-1/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 21: 40-D, running time excess ERT/ERT_{best} on f_{21}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

21 Gallagher 101 peaks

Δftarget ERT_{best}/D	1e+03 0.025	1e+02 0.025	1e+01 26.1	1e+00 529	1e-01 2520	1e-02 2530	1e-03 2530	1e-04 2540	1e-05 2550	1e-07 2560	Δftarget ERT_{best}/D
ALPS	**1**	**1**	20	6.5	**2.7**	**3**	3.3	3.7	4.2	5.9	ALPS [12]
AMaLGaM IDEA	**1**	**1**	21	1800	1700	1700	1700	1700	1700	1700	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1**	37	8	*13e-1/2e3*	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	**1**	**2.9**	**2.3**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	9.3	BFGS [16]
BIPOP-CMA-ES	**1**	**1**	**2.7**	49	110	110	110	110	110	110	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1**	4.1	**1.8**	**1.7**	**1.7**	**1.7**	**1.7**	**1.6**	**1.6**	(1+1)-CMA-ES [2]
DASA	**1**	**1**	46	44	27	27	27	27	27	27	DASA [13]
DEPSO	**1**	**1**	18	16	12	*33e-1/2e3*	.	.	.	.	DEPSO [7]
simple GA	**1**	**1**	120	770	560	*25e-1/1e5*	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1**	38	660	850	850	850	840	840	840	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**1**	13	14	5.6	5.5	5.5	5.5	5.5	5.5	NELDER (Han) [11]
NEWUOA	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1**	**1**	3.6	5.2	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	(1+1)-ES [1]
Monte Carlo	**1**	**1**	*69e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	3.4	19	16	16	16	16	16	16	IPOP-SEP-CMA-ES [15]

Table 22: 40-D, running time excess ERT/ERT_{best} on f_{22}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

22 Gallagher 21 peaks

Δftarget ERT_{best}/D	1e+03 0.025	1e+02 0.025	1e+01 116	1e+00 886	1e-01 16200	1e-02 16200	1e-03 16300	1e-04 16300	1e-05 16300	1e-07 16400	Δftarget ERT_{best}/D
ALPS	**1**	**1**	8.5	12	35	110	*69e-2/1e5*	.	.	.	ALPS [12]
AMaLGaM IDEA	**1**	**1**	2200	760	*69e-2/1e6*	.	.	.	.	.	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1**	18	10	*73e-1/2e3*	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	**1**	**1**	**1.5**	*69e-2/8e3*	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1**	**1**	6.4	60	*69e-2/1e5*	.	.	.	.	.	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1**	**2.7**	**1.8**	**2**	**2**	**2**	**2**	**2**	**2**	(1+1)-CMA-ES [2]
DASA	**1**	**1**	32	31	45	45	45	45	45	45	DASA [13]
DEPSO	**1**	**1**	7.3	10	*26e-1/2e3*	.	.	.	.	.	DEPSO [7]
simple GA	**1**	**1**	87	180	*20e-1/1e5*	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1**	370	760	*69e-2/1e6*	.	.	.	.	.	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**1**	4.7	3.8	9	9	9	8.9	8.9	8.9	NELDER (Han) [11]
NEWUOA	**1**	**1**	**2.7**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [17]
(1+1)-ES	**1**	**1**	3.3	**2.7**	**6.6**	**6.6**	**6.6**	**6.6**	**6.6**	**6.6**	(1+1)-ES [1]
Monte Carlo	**1**	**1**	*71e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	13	6	*69e-2/1e4*	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 23: 40-D, running time excess ERT/ERT_{best} on f_{23}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

23 Katsuuras

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.025	0.025	0.237	298	1890	16500	32000	79000	81100	84000	ERT_{best}/D
ALPS	**1**	**1**	**1**	150	*80e-2/1e5*	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	**1**	**1**	**1.1**	12	**2.5**	**1**	**1**	**1**	**1**	**1**	AMaLGaM IDEA [4]
BayEDAcG	**1**	**1**	**1.1**	*37e-1/2e3*	.	.	.	.	.	.	BayEDAcG [6]
BFGS	**1**	**1**	58	260	*30e-1/5e3*	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**1**	**1**	5.6	4.8	**1**	**1.6**	**2**	**1.4**	**1.4**	**1.4**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**1**	**1**	12	12	*82e-2/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	**1.5**	76	*68e-2/6e5*	.	.	.	.	.	DASA [13]
DEPSO	**1**	**1**	**1.2**	*44e-1/2e3*	.	.	.	.	.	.	DEPSO [7]
simple GA	**1**	**1**	**1.1**	440	*79e-2/1e5*	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	**1**	**1**	**1.1**	**2.3**	**1.1**	**3.1**	**12**	**8.1**	**8**	**7.7**	iAMaLGaM IDEA [4]
NELDER (Han)	**1**	**1**	**1.3**	**1**	*29e-2/1e4*	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	**1**	7.1	**1.8**	*46e-2/8e3*	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	**1**	**1**	24	280	*73e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	**1**	**1**	**1.4**	*22e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	6.2	4.9	6.3	*89e-3/1e4*	.	.	.	.	IPOP-SEP-CMA-ES [15]

Table 24: 40-D, running time excess ERT/ERT_{best} on f_{24}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

24 Lunacek bi-Rastrigin

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	2.06	967	1.46e5	2.45e6	7.5e6	7.51e6	7.51e6	7.51e6	7.51e6	7.51e6	ERT_{best}/D
ALPS	5.8	82	*91e+0/1e5*	.	.	.	.	.	.	.	ALPS [12]
AMaLGaM IDEA	13	**4.2**	17	***42e+0/1e6***	.	.	.	.	.	.	AMaLGaM IDEA [4]
BayEDAcG	15	*28e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [6]
BFGS	560	*89e+1/8e3*	.	.	.	.	.	.	.	.	BFGS [16]
BIPOP-CMA-ES	**2.3**	12	**4.6**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	**2.3**	*34e+1/1e4*	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	3200	*55e+1/1e6*	.	.	.	.	.	.	.	.	DASA [13]
DEPSO	6.6	*37e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [7]
simple GA	110	1500	*14e+1/1e5*	.	.	.	.	.	.	.	simple GA [14]
iAMaLGaM IDEA	6.6	**1**	**8.5**	***10e+0/1e6***	.	.	.	.	.	.	iAMaLGaM IDEA [4]
NELDER (Han)	28	*64e+1/1e4*	.	.	.	.	.	.	.	.	NELDER (Han) [11]
NEWUOA	**1**	*25e+1/9e3*	.	.	.	.	.	.	.	.	NEWUOA [17]
(1+1)-ES	1700	*49e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
Monte Carlo	650	*82e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**2.3**	**1.5**	**1**	***46e+0/1e4***	.	.	.	.	.	.	IPOP-SEP-CMA-ES [15]

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