Comparison tables: BBOB 2009 function testbed in 2-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 [14, 9]. The experimental set-up is described in [13].

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 [13] for details on how ERT is obtained. All numbers are computed with no more than two digits of precision.

Table 1: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	0.5	0.5	0.9	2.83	2.83	3	3	3	3	3	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**2.8**	9.7	56	170	290	440	640	970	ALPS [17]
AMaLGaM IDEA	**1**	**1.1**	**2.1**	4.4	11	14	23	28	32	46	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	**1.9**	**1.1**	**1.1**	**1**	**1**	**1**	**1**	**1**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.9**	4.2	18	79	110	140	160	210	BayEDAcG [10]
BFGS	**1**	**1**	3.3	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	BFGS [30]
Cauchy EDA	**1**	**1**	19	15	27	39	50	63	75	100	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	3.3	3.8	8.5	13	19	24	29	39	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	3.3	3.6	7.6	11	14	18	22	29	(1+1)-CMA-ES [2]
DASA	**1**	**1**	39	23	44	52	62	76	95	120	DASA [19]
DEPSO	**1**	**1**	**2.1**	12	27	46	51	96	120	170	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1.4**	**2.5**	9.4	15	20	32	56	DIRECT [25]
EDA-PSO	**1**	**1**	**1.9**	5	20	34	53	80	110	210	EDA-PSO [6]
full NEWUOA	**1**	**1**	**2.7**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	full NEWUOA [31]
G3-PCX	**1**	**1**	**1.9**	6	17	19	24	29	34	46	G3-PCX [26]
simple GA	**1**	**1**	**2.7**	7.2	62	310	1100	1800	2600	4500	simple GA [22]
GLOBAL	**1**	**1**	**1.9**	5.7	39	50	54	55	56	58	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**2.3**	3.8	6.7	12	14	19	22	31	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	7.8	3.2	3.6	4.1	4.1	4.1	4.1	4.1	LSfminbnd [28]
LSstep	**1**	**1**	46	34	62	63	68	68	69	69	LSstep [28]
MA-LS-Chain	**1**	**1**	**2.4**	7.4	26	40	67	85	92	100	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1.5**	**2.2**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**2.1**	**1.3**	**3**	3.9	5.1	6.3	7.4	9.8	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1**	**1.5**	**2.9**	4.1	5.3	6.5	7.6	10	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**2.8**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [31]
(1+1)-ES	**1**	**1**	3.5	**2.8**	6.7	10	14	18	23	30	(1+1)-ES [1]
POEMS	**1**	**1**	170	80	110	400	680	1100	1300	2100	POEMS [20]
PSO	**1**	**1**	**2.1**	5.3	20	59	120	200	250	470	PSO [7]
PSO_Bounds	**1**	**1.1**	**2.4**	6	26	89	270	460	770	1200	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**1.5**	9.7	49	540	5900	4.8e4	6.8e5	*11e-6/1e6*	Monte Carlo [3]
Rosenbrock	**1**	**1**	5.6	3.1	3.9	4.9	6.2	7.6	8.8	11	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	3.9	5.9	9.5	14	18	24	28	38	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**2.6**	8.9	25	33	37	43	48	60	VNS (Garcia) [11]

Table 2: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	4.93	6.23	8.2	9.47	12.3	12.7	12.9	13.6	14	14.3	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	11	24	58	120	130	160	200	230	260	330	ALPS [17]
AMaLGaM IDEA	4.9	4.8	6.2	7.6	7.5	9.1	10	11	13	16	AMaLGaM IDEA [4]
avg NEWUOA	**1.2**	**1.1**	**1.9**	5.6	8.5	10	14	17	20	27	avg NEWUOA [31]
BayEDAcG	37	62	80	78	82	87	110	110	140	140	BayEDAcG [10]
BFGS	**1.7**	**1.6**	**2.5**	4	3.7	3.9	4.1	4.1	4.1	4.4	BFGS [30]
Cauchy EDA	13	17	18	18	18	20	23	24	25	29	Cauchy EDA [24]
BIPOP-CMA-ES	4	5.4	13	19	18	18	20	20	20	22	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	4.1	5.1	10	13	13	13	14	14	15	16	(1+1)-CMA-ES [2]
DASA	21	19	19	22	21	21	23	25	26	31	DASA [19]
DEPSO	10	16	18	26	27	31	35	40	45	53	DEPSO [12]
DIRECT	5.9	5.1	7.5	8	7.1	8.5	9.4	12	13	46	DIRECT [25]
EDA-PSO	8.8	11	13	19	20	26	39	49	65	88	EDA-PSO [6]
full NEWUOA	**1.2**	**1.2**	**2.4**	5.8	8.3	10	13	15	18	23	full NEWUOA [31]
G3-PCX	8.6	8.4	14	64	69	76	83	82	82	82	G3-PCX [26]
simple GA	11	44	130	320	420	540	780	990	1300	1900	simple GA [22]
GLOBAL	11	19	19	17	13	13	13	13	13	13	GLOBAL [23]
iAMaLGaM IDEA	**2.6**	3.8	5.1	9.2	9.1	10	11	12	12	14	iAMaLGaM IDEA [4]
LSfminbnd	**1.4**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSfminbnd [28]
LSstep	14	12	9.5	9.9	7.9	7.9	7.8	7.5	7.3	7.3	LSstep [28]
MA-LS-Chain	12	14	17	22	20	24	28	28	29	34	MA-LS-Chain [21]
MCS (Neum)	**1.5**	**1.6**	**1.4**	**1.8**	**1.7**	**2.6**	3.2	3.3	3.7	23	MCS (Neum) [18]
NELDER (Han)	**1.9**	**1.8**	**1.7**	**1.8**	**1.8**	**2**	**2.2**	**2.4**	**2.6**	**3**	NELDER (Han) [16]
NELDER (Doe)	**1.6**	**1.7**	**1.6**	**1.9**	**1.7**	**1.9**	**2.2**	**2.3**	**2.5**	**3**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**2.2**	8.8	12	15	19	23	26	35	NEWUOA [31]
(1+1)-ES	3.2	2400	8700	4.7e4	1.2e5	3.8e5	*74e-3/1e6*	.	.	.	(1+1)-ES [1]
POEMS	140	250	380	420	400	460	510	570	630	780	POEMS [20]
PSO	7.5	14	56	83	83	98	120	130	160	200	PSO [7]
PSO_Bounds	6.9	24	54	170	310	360	400	440	530	780	PSO_Bounds [8]
Monte Carlo	21	50	240	1200	5600	1e5	*94e-4/1e6*	.	.	.	Monte Carlo [3]
Rosenbrock	**2.6**	3.1	**2.5**	3.7	4.4	5.4	6.3	6.5	6.9	7.9	Rosenbrock [27]
IPOP-SEP-CMA-ES	4.5	5.4	14	19	16	17	18	18	18	20	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	8.4	15	22	27	24	25	26	26	26	29	VNS (Garcia) [11]

Table 3: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	0.5	0.7	7.33	135	222	223	225	226	227	232	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.1**	**1.6**	9.2	6.7	6.4	11	12	15	19	23	ALPS [17]
AMaLGaM IDEA	**1.1**	**1.1**	3.7	4.6	12	12	12	12	13	13	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**2.7**	5.1	**1.6**	3.2	3.2	3.2	3.2	3.2	3.1	avg NEWUOA [31]
BayEDAcG	**1.1**	**1.2**	4.4	4	9.7	18	41	65	65	64	BayEDAcG [10]
BFGS	**1.2**	18	14	3.1	10	10	10	10	10	10	BFGS [30]
Cauchy EDA	**1.1**	9.6	9.6	3.3	8.4	33	43	43	43	43	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.2**	3.5	3.5	5.2	6.2	6.4	6.5	6.5	6.7	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.9**	6.9	3.8	7.9	7.9	7.9	7.9	7.9	7.8	(1+1)-CMA-ES [2]
DASA	6.3	22	18	**1.8**	6.9	7	7.1	7.2	7.4	7.6	DASA [19]
DEPSO	**1.8**	**2**	5.7	**2.3**	**2.7**	4	4.5	5	5.4	6.4	DEPSO [12]
DIRECT	**1**	**1.1**	**2.7**	**1**	**2.4**	**2.4**	**2.5**	**2.6**	**2.7**	**3**	DIRECT [25]
EDA-PSO	**1.2**	**1.4**	4.8	6.4	14	19	20	20	21	22	EDA-PSO [6]
full NEWUOA	**1**	4	**2.3**	**1.8**	**2.2**	**2.2**	**2.2**	**2.1**	**2.1**	**2.1**	full NEWUOA [31]
G3-PCX	**1.1**	**2**	4.1	7.8	40	40	39	39	39	39	G3-PCX [26]
simple GA	**1**	**2**	8.3	13	19	27	40	55	70	110	simple GA [22]
GLOBAL	**1.1**	**1.6**	7	**1.8**	3.1	3.1	3.1	3.1	3.1	3.1	GLOBAL [23]
iAMaLGaM IDEA	**1.1**	**1.4**	**1.8**	6.3	17	17	17	17	17	17	iAMaLGaM IDEA [4]
LSfminbnd	**2.1**	4.7	17	32	43	64	63	63	63	61	LSfminbnd [28]
LSstep	28	120	24	**1.5**	**1**	**1**	**1**	**1**	**1**	**1**	LSstep [28]
MA-LS-Chain	**1**	**1.5**	5.7	**1.7**	**2.5**	**2.6**	**2.7**	**2.7**	**2.8**	**2.9**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.1**	**1.5**	**1.1**	**1.5**	**1.6**	**1.6**	**2.6**	**2.6**	**2.6**	MCS (Neum) [18]
NELDER (Han)	**1.2**	**1.8**	**1.4**	4	13	13	13	13	12	12	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1**	**1**	**1.7**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	NELDER (Doe) [5]
NEWUOA	**1.5**	**2.4**	4.8	**1.5**	4.2	4.2	4.2	4.1	4.1	4.1	NEWUOA [31]
(1+1)-ES	**1.1**	**2.4**	12	5	15	15	15	15	15	14	(1+1)-ES [1]
POEMS	31	200	42	11	14	20	24	29	32	41	POEMS [20]
PSO	**1.1**	**1.6**	5.1	3.3	3.4	4.7	6	7.2	8.8	11	PSO [7]
PSO_Bounds	**1.1**	**1.8**	4.8	5.3	8.3	14	18	22	26	34	PSO_Bounds [8]
Monte Carlo	**1.1**	**1.5**	14	67	460	3100	2.1e4	*39e-4/1e6*	.	.	Monte Carlo [3]
Rosenbrock	**1**	16	45	15	26	26	26	26	26	25	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.5**	**2.3**	3.4	7.6	8.4	9.2	9.4	9.6	9.8	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.9**	8.8	**2.9**	4.1	4.2	4.2	4.5	4.7	7.7	VNS (Garcia) [11]

