Comparison tables: BBOB 2009 function testbed in 10-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: 10-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	0.1	0.1	2.2	2.27	2.29	2.3	2.3	2.3	2.3	2.3	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	8.9	84	230	410	590	780	950	1100	1500	ALPS [17]
AMaLGaM IDEA	**1**	5	18	45	73	100	130	160	190	240	AMaLGaM IDEA [4]
avg NEWUOA	**1**	27	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	avg NEWUOA [31]
BayEDAcG	**1**	6.5	39	100	230	300	370	440	500	640	BayEDAcG [10]
BFGS	**1**	13	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BFGS [30]
Cauchy EDA	**1**	240	160	350	510	700	870	1100	1200	1600	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	7.8	5.7	12	18	25	31	38	44	58	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	5.3	3.8	7.5	11	15	18	22	25	33	(1+1)-CMA-ES [2]
DASA	**1**	110	29	45	59	77	95	110	130	180	DASA [19]
DEPSO	**1**	**3.2**	19	45	84	130	170	220	280	390	DEPSO [12]
DIRECT	**1**	**1**	8.8	31	64	97	140	190	240	400	DIRECT [25]
EDA-PSO	**1**	9.2	22	800	1500	2300	3100	3900	4700	6400	EDA-PSO [6]
full NEWUOA	**1**	40	3.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	full NEWUOA [31]
G3-PCX	**1**	4.7	7.9	11	15	20	24	28	33	43	G3-PCX [26]
simple GA	**1**	4.4	310	1200	2100	3200	4400	7100	1.2e4	6.1e4	simple GA [22]
GLOBAL	**1**	5.3	15	14	14	14	14	14	14	14	GLOBAL [23]
iAMaLGaM IDEA	**1**	5.7	8.5	25	41	57	72	87	100	140	iAMaLGaM IDEA [4]
LSfminbnd	**1**	39	7.1	8.1	8.3	8.3	8.3	8.3	8.3	8.3	LSfminbnd [28]
LSstep	**1**	960	140	150	160	160	160	160	160	160	LSstep [28]
MA-LS-Chain	**1**	4.7	12	36	58	80	110	120	140	180	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.2**	**2**	**2.1**	**2.2**	**2.9**	**2.9**	**2.9**	**2.9**	MCS (Neum) [18]
NELDER (Han)	**1**	7.1	**2.5**	6.1	9.5	13	16	19	23	31	NELDER (Han) [16]
NELDER (Doe)	**1**	8.3	**2.4**	5.3	8.1	11	14	17	21	32	NELDER (Doe) [5]
NEWUOA	**1**	14	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [31]
(1+1)-ES	**1**	17	3.9	6.9	10	13	16	19	22	28	(1+1)-ES [1]
POEMS	**1**	1600	140	220	620	1e3	1500	2e3	2400	3300	POEMS [20]
PSO	**1**	5.8	10	55	100	150	210	280	330	450	PSO [7]
PSO_Bounds	**1**	5.7	18	180	700	1400	1700	2100	2500	5300	PSO_Bounds [8]
Monte Carlo	**1**	5.4	3e3	*35e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	37	3.4	4.9	6.5	8.1	9.7	11	13	16	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	5.3	4.8	11	16	21	26	33	37	48	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	12	12	18	26	32	38	44	51	65	VNS (Garcia) [11]

Table 2: 10-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	14.6	18.5	18.7	19	19.1	19.1	19.3	19.3	19.4	19.5	ERT$_{\text{best}}$/D
ALPS	47	58	80	100	130	150	170	200	220	280	ALPS [17]
AMaLGaM IDEA	8.7	11	15	20	25	29	32	35	39	46	AMaLGaM IDEA [4]
avg NEWUOA	**2.5**	6.1	16	39	67	90	120	160	180	250	avg NEWUOA [31]
BayEDAcG	32	34	42	57	66	74	81	89	97	110	BayEDAcG [10]
BFGS	4.7	7.5	10	12	14	14	14	14	15	15	BFGS [30]
Cauchy EDA	60	72	95	120	140	160	190	210	230	270	Cauchy EDA [24]
BIPOP-CMA-ES	11	14	20	24	26	27	28	28	29	30	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	7.9	10	16	20	21	22	23	23	24	25	(1+1)-CMA-ES [2]
DASA	6.4	6.7	8.6	11	13	15	18	21	25	34	DASA [19]
DEPSO	8.9	11	16	22	28	34	42	48	55	69	DEPSO [12]
DIRECT	11	12	15	150	150	160	170	380	410	1e3	DIRECT [25]
EDA-PSO	200	250	350	440	520	620	710	810	890	1100	EDA-PSO [6]
full NEWUOA	6.2	18	53	150	300	590	2500	7700	*53e-4/1e4*	.	full NEWUOA [31]
G3-PCX	13	31	89	190	290	370	460	540	640	860	G3-PCX [26]
simple GA	240	300	820	1400	2700	4400	7e3	1.2e4	7.4e4	*53e-4/1e5*	simple GA [22]
GLOBAL	6.5	8.6	12	13	14	14	15	15	15	16	GLOBAL [23]
iAMaLGaM IDEA	5.9	7.9	11	14	16	18	19	21	23	27	iAMaLGaM IDEA [4]
LSfminbnd	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSfminbnd [28]
LSstep	19	16	16	16	16	16	16	16	16	16	LSstep [28]
MA-LS-Chain	7	9.6	14	18	23	27	32	37	42	52	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.3**	**3.2**	**4.6**	**6.5**	**7.5**	10	11	**11**	110	MCS (Neum) [18]
NELDER (Han)	3.9	5.1	**6.1**	**7**	**8.1**	**8.6**	**9.2**	**9.7**	**10**	**11**	NELDER (Han) [16]
NELDER (Doe)	4.2	10	22	52	83	100	120	130	130	200	NELDER (Doe) [5]
NEWUOA	**1.2**	4.4	13	37	74	100	150	180	220	300	NEWUOA [31]
(1+1)-ES	280	1300	5600	1.4e4	2.3e4	3.1e4	4.9e4	1.4e5	2.4e5	7.5e5	(1+1)-ES [1]
POEMS	130	180	220	280	320	380	430	470	540	650	POEMS [20]
PSO	17	26	41	420	420	430	430	440	440	450	PSO [7]
PSO_Bounds	120	190	290	420	530	600	890	1200	1500	1800	PSO_Bounds [8]
Monte Carlo	*67e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1.6**	**3.4**	39	100	160	210	220	280	370	650	Rosenbrock [27]
IPOP-SEP-CMA-ES	4.9	5.6	6.9	7.7	8.5	9.3	**9.9**	**11**	11	**12**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	20	24	29	33	37	39	41	43	44	47	VNS (Garcia) [11]

Table 3: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	0.1	6.9	174	360	361	364	364	364	365	365	ERT$_{\text{best}}$/D
ALPS	**2.6**	30	11	40	59	59	61	64	**67**	81	ALPS [17]
AMaLGaM IDEA	3.7	6.7	4.6	1300	3.9e4	3.9e4	3.8e4	3.8e4	3.8e4	3.8e4	AMaLGaM IDEA [4]
avg NEWUOA	11	16	*21e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**2.1**	18	*22e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	30	370	*70e+0/5e3*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	160	69	4100	*15e+0/5e4*	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	4.5	3.4	3.6	310	5900	5900	5900	5900	5900	5900	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	4.3	14	390	*17e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	17	7.2	**1**	**11**	**19**	**19**	**19**	**19**	**19**	**20**	DASA [19]
DEPSO	**1.5**	8	170	*19e+0/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	5.6	87	*26e+0/1e4*	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	**2.6**	34	18	1800	*20e-1/1e5*	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	9.3	14	*17e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1.7**	71	*20e+0/5e4*	.	.	.	.	.	.	.	G3-PCX [26]
simple GA	**2.6**	150	26	**23**	73	140	460	610	830	3900	simple GA [22]
GLOBAL	**2.3**	6.8	140	*34e+0/2e3*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**2.7**	3.6	4.4	270	2300	2300	2300	2300	2300	2300	iAMaLGaM IDEA [4]
LSfminbnd	57	**2.2**	47	*11e+0/5e3*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	1300	46	**2.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSstep [28]
MA-LS-Chain	**1.9**	5.6	3.9	43	79	79	79	79	79	**79**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	11	*40e-1/4e3*	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	5.1	31	320	*90e-1/1e5*	.	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	4.4	**1.1**	180	*11e+0/2e4*	.	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	5.1	20	*23e+0/6e3*	.	.	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	5.9	74	6400	*90e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
POEMS	470	42	6.7	29	66	68	73	75	79	84	POEMS [20]
PSO	3.9	6.4	150	1800	1800	1800	1800	1800	1800	1800	PSO [7]
PSO_Bounds	**2**	11	50	44	**51**	**52**	**54**	**55**	70	95	PSO_Bounds [8]
Monte Carlo	**2.4**	2900	*63e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	18	330	*53e+0/8e3*	.	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**2.5**	**2.7**	**3.1**	62	*20e-1/1e4*	.	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**2**	5.6	3.2	24	190	210	230	230	260	290	VNS (Garcia) [11]

Table 4: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	0.1	9.82	223	363	366	370	371	374	374	2880	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**2.4**	39	14	100	170	170	170	180	190	30	ALPS [17]
AMaLGaM IDEA	**2.6**	8.9	41	*50e-1/1e6*	.	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	13	42	*27e+0/1e4*	.	.	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**2.1**	28	*18e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	89	850	*10e+1/5e3*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	190	100	*31e+0/5e4*	.	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	5.8	**2.8**	6.5	*50e-1/3e5*	.	.	.	.	.	.	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	3.3	20	*33e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	130	7.8	**1**	**16**	**52**	**51**	**51**	**51**	**51**	**6.8**	DASA [19]
DEPSO	3.1	9.4	66	*18e+0/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	4.2	180	*19e+0/1e4*	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	**2.5**	83	20	*50e-1/1e5*	.	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	35	13	*27e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**2.9**	500	*35e+0/5e4*	.	.	.	.	.	.	.	G3-PCX [26]
simple GA	**2.7**	140	22	**26**	**79**	310	1800	*84e-4/1e5*	.	.	simple GA [22]
GLOBAL	**2.5**	33	*57e+0/2e3*	.	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	3.5	5.5	29	*50e-1/1e6*	.	.	.	.	.	.	iAMaLGaM IDEA [4]
LSfminbnd	56	**1.6**	*21e+0/6e3*	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	670	31	**1.6**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSstep [28]
MA-LS-Chain	**2.8**	6.1	**5.1**	290	2e3	2e3	2e3	2e3	2e3	260	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	27	*12e+0/4e3*	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	5.1	46	3300	*17e+0/1e5*	.	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	3.1	**2.8**	*20e+0/2e4*	.	.	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	11	110	*55e+0/7e3*	.	.	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	9.5	120	6.3e4	*15e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
POEMS	570	35	6.4	43	85	**89**	**91**	**94**	**97**	**13**	POEMS [20]
PSO	3.3	8.5	120	*80e-1/1e5*	.	.	.	.	.	.	PSO [7]
PSO_Bounds	3.5	28	37	190	200	200	200	200	210	30	PSO_Bounds [8]
Monte Carlo	**2.3**	2e4	*86e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	32	780	*70e+0/1e4*	.	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	6.5	**2.7**	6.6	*60e-1/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	3.2	5	7.2	2900	2.5e4	2.5e4	2.7e4	2.7e4	2.7e4	4600	VNS (Garcia) [11]

Table 5: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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 $\mathrm{ERT}_{\mathrm{best}}/D$	1e+03 0.1	1e+02 1.64	1e+01 2.02	1e+00 2.02	1e-01 2.02	1e-02 2.02	1e-03 2.02	1e-04 2.02	1e-05 2.02	1e-07 2.02	Δftarget $\mathrm{ERT}_{\mathrm{best}}/D$
ALPS	**1**	7.4	130	190	220	240	250	250	250	260	ALPS [17]
AMaLGaM IDEA	**1**	4.6	39	45	46	46	46	46	46	46	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.9**	**2**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	avg NEWUOA [31]
BayEDAcG	**1**	5.9	91	120	140	140	140	140	140	140	BayEDAcG [10]
BFGS	**1**	**1.3**	**2.2**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	BFGS [30]
Cauchy EDA	**1**	24	68	70	72	72	72	72	72	72	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.2**	4.8	6	6.1	6.1	6.1	6.1	6.1	6.1	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.1**	3.2	3.9	3.9	3.9	3.9	3.9	3.9	3.9	(1+1)-CMA-ES [2]
DASA	**1**	13	23	31	36	40	43	47	50	58	DASA [19]
DEPSO	**1**	7	33	47	50	50	50	50	50	50	DEPSO [12]
DIRECT	**1**	6	36	52	53	53	53	53	53	53	DIRECT [25]
EDA-PSO	**1**	**2.9**	11	17	20	20	21	21	21	21	EDA-PSO [6]
full NEWUOA	**1**	**2.8**	3.6	4	4	4	4	4	4	4	full NEWUOA [31]
G3-PCX	**1**	6.8	17	26	27	28	28	28	28	28	G3-PCX [26]
simple GA	**1**	5.8	1400	3100	5400	8200	1.1e4	1.5e4	1.9e4	3e4	simple GA [22]
GLOBAL	**1**	5.2	17	18	18	18	18	18	18	18	GLOBAL [23]
iAMaLGaM IDEA	**1**	**2.4**	8.8	11	12	12	12	12	12	12	iAMaLGaM IDEA [4]
LSfminbnd	**1**	8.3	14	15	15	15	15	15	15	15	LSfminbnd [28]
LSstep	**1**	83	170	180	180	180	180	180	180	180	LSstep [28]
MA-LS-Chain	**1**	4.7	41	45	49	49	49	49	49	49	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**1**	**1.6**	3.4	4.2	4.3	4.3	4.3	4.3	4.3	4.3	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.2**	3.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	NELDER (Doe) [5]
NEWUOA	**1**	**1.3**	**1.2**	**1.3**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	NEWUOA [31]
(1+1)-ES	**1**	**1.1**	**2.1**	**2.6**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	(1+1)-ES [1]
POEMS	**1**	130	190	230	260	270	270	270	270	270	POEMS [20]
PSO	**1**	**2.9**	13	17	19	19	20	20	20	20	PSO [7]
PSO_Bounds	**1**	3.1	10	14	15	15	16	16	16	16	PSO_Bounds [8]
Monte Carlo	**1**	11	*27e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	3.7	4.1	4.3	4.4	4.4	4.4	4.4	4.4	4.4	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**2.2**	5.4	7.1	7.2	7.3	7.3	7.3	7.3	7.3	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	5.6	9.6	10	11	11	11	11	11	11	VNS (Garcia) [11]