Table 4: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.5	0.5	10.9	172	230	248	261	270	272	283	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**2.5**	9	7.1	8.3	9.7	12	15	17	20	ALPS [17]
AMaLGaM IDEA	**1**	**2.2**	**2.6**	5.6	51	48	48	46	47	45	AMaLGaM IDEA [4]
avg NEWUOA	**1**	4.5	6.2	4	14	13	12	12	12	11	avg NEWUOA [31]
BayEDAcG	**1**	**2.3**	4.5	13	62	120	110	*10e-1/2e3*	.	.	BayEDAcG [10]
BFGS	**1**	13	11	5.7	12	11	11	10	10	9.8	BFGS [30]
Cauchy EDA	**1**	19	6.8	13	75	410	470	450	450	430	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	3.8	**2.6**	6.9	55	97	99	98	99	110	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**2.4**	5.2	5.5	27	25	24	23	23	22	(1+1)-CMA-ES [2]
DASA	**1**	82	15	**2**	3.6	3.4	3.3	3.3	3.4	3.4	DASA [19]
DEPSO	**1**	**2.4**	7.2	4.2	6.5	11	17	17	17	35	DEPSO [12]
DIRECT	**1**	**1**	**1.8**	**1.8**	6.6	6.1	14	14	16	16	DIRECT [25]
EDA-PSO	**1**	**2.6**	4.2	9.9	18	19	19	19	19	20	EDA-PSO [6]
full NEWUOA	**1**	3.8	5.4	3.9	15	14	13	13	13	12	full NEWUOA [31]
G3-PCX	**1**	**2.1**	20	17	76	70	67	65	64	62	G3-PCX [26]
simple GA	**1**	**2.6**	10	16	22	28	37	49	60	100	simple GA [22]
GLOBAL	**1**	**2.4**	8.5	**1.2**	5.2	4.8	4.6	4.5	4.5	4.3	GLOBAL [23]
iAMaLGaM IDEA	**1**	3.8	**2.5**	9.5	61	57	56	55	55	54	iAMaLGaM IDEA [4]
LSfminbnd	**1**	4.6	**1**	45	120	230	*10e-1/4e3*	.	.	.	LSfminbnd [28]
LSstep	**1**	220	19	**1.3**	**1**	**1**	**1**	**1**	**1**	**1**	LSstep [28]
MA-LS-Chain	**1**	**2.3**	5.6	**1.8**	4.4	4.2	4.1	4	4.1	4.1	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**2**	**1**	**2.9**	**2.7**	**2.7**	**2.7**	**2.7**	**2.6**	MCS (Neum) [18]
NELDER (Han)	**1**	3.1	5	5.3	27	25	24	23	23	22	NELDER (Han) [16]
NELDER (Doe)	**1**	**2.1**	**1.9**	**1.4**	**3.5**	**3.2**	**3.1**	**3**	**3**	**3**	NELDER (Doe) [5]
NEWUOA	**1**	3	5	4.5	18	16	16	15	15	14	NEWUOA [31]
(1+1)-ES	**1**	3.1	4.5	5.5	23	21	20	20	20	19	(1+1)-ES [1]
POEMS	**1**	240	36	9.8	22	23	29	32	35	41	POEMS [20]
PSO	**1.1**	3.2	4	3.3	4.6	5.6	6.4	7.4	8.7	11	PSO [7]
PSO_Bounds	**1**	3.3	4.4	6.3	9.6	17	21	24	27	33	PSO_Bounds [8]
Monte Carlo	**1**	3.3	8.6	67	620	8200	2.8e4	5.5e4	*11e-3/1e6*	.	Monte Carlo [3]
Rosenbrock	**1**	71	27	15	52	48	46	44	44	42	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	3.5	**3**	8.7	75	180	270	260	260	250	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**2.6**	5.1	4.1	8.8	8.2	7.9	8.3	8.8	17	VNS (Garcia) [11]

Table 5: 02-D, running time excess ERT/ERT_{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	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.5	0.5	1.83	2.2	2.2	2.2	2.2	2.2	2.2	2.2	ERT_{best}/D
ALPS	**1**	**1.1**	8.8	76	100	100	100	100	100	100	ALPS [17]
AMaLGaM IDEA	**1**	**1.1**	5.3	16	18	18	18	18	18	18	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.2**	**1.1**	**1.5**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	3.3	92	100	100	100	100	100	100	BayEDAcG [10]
BFGS	**1**	**1**	**1.5**	**2.8**	**2.8**	**2.9**	**2.9**	**2.9**	**2.9**	**2.9**	BFGS [30]
Cauchy EDA	**1**	**1**	16	17	17	17	17	17	17	17	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	3.4	5.3	5.7	5.8	5.8	5.8	5.8	5.8	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	**1.9**	3.1	3.4	3.4	3.4	3.4	3.4	3.4	(1+1)-CMA-ES [2]
DASA	**1**	**1.9**	19	32	40	46	53	60	66	80	DASA [19]
DEPSO	**1**	**1**	6.1	34	35	36	36	36	36	36	DEPSO [12]
DIRECT	**1**	**1**	3.4	**2.8**	4.2	4.2	4.2	4.2	4.2	4.2	DIRECT [25]
EDA-PSO	**1**	**1**	5	15	16	17	17	17	17	17	EDA-PSO [6]
full NEWUOA	**1**	**1.3**	**1**	**1.2**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	full NEWUOA [31]
G3-PCX	**1**	**1.1**	4.1	29	31	31	31	31	31	31	G3-PCX [26]
simple GA	**1**	**1**	4.2	310	2e3	4200	6300	9800	1.5e4	6.8e5	simple GA [22]
GLOBAL	**1**	**1.1**	4.4	69	70	70	70	70	70	70	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	4.6	12	13	13	13	13	13	13	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	4.9	7.3	8.5	9.1	9.1	9.1	9.1	9.1	LSfminbnd [28]
LSstep	**1**	**1.2**	59	79	91	91	91	91	91	91	LSstep [28]
MA-LS-Chain	**1**	**1.1**	4.7	81	120	130	130	130	130	130	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**1.8**	**2.1**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.3**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**1.1**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	NEWUOA [31]
(1+1)-ES	**1**	**1**	**1.9**	**2.4**	**2.5**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	(1+1)-ES [1]
POEMS	**1**	**1**	140	150	170	180	190	190	190	190	POEMS [20]
PSO	**1**	**1.1**	4.2	18	20	21	21	21	21	21	PSO [7]
PSO_Bounds	**1**	**1**	6.1	13	16	16	16	16	16	16	PSO_Bounds [8]
Monte Carlo	**1**	**1**	4.4	530	4.9e4	*22e-3 / 1e6*	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	3.5	3.4	3.5	3.5	3.5	3.5	3.5	3.5	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	4	6.6	7.1	7.1	7.1	7.1	7.1	7.1	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	6.3	27	27	27	27	27	27	27	VNS (Garcia) [11]

Table 6: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.833	1.4	6.33	11.4	20.5	26.9	33.5	39.9	47.3	62.2	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	3.2	3.2	**2.2**	12	31	50	62	73	80	83	ALPS [17]
AMaLGaM IDEA	**1.1**	**1.4**	**2.1**	4.5	4.9	5.5	6.2	6.5	6.7	7	AMaLGaM IDEA [4]
avg NEWUOA	**1.4**	**2.1**	3.1	4.7	3.9	4.4	4.4	4.5	4.7	4.6	avg NEWUOA [31]
BayEDAcG	**2.8**	**1.9**	**1.5**	160	640	*72e-2/2e3*	.	.	.	.	BayEDAcG [10]
BFGS	4.3	4.4	4.2	3.4	**2.7**	**2.4**	**2**	**1.9**	**1.7**	**1.6**	BFGS [30]
Cauchy EDA	11	10	16	18	17	17	17	17	16	16	Cauchy EDA [24]
BIPOP-CMA-ES	3.9	**3**	**2**	**2.8**	3.6	3.9	4.2	4.2	4.1	4.3	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	4.2	3.3	**2.1**	**3**	**2.3**	**2.2**	**2.2**	**2.3**	**2.2**	**2.1**	(1+1)-CMA-ES [2]
DASA	30	29	23	22	18	19	19	18	18	18	DASA [19]
DEPSO	**1.7**	**1.7**	3.8	11	12	14	14	15	16	17	DEPSO [12]
DIRECT	**1.4**	**1**	**1.4**	7.6	5.8	120	800	1500	1200	970	DIRECT [25]
EDA-PSO	3.4	**2.4**	3.1	12	12	15	19	27	29	34	EDA-PSO [6]
full NEWUOA	**1**	**2.2**	3.4	3.7	3.2	3.5	3.7	3.7	4.1	4.5	full NEWUOA [31]
G3-PCX	**2.3**	**1.5**	**2.3**	4.5	3.7	3.9	3.9	3.8	3.8	4.1	G3-PCX [26]
simple GA	4.8	3.4	3.5	14	85	1e3	3100	4100	3600	4900	simple GA [22]
GLOBAL	3.7	**2.9**	**2.3**	8.8	7.4	6.2	5.2	4.5	3.9	3.2	GLOBAL [23]
iAMaLGaM IDEA	**2.7**	**1.9**	**2.4**	3.6	3.8	4	4.1	4.2	4.3	4.4	iAMaLGaM IDEA [4]
LSfminbnd	19	190	280	370	290	260	210	180	150	120	LSfminbnd [28]
LSstep	53	330	910	580	380	330	710	1200	*17e-4/1e4*	.	LSstep [28]
MA-LS-Chain	4.4	**2.9**	**2.2**	13	14	14	12	12	10	10	MA-LS-Chain [21]
MCS (Neum)	**1.4**	190	52	29	19	42	100	110	100	120	MCS (Neum) [18]
NELDER (Han)	**2.1**	**1.5**	**1**	**1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	NELDER (Han) [16]
NELDER (Doe)	**1.6**	**2**	**1.3**	**1.3**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**1.2**	**2.4**	4.4	4.7	3.9	4.4	4.7	4.8	5	4.9	NEWUOA [31]
(1+1)-ES	**2.4**	**2.2**	**2.5**	3.7	3.6	3.6	3.4	3.4	3.3	3.2	(1+1)-ES [1]
POEMS	200	160	99	130	120	140	130	140	180	180	POEMS [20]
PSO	**1.5**	**1.1**	**2.1**	4.6	7.9	18	23	29	32	36	PSO [7]
PSO_Bounds	**2.2**	**1.5**	**2.6**	7	37	77	130	140	140	170	PSO_Bounds [8]
Monte Carlo	3	**2.3**	**2.7**	16	53	780	1.3e4	8.1e4	1.5e5	*28e-5/1e6*	Monte Carlo [3]
Rosenbrock	4	3	**2.2**	**2.1**	**1.8**	**1.8**	**1.8**	**1.8**	**1.7**	**1.5**	Rosenbrock [27]
IPOP-SEP-CMA-ES	4.7	3.1	**1.7**	4.1	3.8	4.5	4.6	4.7	4.6	4.4	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**2.6**	**2.7**	**1.9**	7.2	6.9	6.7	6.3	6.3	6.1	5.7	VNS (Garcia) [11]