Table 6: 10-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 ERT$_{\text{best}}$/D	1e+03 2.79	1e+02 10.2	1e+01 39.9	1e+00 61.5	1e-01 82.6	1e-02 104	1e-03 129	1e-04 157	1e-05 184	1e-07 237	Δftarget ERT$_{\text{best}}$/D
ALPS	30	24	32	43	51	59	64	67	68	87	ALPS [17]
AMaLGaM IDEA	8	6.1	7.9	9.8	11	12	12	11	11	11	AMaLGaM IDEA [4]
avg NEWUOA	**1.5**	**1.6**	**1**	**1**	**1**	**1**	**1.1**	**1.1**	**1.1**	**1.1**	avg NEWUOA [31]
BayEDAcG	23	20	360	*25e+0/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.9**	3.7	3.9	4.2	4.5	4.6	4.5	4.4	4.5	66	BFGS [30]
Cauchy EDA	690	550	190	150	140	130	120	110	100	99	Cauchy EDA [24]
BIPOP-CMA-ES	**2.2**	3.6	**2.1**	**2.1**	**2**	**1.9**	**1.9**	**1.8**	**1.7**	**1.7**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.7**	**1.4**	**1.1**	**2.6**	20	69	150	*21e-4/1e4*	.	.	(1+1)-CMA-ES [2]
DASA	15	9.9	75	150	350	490	570	620	670	700	DASA [19]
DEPSO	11	5.5	6.8	11	14	24	37	*50e-4/2e3*	.	.	DEPSO [12]
DIRECT	4.9	3.1	98	*34e-1/1e4*	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	5.7	14	49	62	68	73	72	71	71	71	EDA-PSO [6]
full NEWUOA	**2.4**	**2.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	full NEWUOA [31]
G3-PCX	5	**2.2**	**1.7**	**2.4**	3.6	3.8	3.9	4.1	4.5	5.4	G3-PCX [26]
simple GA	160	80	140	4700	*28e-1/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	9.3	4.6	3.2	3.3	3.5	3.4	3.4	3.3	4	83	GLOBAL [23]
iAMaLGaM IDEA	3.8	3.8	3.2	4.2	4.8	5.1	5.1	5.1	5	4.9	iAMaLGaM IDEA [4]
LSfminbnd	8.2	85	220	370	300	680	1100	920	790	*40e-1/1e4*	LSfminbnd [28]
LSstep	120	160	600	2400	*24e+0/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	10	4.9	6.6	9.1	9.7	9.5	8.6	7.8	7.3	6.4	MA-LS-Chain [21]
MCS (Neum)	**1.8**	3.6	19	180	170	280	*16e-1/4e3*	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1.8**	4.6	4.2	5.3	5.5	5.8	5.7	6.1	6.3	9	NELDER (Han) [16]
NELDER (Doe)	**1.3**	**1.1**	3.8	10	15	18	25	58	260	*14e-6/2e4*	NELDER (Doe) [5]
NEWUOA	**1**	**1.1**	**2.1**	3.3	4	4.9	5.5	5.9	5.9	6.2	NEWUOA [31]
(1+1)-ES	**2**	**2.8**	**1.8**	**1.9**	**2.1**	**2.5**	**2.4**	**2.4**	**2.4**	**2.6**	(1+1)-ES [1]
POEMS	92	36	30	40	44	46	46	45	44	45	POEMS [20]
PSO	4.9	4.7	400	420	320	260	210	180	160	130	PSO [7]
PSO_Bounds	4.8	5.6	45	120	140	150	140	130	130	160	PSO_Bounds [8]
Monte Carlo	1300	1500	*25e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.5**	**1**	10	38	41	37	34	33	31	29	Rosenbrock [27]
IPOP-SEP-CMA-ES	3	4.2	**2.2**	**2.3**	**2.4**	**2.4**	**2.4**	**2.3**	**2.2**	**2.1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	6	6.1	**2.6**	**2.4**	**2.3**	**2.2**	**2.1**	**2**	**1.9**	**1.8**	VNS (Garcia) [11]

Table 7: 10-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 $\mathrm{ERT}_{\mathrm{best}}$/D	1e+03 0.1	1e+02 3.29	1e+01 17.2	1e+00 161	1e-01 420	1e-02 510	1e-03 514	1e-04 514	1e-05 514	1e-07 539	Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.6**	15	25	9.8	25	57	59	59	59	56	ALPS [17]
AMaLGaM IDEA	**1.5**	4.9	3.9	**1**	**2.3**	**2.6**	**2.6**	**2.6**	**2.6**	**2.5**	AMaLGaM IDEA [4]
avg NEWUOA	3	**1.4**	16	38	*73e-2/1e4*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**2.4**	13	23	*47e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	14	150	*13e+1/100*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	93	50	31	7.2	4.4	4.7	4.9	4.9	4.9	4.9	Cauchy EDA [24]
BIPOP-CMA-ES	3.2	**2.8**	**2.3**	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.5**	**2.1**	7.4	5.9	5	20	20	20	20	19	(1+1)-CMA-ES [2]
DASA	37	33	280	8800	*13e-1/6e5*	.	.	.	.	.	DASA [19]
DEPSO	**2.1**	6.6	9.2	21	32	*14e-1/2e3*	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1.7**	16	68	*70e-2/1e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1.7**	5.6	57	17	130	110	110	110	110	100	EDA-PSO [6]
full NEWUOA	3.7	**2.1**	**1**	7.6	110	*51e-2/1e4*	.	.	.	.	full NEWUOA [31]
G3-PCX	**2.1**	3.7	21	520	*19e-1/2e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**2.7**	23	140	270	680	2900	2800	2800	2800	*48e-2/1e5*	simple GA [22]
GLOBAL	**1.8**	6.1	11	50	*45e-1/500*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.8**	4	3	**1**	**1**	**2.1**	**2.1**	**2.1**	**2.1**	**2**	iAMaLGaM IDEA [4]
LSfminbnd	16	12	95	270	*40e-1/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	110	160	720	*93e-1/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**2.7**	4.8	7.7	15	110	120	120	120	120	110	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.3**	53	*50e-1/4e3*	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	3	**1.4**	69	940	*11e-1/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	4.5	**1.1**	59	400	*19e-1/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	4.1	**1**	27	1e3	*24e-1/1e4*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	6.3	**2.7**	190	7e3	*85e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	1100	88	40	12	74	80	80	80	80	76	POEMS [20]
PSO	**2.2**	3.4	10	770	*11e-1/1e5*	.	.	.	.	.	PSO [7]
PSO_Bounds	**1.9**	4.2	19	730	3300	*13e-1/1e5*	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**2.2**	32	6e4	*94e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	150	400	*67e+0/3e3*	.	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**2.4**	**2.2**	**2.5**	**1.5**	**1.1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1.4**	8.3	3.2	4.1	19	31	34	34	34	33	VNS (Garcia) [11]

Table 8: 10-D, running time excess ERT/$\mathrm{ERT_{best}}$ 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
$\mathrm{ERT_{best}}$/D	4.23	13.2	32.2	80.6	93.4	101	104	106	108	110	$\mathrm{ERT_{best}}$/D
ALPS	53	43	43	120	170	250	330	450	570	3300	ALPS [17]
AMaLGaM IDEA	10	7.4	7.4	13	14	14	15	15	15	16	AMaLGaM IDEA [4]
avg NEWUOA	**1.2**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	avg NEWUOA [31]
BayEDAcG	29	22	75	*93e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.9**	**2.3**	**1.7**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	BFGS [30]
Cauchy EDA	110	82	66	120	110	110	110	110	120	120	Cauchy EDA [24]
BIPOP-CMA-ES	4	**2.4**	**1.9**	4.7	5	5.1	5.2	5.3	5.4	5.6	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	3.1	**2.9**	**1.9**	6.8	6.7	6.5	6.5	6.6	6.6	6.7	(1+1)-CMA-ES [2]
DASA	18	21	22	200	420	630	900	1200	1400	1900	DASA [19]
DEPSO	11	9	12	*54e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	9.1	7.7	32	550	*64e-1/1e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	65	130	140	220	300	410	530	640	760	*46e-8/1e5*	EDA-PSO [6]
full NEWUOA	**2.8**	**2**	**1.3**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	full NEWUOA [31]
G3-PCX	4.6	3.5	**2.9**	6.9	6.8	6.7	6.7	6.7	6.8	7	G3-PCX [26]
simple GA	280	230	210	*53e-1/1e5*	.	.	.	.	.	.	simple GA [22]
GLOBAL	7.7	3.2	**2.1**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	GLOBAL [23]
iAMaLGaM IDEA	6.5	4.7	4	8.4	8.8	8.9	9.1	9.3	9.6	10	iAMaLGaM IDEA [4]
LSfminbnd	7.2	7.3	19	190	180	440	1300	1400	*40e-1/1e4*	.	LSfminbnd [28]
LSstep	140	80	63	180	470	1500	*12e-1/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	7.9	6.7	7.3	13	14	14	15	15	15	15	MA-LS-Chain [21]
MCS (Neum)	**1.6**	**1**	**1**	**1.6**	**1.5**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	MCS (Neum) [18]
NELDER (Han)	**1.6**	**2.5**	**2**	5.4	5.1	5	5	5.1	5.1	5.2	NELDER (Han) [16]
NELDER (Doe)	**2.2**	**1.3**	**1.4**	**2.5**	3.3	3.5	3.7	3.8	4	4.4	NELDER (Doe) [5]
NEWUOA	**1**	**1.4**	**1**	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	NEWUOA [31]
(1+1)-ES	3.7	13	22	160	150	170	200	240	270	340	(1+1)-ES [1]
POEMS	80	59	64	470	840	*45e-3/1e5*	.	.	.	.	POEMS [20]
PSO	9.1	10	13	270	350	470	620	790	1500	6700	PSO [7]
PSO_Bounds	17	44	66	690	750	820	1700	1.4e4	1.4e4	*93e-5/1e5*	PSO_Bounds [8]
Monte Carlo	5400	*36e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.1**	3.6	12	59	81	110	170	320	430	1300	Rosenbrock [27]
IPOP-SEP-CMA-ES	3.2	**2.4**	**2.9**	7.5	7.5	7.4	7.5	7.5	7.5	7.7	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	10	5.6	3.5	8.4	8.7	8.6	8.8	8.8	8.9	9	VNS (Garcia) [11]

Table 9: 10-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	0.1	0.1	20	64.8	85.7	99.3	107	111	114	119	ERT_{best}/D
ALPS	1700	5e3	66	320	470	730	1900	3e3	4400	6.1e4	ALPS [17]
AMaLGaM IDEA	350	700	9.3	17	15	15	15	15	15	16	AMaLGaM IDEA [4]
avg NEWUOA	69	150	**1.3**	**1.8**	**1.5**	**1.4**	**1.3**	**1.3**	**1.2**	**1.2**	avg NEWUOA [31]
BayEDAcG	860	2500	56	*88e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	88	230	**2.1**	**1.9**	**1.6**	**1.4**	**1.4**	**1.3**	**1.3**	**1.3**	BFGS [30]
Cauchy EDA	4400	1e4	100	150	130	120	110	110	110	120	Cauchy EDA [24]
BIPOP-CMA-ES	130	350	3.4	6.3	5.9	5.5	5.4	5.4	5.5	5.5	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	100	350	3.3	7.7	6.6	6.1	5.9	5.8	5.8	5.8	(1+1)-CMA-ES [2]
DASA	750	1.6e4	160	2200	2e3	2400	2900	3700	4300	5800	DASA [19]
DEPSO	420	1100	15	*70e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	9.4	350	*17e-1/1e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	3200	1.7e4	220	340	540	1500	*85e-4/1e5*	.	.	.	EDA-PSO [6]
full NEWUOA	140	250	**1.6**	**2**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.4**	full NEWUOA [31]
G3-PCX	190	470	4.7	15	12	11	10	10	10	9.9	G3-PCX [26]
simple GA	9e3	2.8e4	370	*79e-1/1e5*	.	.	.	.	.	.	simple GA [22]
GLOBAL	330	450	**2.9**	**2.2**	**1.8**	**1.6**	**1.5**	**1.5**	**1.5**	**1.4**	GLOBAL [23]
iAMaLGaM IDEA	250	560	6.3	10	9.6	9	8.9	8.9	9.1	9.3	iAMaLGaM IDEA [4]
LSfminbnd	230	1200	51	120	860	*14e-2/1e4*	.	.	.	.	LSfminbnd [28]
LSstep	5800	3.3e4	420	*90e-1/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	290	870	12	36	31	28	27	26	26	25	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	45	240	**2.4**	3.7	3.4	3.1	3.2	3.2	3.2	3.3	NELDER (Han) [16]
NELDER (Doe)	49	150	**2.7**	7.1	6.5	6.1	6	5.9	6	6	NELDER (Doe) [5]
NEWUOA	**39**	**140**	**1.7**	**1.7**	**1.4**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**	NEWUOA [31]
(1+1)-ES	100	1600	9.5	230	190	190	220	240	280	330	(1+1)-ES [1]
POEMS	3100	6200	110	770	1.7e4	*18e-2/1e5*	.	.	.	.	POEMS [20]
PSO	320	1700	24	840	1900	*11e-2/1e5*	.	.	.	.	PSO [7]
PSO_Bounds	770	4.3e4	450	1100	1600	*78e-3/1e5*	.	.	.	.	PSO_Bounds [8]
Monte Carlo	3.7e5	*33e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	79	200	27	77	70	87	130	180	*12e-5/1e4*	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	130	780	6.9	10	8.9	8.1	7.8	7.7	7.7	7.7	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	340	580	4.6	9.8	12	13	13	12	12	12	VNS (Garcia) [11]