Table 7: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.5	1	1.6	10.7	30.2	96.7	108	108	108	121	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.1**	**1.4**	4.1	4.7	12	9.5	11	11	11	13	ALPS [17]
AMaLGaM IDEA	**1.1**	**1.5**	3.4	20	8.1	**2.7**	**2.5**	**2.5**	**2.5**	**2.4**	AMaLGaM IDEA [4]
avg NEWUOA	**1.7**	**2.7**	4	3.7	6.8	5	10	10	10	9	avg NEWUOA [31]
BayEDAcG	**1.5**	**1.7**	4.2	3.1	79	85	76	76	76	110	BayEDAcG [10]
BFGS	**1.6**	3.7	10	19	34	*76e-2/200*	.	.	.	.	BFGS [30]
Cauchy EDA	5.5	8.4	19	7.6	5.3	**2**	**1.9**	**1.9**	**1.9**	**2.1**	Cauchy EDA [24]
BIPOP-CMA-ES	**1.9**	**1.9**	3.2	**2.6**	3.4	**1.5**	**1.5**	**1.5**	**1.5**	**1.6**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.5**	**1.4**	**2.7**	**1.8**	**2.8**	**1**	**1**	**1**	**1**	**1**	(1+1)-CMA-ES [2]
DASA	30	59	170	170	310	240	440	440	440	390	DASA [19]
DEPSO	**1.7**	**1.7**	6.5	4.8	4.9	**2.6**	3.1	3.1	3.1	3.6	DEPSO [12]
DIRECT	**1.4**	**1**	**2.1**	**1.3**	**1**	**2.7**	**3**	**3**	**3**	**2.7**	DIRECT [25]
EDA-PSO	**1.5**	**1.8**	3.7	3.1	6.2	6.2	9	9	9	14	EDA-PSO [6]
full NEWUOA	**1.9**	**2.7**	**2**	3.7	3.7	**1.7**	**2.9**	**2.9**	**2.9**	**2.7**	full NEWUOA [31]
G3-PCX	**1.3**	**1.5**	4.5	12	35	19	21	21	21	19	G3-PCX [26]
simple GA	**1.6**	**1.6**	5.2	3.9	22	24	47	47	47	67	simple GA [22]
GLOBAL	**1.2**	**1.8**	6.8	4.1	7.5	**2.7**	4.4	4.4	4.4	3.9	GLOBAL [23]
iAMaLGaM IDEA	**1.8**	**1.8**	3.9	12	4.7	**2.8**	**2.5**	**2.5**	**2.5**	**2.4**	iAMaLGaM IDEA [4]
LSfminbnd	**1.3**	**1.1**	6.3	11	66	55	500	500	500	960	LSfminbnd [28]
LSstep	28	28	260	250	460	1500	*29e-3/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	**1.7**	**2.3**	5.8	3.4	4.7	3.6	4.6	4.6	4.6	4.7	MA-LS-Chain [21]
MCS (Neum)	**1.4**	**1.4**	**1**	4.1	4.5	**2.2**	6.5	6.5	6.5	6	MCS (Neum) [18]
NELDER (Han)	**1.5**	**1.3**	**2.5**	25	18	6.6	6.5	6.5	6.5	5.9	NELDER (Han) [16]
NELDER (Doe)	**1.8**	**1.6**	**2.6**	**1**	8.5	5.4	5.2	5.2	5.2	5.4	NELDER (Doe) [5]
NEWUOA	**1.7**	**2**	**2.5**	9.3	9.3	6	14	14	14	12	NEWUOA [31]
(1+1)-ES	**2.3**	3.3	5.6	4.1	4.3	**1.8**	3.3	3.3	3.3	3	(1+1)-ES [1]
POEMS	220	210	180	45	41	21	23	23	23	28	POEMS [20]
PSO	**1.5**	**1.3**	4.1	3.5	4.8	3.2	3.6	3.6	3.6	4.4	PSO [7]
PSO_Bounds	**1.3**	**1.6**	6.2	3.4	5.8	5	6.7	6.7	6.7	14	PSO_Bounds [8]
Monte Carlo	**1.7**	**1.5**	4.6	4.5	43	87	150	150	150	950	Monte Carlo [3]
Rosenbrock	16	42	150	120	170	78	190	190	190	170	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**2.1**	5.5	**2.7**	**2.8**	**1.2**	**1.3**	**1.3**	**1.3**	**1.5**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**2.4**	3.9	3.8	5.1	**2.1**	**2**	**2**	**2**	**2**	VNS (Garcia) [11]

Table 8: 02-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	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	0.6	1.6	2.7	6	18.3	23.1	43.2	46.1	47	56	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**2.9**	**2.8**	4.7	19	31	66	54	74	94	130	ALPS [17]
AMaLGaM IDEA	**2.4**	4.1	6.2	10	6.8	7	4.4	4.7	5.1	5	AMaLGaM IDEA [4]
avg NEWUOA	3.9	**2.5**	**2.6**	**4.6**	**2.4**	**2.4**	**1.4**	**1.4**	**1.4**	**1.3**	avg NEWUOA [31]
BayEDAcG	**2.3**	**2.9**	5.6	11	48	350	*53e-3/2e3*	.	.	.	BayEDAcG [10]
BFGS	7.5	4.9	4.1	5.1	**2.4**	**2.2**	**1.3**	**1.3**	**1.3**	**1.1**	BFGS [30]
Cauchy EDA	15	11	10	24	19	21	12	13	14	13	Cauchy EDA [24]
BIPOP-CMA-ES	3.1	3.3	3.5	7.1	9.2	11	6.4	6.5	6.7	6.2	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	6.4	4.3	3.8	11	6.9	7	4.2	4.1	4.3	4	(1+1)-CMA-ES [2]
DASA	31	33	110	520	480	680	520	580	700	820	DASA [19]
DEPSO	4	3.3	3.6	14	15	25	28	42	65	*76e-7/2e3*	DEPSO [12]
DIRECT	**1**	**1**	**1.4**	5	4.4	8.7	10	16	17	21	DIRECT [25]
EDA-PSO	**1.9**	**3**	5.4	11	50	98	97	140	180	220	EDA-PSO [6]
full NEWUOA	6.6	3.9	7	7	3.2	**2.8**	**1.6**	**1.5**	**1.5**	**1.3**	full NEWUOA [31]
G3-PCX	**2.8**	4	5	24	16	18	11	11	11	9.6	G3-PCX [26]
simple GA	**2**	**2.9**	8.4	34	87	170	1300	8900	*61e-5/1e5*	.	simple GA [22]
GLOBAL	4.4	4.5	14	19	8.2	7.2	4.1	3.9	3.9	3.4	GLOBAL [23]
iAMaLGaM IDEA	**2.3**	**2.8**	4.4	12	8	8.4	5	5.2	5.5	5.2	iAMaLGaM IDEA [4]
LSfminbnd	16	7	420	1500	2300	6300	*90e-2/1e4*	.	.	.	LSfminbnd [28]
LSstep	67	51	37	1500	3600	6100	*32e-2/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	**2.7**	3.6	7.2	16	10	15	9	8.8	9	8.5	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**1.9**	**1.4**	**2.1**	**3.7**	**2**	**2**	**1.1**	**1.2**	**1.2**	**1.2**	NELDER (Han) [16]
NELDER (Doe)	3	3.2	4.6	6.2	**2.9**	**2.7**	**1.6**	**1.5**	**1.6**	**1.5**	NELDER (Doe) [5]
NEWUOA	3.8	**2.8**	4.3	7	3.5	3.2	**1.9**	**1.8**	**1.8**	**1.6**	NEWUOA [31]
(1+1)-ES	**2.3**	**2.2**	47	59	23	34	35	51	70	95	(1+1)-ES [1]
POEMS	230	110	120	110	76	110	74	91	120	130	POEMS [20]
PSO	**2.7**	**2.6**	6.5	11	16	27	26	37	49	67	PSO [7]
PSO_Bounds	3.7	4.3	6	19	24	61	69	120	150	200	PSO_Bounds [8]
Monte Carlo	**2.7**	3.2	5.8	19	72	670	2200	3.9e4	3.1e5	*17e-5/1e6*	Monte Carlo [3]
Rosenbrock	5.8	3.4	4.9	10	5.2	4.8	**2.8**	**2.7**	**2.8**	**2.5**	Rosenbrock [27]
IPOP-SEP-CMA-ES	6.4	3.9	5.2	19	17	17	9.5	9.3	9.6	8.7	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	9.5	4.8	8.1	16	10	11	6.9	6.8	7.2	6.7	VNS (Garcia) [11]

Table 9: 02-D, running time excess ERT/ERT_{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
ERT_{best}/D	0.5	0.5	0.5	8.9	15	21.9	33.8	38.5	40.7	46.2	ERT_{best}/D
ALPS	3.3	7.2	33	19	41	62	64	81	100	140	ALPS [17]
AMaLGaM IDEA	4.2	13	22	6.3	9.5	9.5	7.5	7.4	7.7	7.6	AMaLGaM IDEA [4]
avg NEWUOA	7.7	10	22	4.7	4	3.2	**2.3**	**2.1**	**2**	**1.9**	avg NEWUOA [31]
BayEDAcG	3.8	11	29	10	99	600	*66e-3/2e3*	.	.	.	BayEDAcG [10]
BFGS	4.2	9.2	16	**2.4**	**2.3**	**1.9**	**1.4**	**1.3**	**1.2**	**1.1**	BFGS [30]
Cauchy EDA	16	37	59	14	20	19	14	14	14	14	Cauchy EDA [24]
BIPOP-CMA-ES	**2.6**	10	19	4.6	7.1	7.5	5.8	5.6	5.8	5.9	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	3.5	9.9	26	8.8	8	7.3	5.4	5	5	4.9	(1+1)-CMA-ES [2]
DASA	65	110	320	250	290	330	320	380	550	740	DASA [19]
DEPSO	**2.7**	12	58	12	12	20	19	25	45	97	DEPSO [12]
DIRECT	**1**	**1**	**1**	**2**	5	5.8	8.3	14	18	25	DIRECT [25]
EDA-PSO	3.8	12	47	8.5	27	51	78	120	150	200	EDA-PSO [6]
full NEWUOA	7.1	12	24	**2.7**	**2.2**	**1.8**	**1.3**	**1.2**	**1.1**	**1.1**	full NEWUOA [31]
G3-PCX	4.1	10	28	15	20	18	14	13	13	11	G3-PCX [26]
simple GA	5	15	44	22	90	190	2200	2200	1e4	1.5e4	simple GA [22]
GLOBAL	3.5	11	30	9.1	11	7.9	5.2	4.7	4.5	4.2	GLOBAL [23]
iAMaLGaM IDEA	3.1	7.9	29	6	7.2	6.9	5.3	5.1	5.3	5.3	iAMaLGaM IDEA [4]
LSfminbnd	6.2	15	20	210	670	3100	4100	3600	3400	*76e-3/1e4*	LSfminbnd [28]
LSstep	270	610	750	230	670	1800	2100	3800	*76e-3/1e4*	.	LSstep [28]
MA-LS-Chain	5	9.5	35	8.6	13	13	11	10	10	11	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**2.7**	**3.6**	**10**	**1.6**	**2**	**1.8**	**1.3**	**1.2**	**1.2**	**1.2**	NELDER (Han) [16]
NELDER (Doe)	4.1	6.9	11	**2.3**	**2.6**	**2.1**	**1.5**	**1.4**	**1.4**	**1.4**	NELDER (Doe) [5]
NEWUOA	5.2	8.3	24	3.6	3.3	**2.7**	**1.9**	**1.8**	**1.8**	**1.7**	NEWUOA [31]
(1+1)-ES	4.4	8.1	19	81	120	120	100	110	130	160	(1+1)-ES [1]
POEMS	360	450	560	65	78	110	98	110	130	160	POEMS [20]
PSO	4	15	37	8.7	12	24	28	38	49	67	PSO [7]
PSO_Bounds	3.9	9	48	11	27	96	120	160	200	240	PSO_Bounds [8]
Monte Carlo	3	10	47	17	110	900	3600	6.9e4	3.7e5	*16e-5/1e6*	Monte Carlo [3]
Rosenbrock	8.9	12	22	**2.6**	3.1	**2.9**	**2.2**	**2.2**	**2.2**	**2.2**	Rosenbrock [27]
IPOP-SEP-CMA-ES	3.1	9.5	16	7.6	15	14	10	9.3	9.4	9	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	4.8	21	45	14	15	12	9.8	9.4	9.8	10	VNS (Garcia) [11]