Table 10: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	46.3	104	184	217	245	273	280	308	454	474	ERT$_{\text{best}}$/D
ALPS	59	180	850	7800	*30e-1/5e5*	.	.	.	.	.	ALPS [17]
AMaLGaM IDEA	**2.9**	**2.2**	**1.8**	**1.9**	**2**	**2**	**2.2**	**2.2**	**1.6**	**1.9**	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	**1.3**	**1.9**	3.5	5.4	6.6	9	9.9	8.1	10	avg NEWUOA [31]
BayEDAcG	*16e+3/2e3*	.	.	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.8**	**1.3**	**1**	**1**	**1**	**1**	**1**	**1**	**1.3**	920	BFGS [30]
Cauchy EDA	22	14	10	11	11	12	13	13	10	11	Cauchy EDA [24]
BIPOP-CMA-ES	3.8	**2.7**	**2.3**	**2.1**	**1.9**	**1.8**	**1.8**	**1.7**	**1.2**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.8**	**2.1**	**1.7**	**1.8**	**1.7**	**1.6**	**1.5**	**1.4**	**1**	**1**	(1+1)-CMA-ES [2]
DASA	320	1500	7200	2.2e4	6.1e4	*76e-1/1e6*	.	.	.	.	DASA [19]
DEPSO	310	*19e+2/2e3*	.	.	.	.	.	.	.	.	DEPSO [12]
DIRECT	89	*37e+1/1e4*	.	.	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	300	830	*56e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1.9**	5.3	10	20	33	54	260	240	*79e-4/1e4*	.	full NEWUOA [31]
G3-PCX	6.1	6.9	10	19	26	30	37	40	31	38	G3-PCX [26]
simple GA	3500	1.4e4	*12e+2/1e5*	.	.	.	.	.	.	.	simple GA [22]
GLOBAL	**2.6**	**1.6**	**1.2**	**1.2**	**1.3**	**1.2**	**1.2**	**1.2**	**1.6**	*29e-7/1e3*	GLOBAL [23]
iAMaLGaM IDEA	**2.1**	**1.5**	**1.2**	**1.3**	**1.3**	**1.3**	**1.4**	**1.4**	**1**	**1.1**	iAMaLGaM IDEA [4]
LSfminbnd	440	*14e+2/1e4*	.	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	1600	*88e+2/1e4*	.	.	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	10	8	11	11	9.8	9	9	8.3	5.7	5.6	MA-LS-Chain [21]
MCS (Neum)	170	*11e+2/4e3*	.	.	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1.8**	**2.2**	4.1	16	43	100	240	820	1600	*27e-5/1e5*	NELDER (Han) [16]
NELDER (Doe)	**2.7**	3.7	9.5	25	34	57	330	970	*31e-4/2e4*	.	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**2.1**	3.8	6	7.4	10	11	9.2	12	NEWUOA [31]
(1+1)-ES	43	170	530	1100	1700	2400	3700	9100	1.1e4	*43e-5/1e6*	(1+1)-ES [1]
POEMS	300	1300	*10e+1/1e5*	.	.	.	.	.	.	.	POEMS [20]
PSO	110	1e3	3900	*74e+0/1e5*	.	.	.	.	.	.	PSO [7]
PSO_Bounds	640	2200	*12e+1/1e5*	.	.	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	*72e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	57	80	120	230	*22e+0/1e4*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	9.3	5.6	4	3.7	3.4	3.2	3.2	**2.9**	**2**	**2**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	6	3.7	**2.8**	**2.7**	**2.5**	**2.3**	**2.3**	**2.2**	**1.5**	**1.5**	VNS (Garcia) [11]

Table 11: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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$_{\text{best}}$/D	1.98	2.3	26.6	104	260	295	334	375	409	484	ERT$_{\text{best}}$/D
ALPS	6.3	83	370	460	490	990	4300	*14e-4/5e5*	.	.	ALPS [17]
AMaLGaM IDEA	5.5	14	**4.4**	**1.9**	**1.1**	**1.2**	**1.3**	**1.4**	**1.4**	**1.5**	AMaLGaM IDEA [4]
avg NEWUOA	10	220	36	18	9.5	12	14	14	15	15	avg NEWUOA [31]
BayEDAcG	4	58	*62e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.2**	**7.1**	**1**	**1**	**1.7**	6	56	*12e-4/8e3*	.	.	BFGS [30]
Cauchy EDA	37	200	36	13	7	7.5	7.8	8.1	8.3	8.8	Cauchy EDA [24]
BIPOP-CMA-ES	6	82	13	3.8	**1.7**	**1.6**	**1.5**	**1.4**	**1.3**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.2**	42	9.9	3.8	**1.9**	**2**	**1.9**	**1.8**	**1.7**	**1.5**	(1+1)-CMA-ES [2]
DASA	5.9	850	1300	1e3	750	1100	1400	1600	2e3	3500	DASA [19]
DEPSO	7.1	140	*47e+0/2e3*	.	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1.8**	**7.9**	*20e+0/1e4*	.	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	6.7	200	550	990	5700	*57e-2/1e5*	.	.	.	.	EDA-PSO [6]
full NEWUOA	15	820	290	*31e-1/1e4*	.	.	.	.	.	.	full NEWUOA [31]
G3-PCX	5.7	65	40	22	14	16	17	18	19	21	G3-PCX [26]
simple GA	5.3	100	1.6e4	*17e+0/1e5*	.	.	.	.	.	.	simple GA [22]
GLOBAL	5	17	**2.5**	**1.7**	**1.5**	8.1	*11e-3/2e3*	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	5	25	5.7	**2**	**1**	**1**	**1**	**1**	**1**	**1**	iAMaLGaM IDEA [4]
LSfminbnd	**2.2**	9400	*13e+1/1e4*	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	4.3	6.1e4	*14e+1/1e4*	.	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	7	31	39	14	6	5.6	5.1	4.6	4.3	3.8	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	*30e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	3.8	17	15	8.8	6.9	13	37	85	440	*24e-6/1e5*	NELDER (Han) [16]
NELDER (Doe)	5.2	17	13	7.8	5.4	9.7	17	34	93	*32e-6/2e4*	NELDER (Doe) [5]
NEWUOA	**1.4**	41	11	5.5	3.1	3.4	4	4.1	4.3	4.6	NEWUOA [31]
(1+1)-ES	840	2.1e4	5300	2400	1300	1500	1700	1800	1900	3e3	(1+1)-ES [1]
POEMS	86	200	220	200	140	160	210	270	350	1500	POEMS [20]
PSO	6.7	240	220	150	100	130	160	170	190	500	PSO [7]
PSO_Bounds	6.5	670	1400	920	670	1200	1400	3900	3600	*12e-2/1e5*	PSO_Bounds [8]
Monte Carlo	7.9	120	5.3e5	*12e+0/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.3**	1e3	5500	1400	570	500	440	390	360	300	Rosenbrock [27]
IPOP-SEP-CMA-ES	5.3	260	29	8.4	3.5	3.2	**2.9**	**2.6**	**2.4**	**2.1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	5.9	160	17	4.7	**2**	**1.9**	**1.7**	**1.6**	**1.5**	**1.3**	VNS (Garcia) [11]

Table 12: 10-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	21.2	27.5	51.5	89.6	124	139	157	197	366	515	ERT$_{\text{best}}$/D
ALPS	86	84	57	120	210	1100	5400	1.1e4	1.9e4	*13e-4/5e5*	ALPS [17]
AMaLGaM IDEA	14	13	8.5	6.6	6.6	7.9	9.1	9.2	5.9	5.3	AMaLGaM IDEA [4]
avg NEWUOA	**1.1**	**1.7**	4.7	8	10	12	12	12	6.9	10	avg NEWUOA [31]
BayEDAcG	73	72	48	59	*71e-1/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.5**	**1.3**	**1.3**	**1.4**	**1.4**	**1.3**	**1.3**	**2.2**	**2.6**	23	BFGS [30]
Cauchy EDA	100	110	84	69	68	71	74	68	42	34	Cauchy EDA [24]
BIPOP-CMA-ES	3.7	3.3	3.7	4.6	5.3	5.6	5.6	5.2	3.1	**2.5**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2**	**2.3**	4.2	5.5	6.1	7.4	7.2	6.4	3.8	3.5	(1+1)-CMA-ES [2]
DASA	12	10	7100	4.5e4	1.1e5	*39e-1/1e6*	.	.	.	.	DASA [19]
DEPSO	19	19	19	42	110	*55e-1/2e3*	.	.	.	.	DEPSO [12]
DIRECT	35	31	29	130	170	340	*64e-2/1e4*	.	.	.	DIRECT [25]
EDA-PSO	300	290	490	300	810	4800	*66e-3/1e5*	.	.	.	EDA-PSO [6]
full NEWUOA	**1.2**	**1.4**	**2.9**	4.1	4.6	6.2	6.6	6.2	4.4	4.7	full NEWUOA [31]
G3-PCX	**2.5**	**2.3**	**2.8**	3.7	4	4.4	4.6	4.1	**2.5**	**2**	G3-PCX [26]
simple GA	460	490	1300	1900	1.1e4	*18e-1/1e5*	.	.	.	.	simple GA [22]
GLOBAL	**1.8**	**1.4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2.9**	GLOBAL [23]
iAMaLGaM IDEA	7.7	7.2	5	4.8	4.9	5.4	5.7	5.5	3.4	**3**	iAMaLGaM IDEA [4]
LSfminbnd	**2.6**	**2.4**	98	170	1100	1e3	890	*51e-1/1e4*	.	.	LSfminbnd [28]
LSstep	74	67	170	730	*63e-1/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	12	11	8	7.2	9.7	16	25	29	16	12	MA-LS-Chain [21]
MCS (Neum)	**1.2**	**1**	3.2	3.9	7	11	13	27	76	110	MCS (Neum) [18]
NELDER (Han)	**1.6**	**1.8**	**3**	4.7	5.3	5.3	5.4	4.8	**2.8**	**2.3**	NELDER (Han) [16]
NELDER (Doe)	**1.8**	**1.6**	3	6	7.2	7.6	7.7	6.9	4.3	6.5	NELDER (Doe) [5]
NEWUOA	**1.1**	**1**	**1.9**	**2**	**2.1**	**2.3**	**2.3**	**2.1**	**1.2**	**1**	NEWUOA [31]
(1+1)-ES	**1.9**	1600	1.5e4	4.8e4	*56e-1/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	160	160	1100	2300	3300	*25e-1/1e5*	.	.	.	.	POEMS [20]
PSO	19	20	310	1700	5200	*41e-1/1e5*	.	.	.	.	PSO [7]
PSO_Bounds	160	160	580	1800	3300	*27e-1/1e5*	.	.	.	.	PSO_Bounds [8]
Monte Carlo	*20e+5/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	27	38	340	1200	*14e-1/1e4*	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	3	**2.9**	**3**	4.5	5.6	6.3	6.3	5.7	3.4	**2.7**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	4.4	5.1	4.9	5.6	17	16	15	12	6.9	5.2	VNS (Garcia) [11]

Table 13: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	1.18	7.75	38.7	59.6	79.7	101	459	534	621	778	ERT$_{\text{best}}$/D
ALPS	22	93	53	110	480	830	1100	3e3	*54e-5/5e5*	.	ALPS [17]
AMaLGaM IDEA	12	15	6.8	6.9	7	6.8	**1.8**	**1.8**	**1.8**	**1.8**	AMaLGaM IDEA [4]
avg NEWUOA	3.6	**1.4**	**3**	13	30	76	32	70	280	*39e-5/1e4*	avg NEWUOA [31]
BayEDAcG	17	99	230	*26e+0/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.8**	**1.5**	**1**	**1**	**1**	**1**	86	*14e-4/1e4*	.	.	BFGS [30]
Cauchy EDA	160	130	46	43	42	41	11	11	11	11	Cauchy EDA [24]
BIPOP-CMA-ES	4.5	5.3	3.6	4.2	5.6	4.8	**1.3**	**1.3**	**1.5**	**1.8**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	3.9	3.3	4.7	5.7	6.9	9.7	3.5	3.7	4.4	6.9	(1+1)-CMA-ES [2]
DASA	24	20	220	380	1200	3600	1800	2900	1.1e4	*14e-5/1e6*	DASA [19]
DEPSO	8.8	19	58	*73e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**2.9**	22	62	160	580	*28e-2/1e4*	.	.	.	.	DIRECT [25]
EDA-PSO	5.9	300	140	150	990	2900	3100	*22e-3/1e5*	.	.	EDA-PSO [6]
full NEWUOA	6.2	**2.1**	**1.8**	12	25	66	40	130	*14e-4/1e4*	.	full NEWUOA [31]
G3-PCX	9.8	4.9	13	50	96	160	72	290	820	*26e-5/3e4*	G3-PCX [26]
simple GA	22	490	480	1.1e4	*33e-1/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	11	4.9	**1.7**	**1.4**	**1.3**	**1.2**	5.3	*23e-4/600*	.	.	GLOBAL [23]
iAMaLGaM IDEA	4.7	9.6	3.9	**3.8**	**3.9**	**3.8**	**1**	**1**	**1**	**1**	iAMaLGaM IDEA [4]
LSfminbnd	9	16	28	70	180	460	*53e-3/1e4*	.	.	.	LSfminbnd [28]
LSstep	250	300	470	750	1800	1500	*12e+0/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	6.6	19	16	33	140	160	50	43	43	43	MA-LS-Chain [21]
MCS (Neum)	**1**	4.2	37	44	59	280	*86e-3/4e3*	.	.	.	MCS (Neum) [18]
NELDER (Han)	**2**	3.8	4.4	9.1	15	21	5.9	6.2	9	13	NELDER (Han) [16]
NELDER (Doe)	**2**	**2.4**	7.2	16	40	76	64	160	480	*11e-4/2e4*	NELDER (Doe) [5]
NEWUOA	**2.3**	**1**	**2**	9	20	42	29	69	*20e-4/8e3*	.	NEWUOA [31]
(1+1)-ES	4.4	8.1	11	21	44	99	130	390	940	1.9e4	(1+1)-ES [1]
POEMS	190	130	270	2e3	5100	*31e-1/1e5*	.	.	.	.	POEMS [20]
PSO	6	25	950	1.1e4	1.8e4	1.4e4	*44e-1/1e5*	.	.	.	PSO [7]
PSO_Bounds	5.2	98	2300	6800	1.8e4	1.4e4	*86e-1/1e5*	.	.	.	PSO_Bounds [8]
Monte Carlo	25	*28e+1/1e6*	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	5.2	**2**	3.4	11	15	33	15	42	110	*31e-5/1e4*	Rosenbrock [27]
IPOP-SEP-CMA-ES	4.2	5.2	8.7	10	9.2	8.4	**2.1**	**1.9**	**1.8**	**2**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	13	7.7	4.9	16	20	17	9.4	14	14	20	VNS (Garcia) [11]