Table 10: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	2.9	5.7	14.9	22.9	26.9	30.4	34.2	37.9	40.9	48.8	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	22	25	47	69	160	350	780	1600	2100	3200	ALPS [17]
AMaLGaM IDEA	6.7	5.7	3	3	3.8	4	4.1	4.1	4.3	4.4	AMaLGaM IDEA [4]
avg NEWUOA	**2.6**	3.6	3.8	4.8	6.9	7.6	8.8	9.5	9.9	11	avg NEWUOA [31]
BayEDAcG	17	13	60	190	310	*33e-1/2e3*	.	.	.	.	BayEDAcG [10]
BFGS	**2.3**	**1.5**	**1**	**1.4**	**1.4**	**1.4**	**1.4**	**2.6**	6.3	24	BFGS [30]
Cauchy EDA	14	13	7.4	6.4	7	7	7.4	7.7	8	8.4	Cauchy EDA [24]
BIPOP-CMA-ES	12	12	7.9	9	8.5	7.9	7.7	7.4	7.3	6.8	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	7.3	5.8	7.2	6.6	6.3	5.8	5.5	5.3	5.2	4.8	(1+1)-CMA-ES [2]
DASA	22	15	8900	5.2e4	6.1e4	9.5e4	1.2e5	1.1e5	1e5	8.6e4	DASA [19]
DEPSO	16	26	80	110	330	310	*51e-2/2e3*	.	.	.	DEPSO [12]
DIRECT	3.9	4.3	3.9	9.5	20	68	120	190	220	460	DIRECT [25]
EDA-PSO	17	26	43	140	330	640	1100	2100	3e3	8600	EDA-PSO [6]
full NEWUOA	**2**	**3**	3.8	4.5	6	6.4	7.1	7.7	8.2	9	full NEWUOA [31]
G3-PCX	11	9.5	26	39	39	37	34	31	29	25	G3-PCX [26]
simple GA	27	51	77	700	2800	4300	4.2e4	3.8e4	*23e-3/1e5*	.	simple GA [22]
GLOBAL	18	19	11	7.4	6.4	5.8	5.3	4.9	4.6	4	GLOBAL [23]
iAMaLGaM IDEA	5.5	4	3.3	3.7	4.1	4.1	4	4.1	4.2	4.1	iAMaLGaM IDEA [4]
LSfminbnd	**1.8**	**1**	770	6300	*15e+0/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	**2.1**	**1.2**	770	2800	*15e+0/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	16	20	13	18	19	20	19	18	18	17	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.2**	**1.7**	8.7	47	130	520	1100	1300	3700	MCS (Neum) [18]
NELDER (Han)	**3**	**2.2**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1**	NELDER (Han) [16]
NELDER (Doe)	3.2	**2.2**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**2.3**	**1.9**	3.1	4.3	6.5	7.3	8.5	9.6	10	11	NEWUOA [31]
(1+1)-ES	6.3	5.3	8700	2.4e4	7.7e4	1.5e5	4.3e5	*13e-2/1e6*	.	.	(1+1)-ES [1]
POEMS	110	90	300	540	1400	2100	2400	3200	3700	6400	POEMS [20]
PSO	23	26	180	280	480	650	850	990	1100	1900	PSO [7]
PSO_Bounds	21	24	530	770	740	830	1500	1900	1900	2100	PSO_Bounds [8]
Monte Carlo	23	55	110	690	3900	4.4e4	1.3e5	3.8e5	*61e-4/1e6*	.	Monte Carlo [3]
Rosenbrock	4.8	**2.8**	3.1	3.4	3.2	3	**2.9**	**2.8**	**3.2**	**3**	Rosenbrock [27]
IPOP-SEP-CMA-ES	8.3	12	16	14	16	15	13	12	12	11	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	22	25	17	12	12	11	10	9.4	9.1	8.3	VNS (Garcia) [11]

Table 11: 02-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	4.7	5.67	17.6	22.5	25.2	30.8	33.7	37.6	40.7	48.5	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	17	40	35	80	200	410	880	1200	1700	3400	ALPS [17]
AMaLGaM IDEA	4.8	5.4	**3**	3.5	4.2	3.9	4.2	4.4	4.4	4.6	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	**1.5**	**1.5**	3.3	5.1	5.4	6.8	7.3	8	8.8	avg NEWUOA [31]
BayEDAcG	9.3	18	31	150	1100	*14e-1/2e3*	.	.	.	.	BayEDAcG [10]
BFGS	**1.6**	**1.7**	**1.2**	**1.6**	**2**	**1.7**	**1.9**	**2.7**	5.7	36	BFGS [30]
Cauchy EDA	13	15	6.7	7.4	8.1	8	8.3	8.1	8.9	9	Cauchy EDA [24]
BIPOP-CMA-ES	4.7	8.7	7.9	8.8	9.2	8.2	8	7.6	7.5	6.8	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	4.8	5.9	5.8	6.4	6.6	5.7	5.6	5.4	5.1	4.7	(1+1)-CMA-ES [2]
DASA	15	15	9e3	4e4	5.4e4	5.7e4	5.3e4	5e4	4.7e4	4.2e4	DASA [19]
DEPSO	24	34	34	110	*45e-2/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	3.3	5.1	**2.6**	5.2	28	49	58	190	270	460	DIRECT [25]
EDA-PSO	8.6	27	96	260	460	990	1900	2900	6500	*36e-6/1e5*	EDA-PSO [6]
full NEWUOA	**1.6**	3.5	**2.7**	4.4	6.2	6.2	7	7.7	8	8.6	full NEWUOA [31]
G3-PCX	9.5	9.1	9.7	25	28	36	35	33	32	27	G3-PCX [26]
simple GA	20	57	53	220	5e3	4.6e4	*14e-2/1e5*	.	.	.	simple GA [22]
GLOBAL	17	23	9.2	7.5	6.9	5.8	5.4	4.9	4.6	4	GLOBAL [23]
iAMaLGaM IDEA	4.5	6	**2.8**	3.3	4	3.8	4	3.9	3.9	4	iAMaLGaM IDEA [4]
LSfminbnd	**2.1**	**1.8**	500	2900	5500	*96e-1/1e4*	.	.	.	.	LSfminbnd [28]
LSstep	**1**	**1**	380	1800	2600	*81e-1/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	12	15	11	18	23	21	20	20	20	17	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.1**	87	120	170	300	920	1300	2e3	*91e-5/3e4*	MCS (Neum) [18]
NELDER (Han)	**2**	**2.1**	**1**	**1.1**	**1.1**	**1**	**1.1**	**1.1**	**1.1**	**1**	NELDER (Han) [16]
NELDER (Doe)	**2.2**	**2.4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**1.2**	**1.5**	**1.5**	3.2	5.5	6.1	6.9	7.7	8.4	11	NEWUOA [31]
(1+1)-ES	4.2	850	7700	2.1e4	6e4	2.3e5	4.4e5	*63e-3/1e6*	.	.	(1+1)-ES [1]
POEMS	55	83	1e3	1400	2100	2800	4e3	6500	7900	7100	POEMS [20]
PSO	10	23	480	530	660	670	860	1e3	1300	1900	PSO [7]
PSO_Bounds	11	21	3200	5200	6300	5500	6700	6300	6100	5500	PSO_Bounds [8]
Monte Carlo	16	51	94	870	6300	4.3e4	2.1e5	*97e-4/1e6*	.	.	Monte Carlo [3]
Rosenbrock	**2.3**	**2.9**	**2.4**	**2.7**	3	**2.7**	**2.6**	**2.5**	**2.6**	**2.5**	Rosenbrock [27]
IPOP-SEP-CMA-ES	5.4	6.9	13	17	17	14	13	13	12	11	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	8.4	14	12	12	12	11	10	9.7	9.4	8.6	VNS (Garcia) [11]

Table 12: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	5	9.17	16.9	23	37.6	47	52.4	62.7	76.3	97.4	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	19	37	40	51	76	94	130	210	230	370	ALPS [17]
AMaLGaM IDEA	5.4	4.1	5.8	13	17	17	17	18	16	15	AMaLGaM IDEA [4]
avg NEWUOA	**1.7**	**1.1**	**1**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.4**	**1.4**	avg NEWUOA [31]
BayEDAcG	40	26	69	87	*67e-2/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.8**	**1.1**	**1.2**	3.2	3.1	**2.9**	**2.8**	**2.6**	**2.4**	4.2	BFGS [30]
Cauchy EDA	11	9.9	14	24	19	18	18	17	15	14	Cauchy EDA [24]
BIPOP-CMA-ES	6	6.1	7.9	12	9.9	9.1	9	11	9.6	8.2	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	4.9	7	9.4	13	10	8.9	8.7	7.6	6.5	5.6	(1+1)-CMA-ES [2]
DASA	16	64	2700	6800	6100	8800	1.4e4	1.2e4	9700	7900	DASA [19]
DEPSO	17	16	41	55	51	48	45	40	35	45	DEPSO [12]
DIRECT	3	3.3	6.2	35	80	70	160	270	250	290	DIRECT [25]
EDA-PSO	11	24	40	98	160	300	790	1e3	1e3	820	EDA-PSO [6]
full NEWUOA	**1.4**	**1.9**	4.6	5.2	3.8	3.4	3.3	3	**2.7**	**2.4**	full NEWUOA [31]
G3-PCX	9.1	6.1	12	29	34	34	32	31	29	28	G3-PCX [26]
simple GA	23	39	93	170	580	1e3	2400	2700	2200	1900	simple GA [22]
GLOBAL	11	11	8.1	8.3	7.2	6.3	6.4	5.9	5	4.4	GLOBAL [23]
iAMaLGaM IDEA	4.1	**2.5**	4.5	7	6.4	6.4	6.4	6	5.8	5.4	iAMaLGaM IDEA [4]
LSfminbnd	**1.7**	**1**	590	1200	770	630	570	490	410	330	LSfminbnd [28]
LSstep	500	280	300	230	230	350	720	600	820	640	LSstep [28]
MA-LS-Chain	13	13	12	15	13	12	13	13	12	10	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.1**	62	49	32	26	24	28	39	30	MCS (Neum) [18]
NELDER (Han)	**1.9**	**1.4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Han) [16]
NELDER (Doe)	**2**	**1.4**	**1.1**	**1.6**	**1.6**	**1.7**	**1.7**	**1.6**	**1.4**	**1.3**	NELDER (Doe) [5]
NEWUOA	**1.5**	**1.1**	**1.9**	**2.9**	**2.3**	**2.1**	**2**	**1.8**	**1.6**	**1.4**	NEWUOA [31]
(1+1)-ES	3.8	1500	6800	1.7e4	2.3e4	5.5e4	1.3e5	2.3e5	1.9e5	*25e-3/1e6*	(1+1)-ES [1]
POEMS	64	79	83	650	1100	1200	1600	2100	2900	1.5e4	POEMS [20]
PSO	11	12	19	57	110	130	160	180	220	300	PSO [7]
PSO_Bounds	12	19	230	440	390	510	690	630	560	560	PSO_Bounds [8]
Monte Carlo	18	27	97	580	3200	1.6e4	1.4e5	*38e-4/1e6*	.	.	Monte Carlo [3]
Rosenbrock	3.3	**2.9**	**2.5**	3.6	**3**	5.4	5.1	4.5	3.9	3.3	Rosenbrock [27]
IPOP-SEP-CMA-ES	7.4	9.2	7.6	9.5	9.6	8.8	8.5	8.1	7	6.3	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	17	17	15	13	8.8	7.5	7.1	6.4	5.6	4.9	VNS (Garcia) [11]