Table 14: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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 ERT$_{\text{best}}$/D	1e+03 0.1	1e+02 0.1	1e+01 3.69	1e+00 9.83	1e-01 13.3	1e-02 20.5	1e-03 39.2	1e-04 50.5	1e-05 68.7	1e-07 430	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**2.7**	19	50	74	76	85	320	1400	*28e-7/5e5*	ALPS [17]
AMaLGaM IDEA	**1**	3.1	4.7	9	13	12	8.5	8.4	7.5	**1.6**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	9.2	**1.7**	**1.3**	**1.3**	**1.2**	**1.1**	**2.2**	7.1	64	avg NEWUOA [31]
BayEDAcG	**1**	**2.5**	7.8	75	110	210	*11e-3/2e3*	.	.	.	BayEDAcG [10]
BFGS	**1**	11	**1.6**	**1.6**	**1.6**	**1.4**	**1**	**1**	**1**	*11e-7/9e3*	BFGS [30]
Cauchy EDA	**1**	230	71	85	94	88	60	57	51	11	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	9.2	**2.6**	3.3	3.8	4.1	4.3	4.9	5.2	**1.4**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	4.9	**2**	**1.9**	**2.3**	**2.4**	**2.5**	3.7	4.4	**1.1**	(1+1)-CMA-ES [2]
DASA	**1**	27	14	13	14	15	80	600	3600	*18e-7/1e6*	DASA [19]
DEPSO	**1.1**	**2.5**	6.6	9.5	15	21	33	*35e-5/2e3*	.	.	DEPSO [12]
DIRECT	**1**	**1**	**2.5**	11	50	110	500	*23e-4/1e4*	.	.	DIRECT [25]
EDA-PSO	**1**	4	4.2	130	240	250	170	190	1100	*68e-7/1e5*	EDA-PSO [6]
full NEWUOA	**1**	7	3.1	**1.8**	**2**	**1.7**	**1.4**	**2.8**	12	*37e-8/1e4*	full NEWUOA [31]
G3-PCX	**1**	**2.5**	3.9	**2.8**	**3**	3.1	**2.9**	5.5	16	120	G3-PCX [26]
simple GA	**1**	3.2	18	250	370	400	4200	*13e-4/1e5*	.	.	simple GA [22]
GLOBAL	**1.1**	3.1	8	3.7	3.1	**2.3**	**1.4**	**1.3**	**1.1**	*23e-7/300*	GLOBAL [23]
iAMaLGaM IDEA	**1.1**	3.4	**2.2**	5	7.2	7	5	5.1	4.5	**1**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	45	7.5	5.5	5.6	8.1	52	*30e-5/1e4*	.	.	LSfminbnd [28]
LSstep	**1**	560	150	120	110	170	*29e-4/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**2.7**	4.4	8.3	12	13	13	15	16	3.6	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.1**	**2.4**	**2.9**	**2.8**	**2.8**	6.9	*32e-6/4e3*	.	MCS (Neum) [18]
NELDER (Han)	**1**	3.7	**1.2**	**2.1**	**2.9**	**2.9**	**2.6**	3.2	**4.2**	8.8	NELDER (Han) [16]
NELDER (Doe)	**1**	4.9	**1.1**	**2.4**	**2.8**	3.5	3.7	4.5	6.3	43	NELDER (Doe) [5]
NEWUOA	**1**	7.2	**1**	**1**	**1**	**1**	**1**	**2.3**	7.3	570	NEWUOA [31]
(1+1)-ES	**1**	6.8	**2.2**	**2**	**2.2**	**2.3**	4.6	44	580	*82e-8/1e6*	(1+1)-ES [1]
POEMS	110	970	68	50	110	140	120	170	3e3	*12e-6/1e5*	POEMS [20]
PSO	**1.1**	**2.9**	3.2	8.6	17	22	28	140	2100	*83e-7/1e5*	PSO [7]
PSO_Bounds	**1**	3.2	3.7	29	93	180	230	560	*13e-6/1e5*	.	PSO_Bounds [8]
Monte Carlo	**1**	**2.5**	17	*15e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	25	**2.1**	**1.3**	**1.4**	**1.7**	6.3	46	190	*96e-7/1e4*	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	4.4	3	3.2	3.7	3.9	5.2	9	8.9	**2**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	3	7.6	5.3	5.6	5.5	6.1	7.6	7.4	**1.8**	VNS (Garcia) [11]

Table 15: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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 ERT$_{\text{best}}$/D	1e+03 0.1	1e+02 18.6	1e+01 477	1e+00 3920	1e-01 7360	1e-02 7470	1e-03 7580	1e-04 7670	1e-05 7780	1e-07 7980	Δftarget ERT$_{\text{best}}$/D
ALPS	**1.9**	12	15	*30e-1/5e5*	.	.	.	.	.	.	ALPS [17]
AMaLGaM IDEA	**1.9**	**2.5**	**1**	**3.5**	**3.7**	**3.7**	**3.7**	**3.7**	**3.7**	**3.6**	AMaLGaM IDEA [4]
avg NEWUOA	5.5	4.3	230	*25e+0/7e3*	.	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1.8**	7.6	*28e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	59	110	*70e+0/4e3*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	80	22	*16e+0/5e4*	.	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1.9**	**1**	**1**	**1.7**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.2**	**2.9**	150	*18e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	29	270	2.9e4	*19e+0/1e6*	.	.	.	.	.	.	DASA [19]
DEPSO	**1.6**	3.4	*37e+0/2e3*	.	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**2.2**	84	*17e+0/1e4*	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	**2.5**	23	7	170	190	190	190	180	180	180	EDA-PSO [6]
full NEWUOA	5.4	**2.6**	300	*21e+0/1e4*	.	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1.7**	100	1500	*24e+0/5e4*	.	.	.	.	.	.	G3-PCX [26]
simple GA	**1.7**	56	27	*41e-1/1e5*	.	.	.	.	.	.	simple GA [22]
GLOBAL	**1.4**	13	*67e+0/900*	.	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.7**	**1.6**	**2.6**	9.4	10	10	10	10	10	9.9	iAMaLGaM IDEA [4]
LSfminbnd	14	14	*29e+0/1e4*	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	450	310	*74e+0/1e4*	.	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1.8**	**2.3**	3.6	23	98	96	95	94	92	90	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.7**	*24e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	3.3	8.1	240	*99e-1/1e5*	.	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**2.9**	3.7	47	*90e-1/2e4*	.	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	5.1	4.5	170	*22e+0/6e3*	.	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	5.4	17	2100	*99e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
POEMS	240	19	320	*11e+0/1e5*	.	.	.	.	.	.	POEMS [20]
PSO	**1.6**	**2.1**	840	*23e+0/1e5*	.	.	.	.	.	.	PSO [7]
PSO_Bounds	**1.7**	5.7	360	*11e+0/1e5*	.	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1.3**	1e3	*68e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	13	710	*89e+0/1e4*	.	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**2.3**	**1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1.6**	**1.8**	6.5	4300	6200	6100	6e3	5900	5900	7700	VNS (Garcia) [11]