Table 13: 02-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	0.5	2.3	11.3	17.6	23.2	30	35.4	41.5	47.4	61.1	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.3**	3.2	13	47	100	170	300	1300	3700	2.9e4	ALPS [17]
AMaLGaM IDEA	**1.1**	3.4	**2.6**	3.2	3.6	3.7	3.9	4	3.9	4.1	AMaLGaM IDEA [4]
avg NEWUOA	**1.8**	6.7	6.7	17	38	54	73	130	140	770	avg NEWUOA [31]
BayEDAcG	**1.4**	**2.4**	52	140	570	950	*11e-1/2e3*	.	.	.	BayEDAcG [10]
BFGS	**1.2**	5	6.8	15	45	74	160	660	580	*67e-5/5e3*	BFGS [30]
Cauchy EDA	4.1	15	7.3	7.7	7.7	8.2	8.5	8.6	8.5	8.5	Cauchy EDA [24]
BIPOP-CMA-ES	**1.3**	4.3	3.2	5.4	5.7	5.9	6.4	6.1	6.6	7	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.1**	4.4	5.2	7.3	7	7.3	8.1	7.6	7.9	7.6	(1+1)-CMA-ES [2]
DASA	13	90	540	850	2600	4900	1.6e4	4.7e4	1.4e5	*62e-5/1e6*	DASA [19]
DEPSO	**1.1**	6.1	8.4	25	63	120	*18e-3/2e3*	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**2.5**	4.2	5.1	8.7	24	49	74	120	DIRECT [25]
EDA-PSO	**1.4**	3.5	6.4	42	180	270	710	4e3	3.1e4	*27e-5/1e5*	EDA-PSO [6]
full NEWUOA	**1.5**	5.2	8.5	12	31	76	140	290	760	1800	full NEWUOA [31]
G3-PCX	**1.2**	3.9	13	30	36	47	50	55	70	61	G3-PCX [26]
simple GA	**1.3**	3.7	25	170	1100	2.2e4	*25e-3/1e5*	.	.	.	simple GA [22]
GLOBAL	**1.3**	**2.8**	9.2	9.3	7.3	6	13	*67e-5/400*	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.1**	3.3	**2.6**	**3.1**	**3.6**	**3.3**	**3.6**	**3.6**	**3.6**	**3.7**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	16	52	110	170	470	850	*13e-3/1e4*	.	.	LSfminbnd [28]
LSstep	28	420	280	570	1e3	1500	*35e-2/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	**1.1**	3.3	8.7	17	18	21	23	21	19	22	MA-LS-Chain [21]
MCS (Neum)	**1**	4.7	23	20	170	960	2200	2500	*75e-4/3e4*	.	MCS (Neum) [18]
NELDER (Han)	**1.7**	**1.6**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Han) [16]
NELDER (Doe)	**1.3**	**2.2**	**1.1**	**1.1**	**1**	**1**	**1**	**1**	**1.1**	**1**	NELDER (Doe) [5]
NEWUOA	**1.6**	**2.8**	6.3	10	22	25	72	62	91	150	NEWUOA [31]
(1+1)-ES	**1.9**	31	37	94	210	370	790	4200	8100	3.7e4	(1+1)-ES [1]
POEMS	170	110	48	93	140	330	1100	2300	6300	2.4e4	POEMS [20]
PSO	**1.6**	3.3	9	27	76	140	330	1100	2900	1.1e4	PSO [7]
PSO_Bounds	**1.1**	3.8	9.2	43	120	260	620	1200	3e3	*93e-7/1e5*	PSO_Bounds [8]
Monte Carlo	**1.6**	5.4	18	280	1.2e4	1.1e5	*32e-3/1e6*	.	.	.	Monte Carlo [3]
Rosenbrock	3.2	4.8	5.6	7	7.5	18	28	43	70	170	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.1**	3.7	13	20	18	15	14	14	13	11	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1.4**	3.9	8.8	9.7	9.6	8.8	9.2	9.1	8.6	8.4	VNS (Garcia) [11]

Table 14: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.5	0.5	0.7	3.7	8.1	12.2	18.9	27.8	33.7	45.1	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**1.6**	**2.4**	14	60	75	83	130	530	ALPS [17]
AMaLGaM IDEA	**1**	**1.2**	**1.6**	3.3	3.9	4.7	4.2	3.9	3.8	4.2	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.4**	3.4	**2.2**	**1.4**	**1.3**	**1.6**	**1.8**	**2.2**	6.8	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.9**	**1.8**	10	25	67	98	180	*12e-5/2e3*	BayEDAcG [10]
BFGS	**1**	**1.4**	**2.1**	**2.8**	**1.8**	**1.7**	**1.4**	**1.1**	**1**	6	BFGS [30]
Cauchy EDA	**1**	4.6	13	13	12	11	10	8.6	8.9	8.5	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1.1**	**1.9**	**2.5**	3	4.2	4.6	5.3	5.5	7.1	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.4**	**1.7**	3.1	3.4	3.6	4	3.9	4.4	4.7	(1+1)-CMA-ES [2]
DASA	**1**	18	22	22	16	18	33	590	9300	3.1e5	DASA [19]
DEPSO	**1**	**1**	**1.4**	5.2	10	16	17	18	55	*17e-7/2e3*	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1.3**	**2.1**	**2.8**	6	8.6	12	32	DIRECT [25]
EDA-PSO	**1**	**1.2**	**1.4**	**2.9**	8.2	12	15	74	160	1100	EDA-PSO [6]
full NEWUOA	**1**	**1.4**	3.2	**1.4**	**1**	**1**	**1**	**1.1**	**1.5**	3.7	full NEWUOA [31]
G3-PCX	**1**	**1.2**	**1.8**	6.3	6.3	5.9	6.6	7.6	9.1	11	G3-PCX [26]
simple GA	**1**	**1.1**	**1**	4	41	200	280	630	3200	*58e-7/1e5*	simple GA [22]
GLOBAL	**1**	**1.1**	**1.7**	5.5	13	13	8.8	6.2	8.2	*34e-7/300*	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.5**	**1.6**	3.7	3.9	4	3.9	3.4	3.5	3.6	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1.3**	4.7	5.4	**3**	6.2	76	1500	*23e-5/1e4*	.	LSfminbnd [28]
LSstep	**1**	55	40	73	50	120	1600	5100	*23e-4/1e4*	.	LSstep [28]
MA-LS-Chain	**1**	**1.3**	**1.7**	3.1	9.6	15	13	12	12	17	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1.4**	**1.7**	**2.8**	3.1	23	8200	MCS (Neum) [18]
NELDER (Han)	**1**	**1.5**	**2.1**	**1.4**	**1.4**	**1.4**	**1.2**	**1**	**1**	**1.1**	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.1**	**1.3**	**1.4**	**1.3**	**1.3**	**1.1**	**1**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**1**	**1.1**	3.7	**2.4**	**1.6**	**1.5**	**1.6**	**1.8**	**2.1**	5.4	NEWUOA [31]
(1+1)-ES	**1**	**1.7**	**2.3**	**2.5**	**2.5**	3.4	9.2	160	3400	*22e-7/1e6*	(1+1)-ES [1]
POEMS	**1**	140	190	86	73	160	180	180	330	3300	POEMS [20]
PSO	**1**	**1.1**	**1.4**	4.8	13	25	36	48	85	1700	PSO [7]
PSO_Bounds	**1**	**1.1**	**1.5**	**2.7**	14	45	72	110	180	1200	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**1.8**	**2.6**	31	560	7200	1.1e5	4.2e5	*15e-5/1e6*	Monte Carlo [3]
Rosenbrock	**1**	**2.2**	4	**1.9**	**1.6**	**1.6**	**1.9**	**1.8**	**2.4**	**3**	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.2**	**1.6**	**1.8**	4.4	4.9	7.4	9.7	10	11	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**2.1**	6.2	10	9.4	9	8.1	8.6	9.3	VNS (Garcia) [11]

Table 15: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.5	0.6	18.6	146	517	533	556	582	616	706	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.1**	**1.6**	**2.7**	6.8	3.4	4.8	5.7	7.1	7.9	9.1	ALPS [17]
AMaLGaM IDEA	**1.1**	**2.8**	**1.1**	4.3	**2.7**	**2.8**	**2.8**	**2.7**	**2.6**	**2.3**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**2.6**	**2.5**	**2.5**	3.3	3.2	3.1	**2.9**	**2.8**	**2.4**	avg NEWUOA [31]
BayEDAcG	**1**	**2.2**	**2.1**	8.2	7.6	26	*16e-2/2e3*	.	.	.	BayEDAcG [10]
BFGS	**1.2**	17	4.2	4.6	7.9	7.7	7.3	7	6.6	5.8	BFGS [30]
Cauchy EDA	9.1	38	4.9	**2.9**	3.2	11	14	14	13	12	Cauchy EDA [24]
BIPOP-CMA-ES	**1.2**	**2.9**	**1.1**	**1.8**	**2.1**	**2.2**	**2.2**	**2.1**	**2.1**	**1.9**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.2**	**2.8**	22	7.7	7.6	7.4	7.1	6.8	6.5	5.7	(1+1)-CMA-ES [2]
DASA	4.6	22	64	84	64	62	60	57	54	48	DASA [19]
DEPSO	**1.1**	**1.6**	**2.9**	3.8	**1.7**	**2.2**	**2.5**	**2.6**	3	6.3	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	DIRECT [25]
EDA-PSO	**1**	3.3	**2**	9.3	6.1	8.3	8.3	8.5	8.4	8.1	EDA-PSO [6]
full NEWUOA	**1.2**	3.1	**1.5**	**1.4**	3.5	3.4	3.3	3.1	**3**	**2.6**	full NEWUOA [31]
G3-PCX	**1.1**	**2.3**	7.8	13	22	21	20	19	18	16	G3-PCX [26]
simple GA	**1.2**	**2.3**	4.2	18	13	34	96	98	100	120	simple GA [22]
GLOBAL	**1.1**	**2.6**	**3**	**1.6**	**2.6**	**2.5**	**2.4**	**2.3**	**2.2**	**2**	GLOBAL [23]
iAMaLGaM IDEA	**1.1**	**2.5**	**1**	4.2	5.1	5.1	5	4.8	4.6	4.1	iAMaLGaM IDEA [4]
LSfminbnd	**1.1**	6.2	3.7	20	36	51	66	210	*71e-2/9e3*	.	LSfminbnd [28]
LSstep	**1.1**	47	170	200	80	79	77	74	71	63	LSstep [28]
MA-LS-Chain	**1.1**	**2**	**1.7**	**1.9**	**1.6**	**1.5**	**1.5**	**1.5**	**1.4**	**1.3**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**2.1**	3.5	**1.4**	**1.4**	**1.3**	**1.3**	**1.2**	**1.1**	MCS (Neum) [18]
NELDER (Han)	**1**	**1.9**	8.4	7.3	9.7	9.4	9	8.6	8.2	7.1	NELDER (Han) [16]
NELDER (Doe)	**1**	3.2	**1.1**	**1.3**	**1.4**	**1.3**	**1.3**	**1.2**	**1.2**	**1**	NELDER (Doe) [5]
NEWUOA	**1.1**	11	4.1	3.4	3.3	3.2	3	**2.9**	**2.7**	**2.4**	NEWUOA [31]
(1+1)-ES	**1.4**	3.7	**1.1**	5.3	8.4	8.2	7.9	7.5	7.1	6.3	(1+1)-ES [1]
POEMS	28	120	16	19	18	20	21	21	22	22	POEMS [20]
PSO	**1.1**	**2.4**	**1.9**	4.1	16	16	16	16	16	15	PSO [7]
PSO_Bounds	**1.2**	**2.3**	**1.7**	6.6	3.9	7.3	9.2	11	11	12	PSO_Bounds [8]
Monte Carlo	**1.1**	**2.1**	**2.4**	64	150	1500	5800	1.2e4	*50e-4/1e6*	.	Monte Carlo [3]
Rosenbrock	**1.3**	19	15	9.7	9.5	9.2	8.9	8.5	8	7	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	3.8	**1.5**	**2.9**	**2.1**	**2.2**	**2.2**	**2.1**	**2.1**	**1.9**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	3.3	3.4	**1.9**	**2.4**	**2.4**	**2.3**	**2.4**	**2.7**	3.7	VNS (Garcia) [11]

Table 16: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	0.5	0.567	4.57	25	87.2	163	179	195	205	269	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.3**	**2.7**	5.6	9.1	14	19	25	34	37	ALPS [17]
AMaLGaM IDEA	**1**	**1.2**	3.2	**3.4**	5.1	4.6	4.5	4.2	4.1	3.3	AMaLGaM IDEA [4]
avg NEWUOA	**1**	12	15	9.1	5.5	6.8	13	21	37	73	avg NEWUOA [31]
BayEDAcG	**1**	**1.4**	**1.5**	9.8	24	39	76	71	68	110	BayEDAcG [10]
BFGS	**1**	11	40	150	170	270	*27e-2/6e3*	.	.	.	BFGS [30]
Cauchy EDA	**1**	4.2	4.5	4.4	6.1	15	29	31	35	27	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	3.1	3.5	3.5	**2.5**	**2.4**	**2.3**	**2.3**	**1.9**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.2**	6	**2.3**	**2.3**	5.2	8.8	12	11	12	(1+1)-CMA-ES [2]
DASA	**1**	9	29	150	180	130	210	250	340	530	DASA [19]
DEPSO	**1**	**1.5**	3.9	10	10	9.6	26	38	72	*16e-4/2e3*	DEPSO [12]
DIRECT	**1**	**1.4**	**1.6**	**1**	**1**	**1**	**1**	**1.5**	**2**	**1.9**	DIRECT [25]
EDA-PSO	**1**	**1.8**	**2.6**	4.8	15	200	290	370	410	320	EDA-PSO [6]
full NEWUOA	**1**	**2.5**	8.1	5.9	3.9	3.2	5.5	7.6	10	16	full NEWUOA [31]
G3-PCX	**1**	**1.4**	**2.8**	8.9	3.1	4.5	4.8	5	5.3	11	G3-PCX [26]
simple GA	**1**	**1.2**	**2**	4.1	16	42	180	450	690	690	simple GA [22]
GLOBAL	**1**	**1.7**	3.9	5.1	**2.4**	**1.4**	**1.5**	**1.4**	**1.7**	**1.5**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.1**	**1**	6.9	7.4	9.1	9.2	8.6	8.3	7	iAMaLGaM IDEA [4]
LSfminbnd	**1**	3.6	5.6	5.7	5.4	8.3	14	33	38	110	LSfminbnd [28]
LSstep	**1**	**1.5**	**1.6**	11	23	63	70	150	200	150	LSstep [28]
MA-LS-Chain	**1**	**1.2**	**1.3**	3.6	4.2	6.4	10	11	10	8.3	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.1**	5.1	6.7	**2.7**	4.3	6.8	10	29	120	MCS (Neum) [18]
NELDER (Han)	**1**	**1.3**	**1.2**	7.6	4.4	4.7	4.3	4	3.8	**2.9**	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.1**	**1.6**	3.5	**1.8**	**1.1**	**1.1**	**1**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**1**	**2.4**	9	10	6.8	6.9	22	37	44	77	NEWUOA [31]
(1+1)-ES	**1**	**1.7**	35	38	35	33	56	73	84	120	(1+1)-ES [1]
POEMS	**1**	98	71	650	200	110	110	110	110	88	POEMS [20]
PSO	**1**	**1.7**	**2.5**	3.8	6.1	100	94	88	86	69	PSO [7]
PSO_Bounds	**1**	**1.2**	**2.8**	6.4	11	110	120	120	120	100	PSO_Bounds [8]
Monte Carlo	**1**	**1.2**	**2.3**	5	20	140	1200	2.4e4	7.2e4	*18e-5/1e6*	Monte Carlo [3]
Rosenbrock	**1**	10	33	36	33	27	79	290	*19e-4/8e3*	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.8**	3.2	4.1	**2.4**	**2.9**	4	3.8	3.9	3.3	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.2**	4.6	5	4.8	4.9	4.7	4.7	5.6	6.8	VNS (Garcia) [11]

Table 17: 02-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	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	0.5	0.5	1.33	30.4	66.5	138	198	372	543	828	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.2**	**1.5**	**2.8**	16	15	17	12	12	11	ALPS [17]
AMaLGaM IDEA	**1**	**1.5**	**1.5**	**1.3**	4.8	**2.7**	4.5	3.3	**2.9**	**2.1**	AMaLGaM IDEA [4]
avg NEWUOA	**1.1**	**1.3**	12	4.6	13	33	120	*75e-4/5e3*	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.1**	**1**	**2**	8	7	8.7	8.8	27	*87e-6/2e3*	BayEDAcG [10]
BFGS	**1**	6.4	15	16	90	*24e-2/2e3*	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	7.9	18	120	56	28	20	11	16	13	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1.2**	4.1	**1.8**	**1.5**	**1**	**1**	**1**	**1.3**	**1.1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	12	3.1	5.9	14	14	14	16	10	(1+1)-CMA-ES [2]
DASA	**1**	**1**	21	29	37	52	93	230	340	220	DASA [19]
DEPSO	**1**	**1.3**	**2.7**	**1.1**	4.3	3.7	3.7	**2.8**	**2.4**	**2.8**	DEPSO [12]
DIRECT	**1**	**1**	**1.4**	**1**	**1**	**1**	**1.4**	**1.2**	**1**	**1**	DIRECT [25]
EDA-PSO	**1.1**	**1.1**	**2.6**	**2**	3.9	7.4	9.9	8.2	8	7.1	EDA-PSO [6]
full NEWUOA	**1**	**1.4**	8.2	4.4	14	21	53	48	*30e-4/6e3*	.	full NEWUOA [31]
G3-PCX	**1**	**1.1**	**2.5**	4.5	6.2	3.9	3.2	**2.6**	4.4	**3**	G3-PCX [26]
simple GA	**1**	**1.2**	**2.1**	5.1	47	61	91	120	150	*69e-8/1e5*	simple GA [22]
GLOBAL	**1**	**1.2**	**2.6**	4	4.1	3.9	4.4	9.6	*75e-4/500*	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.2**	**1.3**	8.8	6.2	4.2	5.1	4.2	4	**2.8**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1.2**	5.4	**1.2**	7.3	55	*16e-3/5e3*	.	.	.	LSfminbnd [28]
LSstep	**1.1**	**2**	42	40	35	44	82	390	*10e-4/1e4*	.	LSstep [28]
MA-LS-Chain	**1.1**	**1.3**	**1.3**	**2.2**	5.3	4.3	4.8	**2.8**	3.1	**2.9**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.3**	4.3	4.8	5.4	9.2	44	140	130	MCS (Neum) [18]
NELDER (Han)	**1**	**1.5**	130	28	20	14	11	12	9.6	6.3	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.5**	**1.4**	**1.5**	3.3	**3**	3.1	7	5.9	4	NELDER (Doe) [5]
NEWUOA	**1**	**1.9**	7.7	6.8	18	33	120	*75e-4/5e3*	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.1**	**2.7**	5.9	6.7	4.8	8.5	13	23	15	(1+1)-ES [1]
POEMS	4.5	110	110	18	35	31	32	23	24	21	POEMS [20]
PSO	**1.1**	**1.2**	**1.9**	**1.6**	5	6.2	8.1	6.2	5.5	5.5	PSO [7]
PSO_Bounds	**1**	**1.3**	**1.9**	**1.3**	13	15	22	15	21	30	PSO_Bounds [8]
Monte Carlo	**1**	**1.1**	**1.7**	5.2	220	4900	7.4e4	*73e-4/1e6*	.	.	Monte Carlo [3]
Rosenbrock	**1**	20	45	83	140	500	350	*24e-2/5e3*	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.9**	4	**2.2**	**2.8**	**2.3**	**1.8**	**1.6**	**1.5**	**1.4**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**2.5**	5.7	4.7	**2.7**	**2.9**	**2.6**	6.7	32	VNS (Garcia) [11]

Table 18: 02-D, running time excess 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	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	0.5	1.6	9.5	66.9	333	625	854	1040	1220	1430	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.1**	**1.3**	**1.6**	6.6	5.5	5.4	6.7	8.1	9.6	13	ALPS [17]
AMaLGaM IDEA	**1.1**	**1.3**	**1.3**	4.1	**1**	**1**	**1.1**	**1.2**	**1.1**	**1.1**	AMaLGaM IDEA [4]
avg NEWUOA	**1.7**	7.9	5.4	9	6.1	62	*58e-3/6e3*	.	.	.	avg NEWUOA [31]
BayEDAcG	**1.4**	**1.5**	**2.3**	19	19	48	*53e-2/2e3*	.	.	.	BayEDAcG [10]
BFGS	5.4	11	14	30	110	*74e-2/2e3*	.	.	.	.	BFGS [30]
Cauchy EDA	**2.6**	2200	380	55	11	6.4	5	7	7.4	6.7	Cauchy EDA [24]
BIPOP-CMA-ES	**1.6**	**2.4**	**2.2**	6.5	**1.9**	**1.1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	22	6.6	13	17	38	83	140	*32e-3/1e4*	.	(1+1)-CMA-ES [2]
DASA	3.3	27	26	91	86	740	1800	4200	5900	5e3	DASA [19]
DEPSO	**1.3**	**1**	**2.7**	3.1	**2.1**	3.3	11	9.4	8.3	*75e-4/2e3*	DEPSO [12]
DIRECT	**1.4**	**1.9**	**1**	**1**	**1.1**	**1.2**	3.4	4.8	4.9	11	DIRECT [25]
EDA-PSO	**1.3**	**1.3**	**2.4**	5.4	7.1	9.1	11	12	13	15	EDA-PSO [6]
full NEWUOA	**1.2**	5	**3**	16	19	71	*58e-3/6e3*	.	.	.	full NEWUOA [31]
G3-PCX	**1.9**	**1.1**	**2**	10	21	41	48	72	99	85	G3-PCX [26]
simple GA	**1.1**	**1.5**	4.3	15	23	110	280	680	1200	*24e-4/1e5*	simple GA [22]
GLOBAL	**1.3**	**1.2**	**2**	3.1	**2.2**	4.8	7.6	*58e-3/1e3*	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.2**	**1.8**	**1.4**	12	**2.9**	**1.8**	**2.3**	**2**	**2**	**1.8**	iAMaLGaM IDEA [4]
LSfminbnd	**2.1**	3.6	**1.3**	**2.1**	7	33	*58e-3/4e3*	.	.	.	LSfminbnd [28]
LSstep	28	18	12	79	60	110	*24e-2/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	**1.7**	**1.5**	**1.6**	3.2	**2.5**	3.2	4	3.9	5.8	7	MA-LS-Chain [21]
MCS (Neum)	**1.4**	**3**	**1.3**	**2.8**	**1.7**	8.4	140	350	*30e-4/3e4*	.	MCS (Neum) [18]
NELDER (Han)	**1.2**	**1.3**	21	44	18	20	38	47	40	34	NELDER (Han) [16]
NELDER (Doe)	**1.3**	**1.3**	**1.2**	3.1	**2.4**	4.3	5.8	8.7	25	21	NELDER (Doe) [5]
NEWUOA	**1.3**	13	5.6	12	14	62	*98e-3/6e3*	.	.	.	NEWUOA [31]
(1+1)-ES	**1.5**	**2.4**	63	230	620	1500	4900	1.4e4	*75e-4/1e6*	.	(1+1)-ES [1]
POEMS	100	72	28	120	29	28	23	31	45	42	POEMS [20]
PSO	**1.3**	**1.3**	**1.7**	3.4	**2.8**	3.2	3.5	5.6	6.5	7.2	PSO [7]
PSO_Bounds	**1.4**	**1.5**	**1.5**	5.3	6.7	8.8	10	12	17	23	PSO_Bounds [8]
Monte Carlo	**1.1**	**1.2**	**2.2**	21	270	1.1e4	*24e-3/1e6*	.	.	.	Monte Carlo [3]
Rosenbrock	26	54	61	56	200	*53e-2/5e3*	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.5**	4.9	**2.1**	6.2	**2.1**	**1.3**	**1.1**	**1**	**1.1**	**1.1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.6**	3.8	16	5.4	3.6	4.8	8.1	18	150	VNS (Garcia) [11]

Table 19: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.5	0.5	0.5	0.5	13.2	108	114	120	126	138	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.1**	5.5	55	17	12	22	30	41	54	ALPS [17]
AMaLGaM IDEA	**1**	**1.1**	6.3	40	**6.2**	18	18	17	17	16	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.3**	8	110	13	22	21	20	19	18	avg NEWUOA [31]
BayEDAcG	**1**	**1.1**	3.9	44	9.9	13	57	*35e-4/2e3*	.	.	BayEDAcG [10]
BFGS	**1**	11	37	310	61	30	29	27	26	24	BFGS [30]
Cauchy EDA	**1**	**1.1**	16	110	51	170	860	1300	2800	*18e-4/5e4*	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	6	31	10	12	12	15	14	14	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	5.6	87	33	32	31	29	28	26	(1+1)-CMA-ES [2]
DASA	**1**	7.5	42	760	97	250	250	250	260	270	DASA [19]
DEPSO	**1**	**1**	4.4	59	17	18	35	36	69	67	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1**	**4.6**	10	9.6	9.1	**8.9**	59	DIRECT [25]
EDA-PSO	**1**	**1.1**	5.2	37	13	17	30	57	62	72	EDA-PSO [6]
full NEWUOA	**1**	**1.3**	6.7	88	17	17	17	16	15	14	full NEWUOA [31]
G3-PCX	**1**	**1**	5.3	52	37	49	47	45	43	40	G3-PCX [26]
simple GA	**1**	**1.2**	4.5	51	20	21	110	360	640	4900	simple GA [22]
GLOBAL	**1**	**1.3**	4.3	50	9.4	11	10	10	9.6	**8.8**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.1**	5.5	**25**	63	50	48	48	46	42	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1.1**	9.4	49	10	29	70	120	310	*59e-5/5e3*	LSfminbnd [28]
LSstep	**1**	**1.9**	140	440	27	63	140	580	*11e-4/1e4*	.	LSstep [28]
MA-LS-Chain	**1**	**1.1**	6.7	60	7.2	15	15	14	14	13	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	3.1	380	64	32	30	29	27	25	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.1**	4.6	52	10	**8.1**	**7.8**	**7.4**	**7.1**	**6.5**	NELDER (Doe) [5]
NEWUOA	**1**	**1.5**	6.2	130	16	27	26	25	24	22	NEWUOA [31]
(1+1)-ES	**1**	**1.6**	6.2	100	22	23	25	27	30	38	(1+1)-ES [1]
POEMS	**1**	130	340	550	57	210	200	200	190	190	POEMS [20]
PSO	**1**	**1.1**	5.3	34	9.1	**4.7**	**6**	**8.7**	9.9	16	PSO [7]
PSO_Bounds	**1**	**1.5**	5.1	40	7.8	11	20	36	47	71	PSO_Bounds [8]
Monte Carlo	**1**	**1.2**	4.5	64	16	36	110	310	720	3.2e4	Monte Carlo [3]
Rosenbrock	**1**	6.9	42	160	34	30	29	28	26	24	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.5**	4.3	29	6.8	19	20	19	19	18	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.2**	**2.2**	43	12	19	19	20	20	21	VNS (Garcia) [11]

Table 20: 02-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	1.1	1.6	1.87	30.3	182	183	183	184	185	188	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**2.1**	**2.8**	3.1	14	6.2	9.2	12	16	20	26	ALPS [17]
AMaLGaM IDEA	**2.2**	**2.5**	**2.6**	26	37	38	38	38	38	38	AMaLGaM IDEA [4]
avg NEWUOA	**3**	**2.2**	**2.1**	9.8	4	4	4	4	4	3.9	avg NEWUOA [31]
BayEDAcG	3.2	4	3.6	9.2	32	*25e-2/2e3*	.	.	.	.	BayEDAcG [10]
BFGS	**2.5**	**2.2**	**2.1**	6	**2.7**	**2.7**	**2.7**	**2.7**	**2.7**	**2.6**	BFGS [30]
Cauchy EDA	26	20	18	9.9	31	150	1300	2e3	2e3	1900	Cauchy EDA [24]
BIPOP-CMA-ES	**2.9**	**2.8**	**2.7**	13	9.9	10	11	11	11	11	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.2**	**2**	**2.1**	7.5	8.5	8.6	8.6	8.6	8.6	8.6	(1+1)-CMA-ES [2]
DASA	59	52	49	81	44	45	45	45	45	45	DASA [19]
DEPSO	**1.4**	**1**	**1**	9.9	4.9	5.6	6.4	6.8	8	9.2	DEPSO [12]
DIRECT	5.7	5.9	6.1	**1**	**2.9**	3	3.1	3.3	3.7	3.9	DIRECT [25]
EDA-PSO	**1.7**	3.3	3.2	9	13	21	25	25	26	27	EDA-PSO [6]
full NEWUOA	**2.9**	**2.1**	**1.8**	18	8.3	8.3	8.3	8.3	8.2	8.1	full NEWUOA [31]
G3-PCX	**2.9**	**2.8**	**2.9**	38	7.8	7.8	8	8.1	8.1	8.2	G3-PCX [26]
simple GA	**2.7**	**2.4**	**2.8**	14	15	27	45	65	85	130	simple GA [22]
GLOBAL	**1.8**	**1.9**	**2.4**	11	4.5	4.5	4.5	4.5	4.5	4.5	GLOBAL [23]
iAMaLGaM IDEA	**2.1**	**2.4**	**2.2**	51	26	26	27	27	27	27	iAMaLGaM IDEA [4]
LSfminbnd	6.5	6.7	6.6	150	*68e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	94	210	180	120	25	27	30	37	40	50	LSstep [28]
MA-LS-Chain	**1.5**	**1.9**	**2.4**	4.2	**1.8**	**2**	**2.1**	**2.2**	**2.3**	**2.4**	MA-LS-Chain [21]
MCS (Neum)	**2.9**	6.2	5.7	**2.2**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**1.5**	**1.3**	**1.3**	36	28	28	28	28	28	27	NELDER (Han) [16]
NELDER (Doe)	**1.6**	**1.7**	**1.5**	**3.9**	**2.8**	**2.8**	**2.9**	**2.9**	**2.9**	**2.9**	NELDER (Doe) [5]
NEWUOA	**3**	**2.2**	**2.1**	7	5.9	5.9	5.9	5.9	5.8	5.8	NEWUOA [31]
(1+1)-ES	4.1	3.7	3.3	13	9	9.1	9.2	9.2	9.2	9.2	(1+1)-ES [1]
POEMS	190	140	130	25	30	35	42	46	52	61	POEMS [20]
PSO	**2.5**	**2.2**	**2.5**	8.3	5	6.3	8.7	10	12	15	PSO [7]
PSO_Bounds	**2.5**	**2.9**	3.7	11	6	13	20	25	30	36	PSO_Bounds [8]
Monte Carlo	**2.2**	**2.8**	3.6	21	67	680	5800	8.2e4	*80e-5/1e6*	.	Monte Carlo [3]
Rosenbrock	5	4	4	6.8	4.1	4.2	4.2	4.2	4.2	4.2	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.6**	**1.8**	**1.8**	9.4	15	16	17	18	18	18	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	3.8	4.3	18	9.3	9.6	9.7	9.9	10	13	VNS (Garcia) [11]

Table 21: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	0.5	0.5	0.833	25.3	87.2	138	145	153	162	165	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**1.2**	**2.2**	**1.8**	**2.6**	4.9	6.4	7.8	12	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**1.3**	28	17	11	11	10	10	10	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	6.1	6.5	4.6	**2.9**	**2.8**	**2.7**	**2.6**	**2.7**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.7**	**1.6**	9.3	14	39	57	86	85	BayEDAcG [10]
BFGS	**1**	**1**	**2.6**	4.8	3	**2**	**1.9**	**1.8**	**1.7**	**1.8**	BFGS [30]
Cauchy EDA	**1**	**1**	6	310	93	62	65	62	81	80	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	**1.4**	11	10	8.2	9.7	9.3	8.9	8.9	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	**1.2**	12	9.6	6.1	5.9	5.6	5.3	5.3	(1+1)-CMA-ES [2]
DASA	**1**	**1**	13	150	140	88	84	80	77	76	DASA [19]
DEPSO	**1**	**1**	**2.1**	**2.5**	**1.5**	**1.8**	**2.4**	**2.6**	**2.9**	5.6	DEPSO [12]
DIRECT	**1**	**1**	**1.3**	**1**	**1**	**1**	**1**	**2**	**2**	**2.3**	DIRECT [25]
EDA-PSO	**1**	**1**	**1**	**1.8**	83	54	53	52	51	52	EDA-PSO [6]
full NEWUOA	**1**	**1**	**2.2**	3.6	**3**	**1.9**	**1.8**	**1.7**	**1.7**	**1.7**	full NEWUOA [31]
G3-PCX	**1**	**1**	**1.4**	**2.7**	**2.9**	**1.9**	**1.9**	**1.8**	**1.8**	**1.8**	G3-PCX [26]
simple GA	**1**	**1**	**1.4**	**1**	**1.7**	4.1	7.7	18	120	270	simple GA [22]
GLOBAL	**1**	**1**	**1.5**	**1.1**	**1.1**	**1**	**1**	**1**	**1**	**1**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.6**	21	12	7.9	7.8	7.5	7.2	7.1	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	**2.1**	39	20	26	46	60	73	170	LSfminbnd [28]
LSstep	**1**	**1**	18	370	150	100	100	100	120	190	LSstep [28]
MA-LS-Chain	**1**	**1**	**1.4**	**1.1**	**1.5**	**1.5**	**1.7**	**1.9**	**1.9**	**2**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.6**	22	14	8.8	8.4	8	7.6	7.5	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**1.8**	19	20	13	12	12	11	11	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.4**	**2.6**	**2.6**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	3.5	3.9	4	**2.5**	**2.4**	**2.3**	**2.2**	**2.3**	NEWUOA [31]
(1+1)-ES	**1**	**1**	**2.8**	14	19	12	11	11	10	10	(1+1)-ES [1]
POEMS	**1**	**1**	130	93	890	560	540	520	490	490	POEMS [20]
PSO	**1**	**1**	**1.2**	**1.4**	83	53	51	48	46	47	PSO [7]
PSO_Bounds	**1**	**1**	**1.5**	33	300	190	180	170	170	170	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**2**	**1.8**	**1.2**	3.5	8.8	28	42	640	Monte Carlo [3]
Rosenbrock	**1**	**1**	**2.3**	5.5	3.9	**2.5**	**2.4**	**2.3**	**2.2**	**2.1**	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	**1.3**	9.6	6.4	6.3	8.5	8.7	8.6	9.2	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**1.1**	6.1	14	9.1	8.8	8.5	8.4	8.4	VNS (Garcia) [11]

Table 22: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	0.5	0.5	2.53	13.4	83.9	109	125	142	144	153	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**1.2**	**1.3**	**1**	**3**	5.2	7.1	9.2	15	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**1.3**	51	18	19	17	15	15	15	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	**3**	3.8	**1.3**	**1.1**	**1.1**	**1.1**	**1.1**	**1.3**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.3**	3.3	7.6	11	34	59	200	*37e-4 /2e3*	BayEDAcG [10]
BFGS	**1**	**1**	5.4	5	**1.5**	**1.2**	**1.1**	**1**	**1**	**1**	BFGS [30]
Cauchy EDA	**1**	**1**	27	610	190	270	390	450	540	510	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	**1**	7.3	11	8.7	10	9.2	9.1	8.7	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	14	26	7.2	5.7	5	4.5	4.4	4.3	(1+1)-CMA-ES [2]
DASA	**1**	**1**	11	80	22	21	22	28	40	63	DASA [19]
DEPSO	**1**	**1**	**2.3**	4.7	**2.4**	4	4.6	5	6.6	9.8	DEPSO [12]
DIRECT	**1**	**1**	**1.5**	**2.1**	**1.3**	**1.3**	**1.4**	**2.2**	4.8	5.1	DIRECT [25]
EDA-PSO	**1**	**1**	**1.1**	4	**1.7**	4.2	4.9	8.4	11	25	EDA-PSO [6]
full NEWUOA	**1**	**1**	6.5	6.8	**1.5**	**1.2**	**1.1**	**1.1**	**1.1**	**1.2**	full NEWUOA [31]
G3-PCX	**1**	**1**	**2.1**	**2.2**	**1.1**	**1.1**	**1.1**	**1.3**	**1.4**	**1.6**	G3-PCX [26]
simple GA	**1**	**1**	**1.2**	**3**	**1.3**	3.3	7.1	17	280	1900	simple GA [22]
GLOBAL	**1**	**1**	**1.7**	**2.9**	**1.3**	**1.5**	**1.5**	**1.3**	**1.4**	**1.3**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.5**	14	9.9	8.9	8	7.2	7.1	7.3	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	**1.4**	4.7	5.1	53	49	61	69	460	LSfminbnd [28]
LSstep	**1**	**1**	**1**	80	140	140	150	280	970	920	LSstep [28]
MA-LS-Chain	**1**	**1**	**1**	**2.8**	**1.6**	**1.9**	**2.2**	**2.3**	**2.4**	**2.4**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**2.4**	40	7.4	6	5.3	4.7	4.8	5.2	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	7.7	39	9.8	7.6	6.6	5.9	5.8	5.5	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.3**	8.1	**1.8**	**1.4**	**1.2**	**1.1**	**1.1**	**1.1**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**1.9**	6.3	**1.2**	**1**	**1**	**1**	**1**	**1.1**	NEWUOA [31]
(1+1)-ES	**1**	**1**	**1.6**	46	11	9.8	9.4	9.4	10	12	(1+1)-ES [1]
POEMS	**1**	**1**	64	940	230	190	160	150	150	150	POEMS [20]
PSO	**1**	**1**	**1.5**	**2.7**	**1**	**1.8**	**1.9**	**2.3**	3.8	6.5	PSO [7]
PSO_Bounds	**1**	**1**	**1.2**	540	87	67	60	56	58	64	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**1.3**	**2.8**	**1.5**	3.1	7.2	24	93	760	Monte Carlo [3]
Rosenbrock	**1**	**1**	12	17	4.5	3.5	3.1	**2.7**	**2.7**	**2.6**	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	**1**	7.7	4.4	4.1	3.9	3.6	3.8	3.8	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**2**	**1**	**2.8**	3.8	4.8	4.7	5	5.3	VNS (Garcia) [11]

Table 23: 02-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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

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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	0.5	0.5	3.9	96.5	117	131	150	157	174	190	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**1.4**	14	86	140	200	640	4100	2.8e4	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**1.3**	7.5	10	9.8	9	8.9	8.4	8.1	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	4.2	6.7	25	100	260	*49e-3/6e3*	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**2**	11	*56e-2/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	4.8	4.9	28	120	480	460	410	*73e-3/5e3*	BFGS [30]
Cauchy EDA	**1**	**1**	**1.8**	16	860	*14e-2/5e4*	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	**1.8**	8.3	15	14	13	13	12	12	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	**2.1**	5.1	8.4	8.6	7.7	7.6	6.9	6.6	(1+1)-CMA-ES [2]
DASA	**1**	**1**	5.7	17	170	1800	8600	9600	8700	7900	DASA [19]
DEPSO	**1**	**1**	**2.2**	24	*96e-2/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1.5**	4.2	290	270	240	230	210	200	DIRECT [25]
EDA-PSO	**1**	**1**	**2.3**	18	1400	*13e-2/1e5*	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**1**	6	**1.5**	24	46	81	79	71	65	full NEWUOA [31]
G3-PCX	**1**	**1**	**1.9**	**1.6**	6.1	6	5.8	5.8	5.5	7.4	G3-PCX [26]
simple GA	**1**	**1**	**1.4**	6.6	330	840	3300	*41e-4/1e5*	.	.	simple GA [22]
GLOBAL	**1**	**1**	**1**	**2.6**	97	*21e-2/2e3*	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.3**	5.3	**5.5**	**5.3**	**4.9**	**5**	**4.7**	**4.6**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	**1.3**	**2.1**	30	120	200	190	*25e-3/7e3*	.	LSfminbnd [28]
LSstep	**1**	**1**	**2.6**	18	1300	*24e-2/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1**	**1.8**	5.5	7.4	7.1	6.6	6.7	6.4	7	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	3.4	**2.8**	6.3	23	210	500	1e3	1900	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**1.3**	**1.6**	**2.2**	**2.2**	**2**	**1.9**	**1.8**	**1.7**	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	4.7	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	7.8	3.2	32	89	130	170	500	460	NEWUOA [31]
(1+1)-ES	**1**	**1**	**2.6**	3.7	19	55	240	1e3	2100	6700	(1+1)-ES [1]
POEMS	**1**	**1**	14	28	190	180	180	190	180	190	POEMS [20]
PSO	**1**	**1**	**1.3**	9	42	59	73	79	88	95	PSO [7]
PSO_Bounds	**1**	**1**	**1.7**	9.4	260	460	500	690	660	860	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**1.5**	8	1900	*46e-3/1e6*	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	**1.9**	**2.2**	9.9	15	17	23	29	*66e-7/5e3*	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	**2.6**	8.1	14	16	14	14	13	12	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**1.8**	8.3	38	67	65	62	56	52	VNS (Garcia) [11]

Table 24: 02-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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

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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	0.5	0.5	9.13	429	4260	11700	12100	12400	12400	12400	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**1**	6.5	4	**2.8**	**2.9**	**2.9**	3	3.2	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**1.2**	35	11	6.7	6.7	6.6	6.6	6.7	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	3.3	**1.9**	**1.4**	6.2	6	5.9	5.9	5.9	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.9**	68	*22e-1/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	3.4	5.1	**2.9**	*42e-2/3e3*	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	**1**	3.9	33	170	*49e-2/5e4*	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	4.6	19	17	13	22	22	22	22	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	**2.7**	6.1	4.8	**2.9**	**2.8**	**2.7**	**2.7**	3.6	(1+1)-CMA-ES [2]
DASA	**1**	**1**	10	140	110	61	59	58	58	58	DASA [19]
DEPSO	**1**	**1**	3.3	67	*24e-1/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1.9**	79	8.7	5	4.9	4.7	4.7	4.8	DIRECT [25]
EDA-PSO	**1**	**1**	**1.6**	100	12	9	9	8.8	8.8	8.9	EDA-PSO [6]
full NEWUOA	**1**	**1**	**2.8**	**1**	**1**	**1.1**	**1**	**1**	**1**	**1**	full NEWUOA [31]
G3-PCX	**1**	**1**	**1.2**	37	20	*10e-2/5e4*	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1**	**1.6**	67	*79e-2/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1**	**2.7**	3.3	7	*51e-2/2e3*	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.4**	28	9.1	5.4	5.3	5.2	5.3	5.3	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	**2.8**	8.3	*37e-2/8e3*	.	.	.	.	.	LSfminbnd [28]
LSstep	3	3	4.8	29	33	12	12	*11e-1/1e4*	.	.	LSstep [28]
MA-LS-Chain	**1**	**1**	**2.5**	31	34	*11e-1/1e4*	.	.	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**2.5**	5.7	**1.6**	**2.7**	**2.7**	**2.6**	**2.6**	**2.6**	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	16	7.4	5	6.6	6.4	6.2	6.2	6.2	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.5**	**1.9**	**1.5**	3.2	3.1	3	3	3	NELDER (Doe) [5]
NEWUOA	**1**	**1**	3.1	**2.8**	**1.9**	**2**	**1.9**	**1.9**	**1.9**	**1.9**	NEWUOA [31]
(1+1)-ES	**1**	**1**	8	12	11	21	20	19	19	19	(1+1)-ES [1]
POEMS	**1**	**1**	28	1500	170	*20e-1/1e5*	.	.	.	.	POEMS [20]
PSO	**1**	**1**	**2.4**	470	49	18	17	17	17	17	PSO [7]
PSO_Bounds	**1**	**1**	**1.3**	1500	150	57	55	54	54	54	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**2.5**	14	150	570	*49e-3/1e6*	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	19	35	15	11	11	11	11	11	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	**1.7**	7.2	3.9	3.7	3.7	3.6	3.6	3.6	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**1.2**	5.3	**1.7**	**1**	**1**	**1.1**	**1.9**	4.7	VNS (Garcia) [11]

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