Table 16: 10-D, running time excess ERT/$\mathrm{ERT_{best}}$ 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 $\mathrm{ERT_{best}}$/D	1e+03 0.1	1e+02 0.1	1e+01 42.5	1e+00 703	1e-01 1580	1e-02 4570	1e-03 5120	1e-04 6510	1e-05 6580	1e-07 7160	Δftarget $\mathrm{ERT_{best}}$/D
ALPS	**1**	**1.5**	8.2	3	56	470	*23e-3/5e5*	.	.	.	ALPS [17]
AMaLGaM IDEA	**1**	**1.4**	8.5	4.9	5.8	**4.5**	**5.1**	**4.2**	**4.2**	**3.9**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.5**	3.3	41	*13e-1/1e4*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.3**	41	*95e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	190	*18e+0/1e4*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	4.3	400	*76e-1/5e4*	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1.1**	3	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.3**	5.4	49	*12e-1/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1.7**	190	3e3	*11e-1/1e6*	.	.	.	.	.	DASA [19]
DEPSO	**1**	**1.2**	170	*11e+0/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**2.2**	**2.5**	**1.6**	**2.4**	9.9	*21e-3/1e4*	.	.	.	DIRECT [25]
EDA-PSO	**1**	**1.5**	55	130	190	95	130	100	100	95	EDA-PSO [6]
full NEWUOA	**1**	**1.1**	3.6	16	90	*99e-2/1e4*	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.3**	4.7	69	*75e-2/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1.5**	28	130	910	*91e-2/1e5*	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1.3**	**1**	**1.7**	*11e-1/800*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.2**	3.3	**1.8**	6.5	8.2	9.8	8.6	8.6	8	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1.4**	7.9	*28e-1/1e4*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	**1**	**2.1**	51	*47e-1/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.2**	**2**	16	460	*30e-2/5e4*	.	.	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**2.4**	17	86	*33e-1/4e3*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**1.5**	17	100	*75e-2/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.3**	**1.4**	23	*69e-2/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**2.3**	4.7	*25e-1/9e3*	.	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.6**	65	3700	*12e-1/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	**1**	12	4.4	58	61	79	62	62	92	POEMS [20]
PSO	**1**	**1.4**	5.2	130	*92e-2/1e5*	.	.	.	.	.	PSO [7]
PSO_Bounds	**1**	**1.5**	42	140	260	*89e-2/1e5*	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.6**	43	*31e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**2.9**	770	*12e+0/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.5**	**2.9**	**1.2**	**1.6**	**1.2**	**1.3**	**1.3**	**1.3**	**1.2**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.4**	4.1	3.7	28	37	180	370	670	1600	VNS (Garcia) [11]

Table 17: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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$_{\text{best}}$/D	1e+03 0.1	1e+02 0.1	1e+01 2.64	1e+00 42.9	1e-01 220	1e-02 633	1e-03 985	1e-04 1530	1e-05 2020	1e-07 2650	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1.2**	3.5	18	19	130	1100	*14e-4/5e5*	.	.	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**2.8**	3.8	**1.5**	**1.7**	**2.3**	**3.2**	**4.1**	**4**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.1**	**2.2**	990	*10e-1/3e4*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.3**	4	11	6.4	7.3	*18e-3/2e3*	.	.	.	BayEDAcG [10]
BFGS	**1**	79	53	*36e-1/8e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	56	67	35	27	12	9.4	6.9	6.2	6.6	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1.4**	**1.6**	**1.1**	**1.7**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	3.9	14	620	*15e-1/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	110	2e4	*83e-2/1e6*	.	.	.	.	.	DASA [19]
DEPSO	**1**	**1.5**	5.5	6.7	4.9	15	*28e-3/2e3*	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1.3**	3.7	7.2	23	*44e-4/1e4*	.	.	.	DIRECT [25]
EDA-PSO	**1**	**1.1**	**2.4**	44	22	13	11	9.4	8.8	9.4	EDA-PSO [6]
full NEWUOA	**1**	**2.1**	3.1	290	*95e-2/1e4*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.2**	**3**	5400	*15e-1/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1.5**	4.8	77	45	210	1500	*11e-3/1e5*	.	.	simple GA [22]
GLOBAL	**1**	**1.2**	3.9	*27e-1/2e3*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.6**	**1.8**	3.3	**2.2**	3.6	5	8.6	12	iAMaLGaM IDEA [4]
LSfminbnd	**1**	4.1	35	*26e-1/1e4*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	**1**	110	960	*73e-1/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.2**	**2.8**	5	8.9	15	21	21	26	53	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	1400	*18e-1/4e3*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**2.4**	19	4200	6600	*11e-1/1e5*	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.2**	**1.2**	450	*77e-2/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**2.9**	**1.4**	2100	*14e-1/2e4*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.9**	3500	*32e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	290	91	23	15	33	58	63	140	250	POEMS [20]
PSO	**1**	**1.3**	**1.6**	5	230	1e3	*52e-3/1e5*	.	.	.	PSO [7]
PSO_Bounds	**1**	**1.2**	**1.5**	29	320	1e3	1400	*71e-3/1e5*	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.3**	3.2	*21e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	1.5e4	8300	*12e+0/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	**1.6**	**1**	**1.1**	**1.3**	**1.3**	**1**	**1**	**1.1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	5.7	**1.4**	**1**	**2.2**	7.7	28	330	*39e-8/7e6*	VNS (Garcia) [11]

Table 18: 10-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	0.1	0.193	23.8	83.6	701	1590	2750	3160	3720	4270	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	3.2	13	20	60	4700	*19e-3/5e5*	.	.	.	ALPS [17]
AMaLGaM IDEA	**1.2**	**1.8**	**2.9**	**2.8**	**1.4**	**1.5**	**2.2**	**2.3**	**2.7**	**2.4**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	10	73	*32e-1/9e4*	.	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**2.3**	8.8	13	6.4	19	*17e-2/2e3*	.	.	.	BayEDAcG [10]
BFGS	**1.7**	160	5e3	*16e+0/8e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1.1**	110	31	24	5.2	3.6	**2.8**	**3**	3.1	4.1	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	3.1	**1**	**1**	**1**	**1**	**1.2**	**1.1**	**1.1**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	4	110	*40e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1.4**	17	1400	8.1e4	*19e-1/1e6*	.	.	.	.	.	DASA [19]
DEPSO	**1**	4.4	4.3	10	13	*19e-2/2e3*	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**2.3**	8.1	4.2	28	*38e-3/1e4*	.	.	.	DIRECT [25]
EDA-PSO	**1**	**2.1**	28	42	9.2	6	7.5	21	79	*43e-6/1e5*	EDA-PSO [6]
full NEWUOA	**1.1**	13	120	1700	*39e-1/1e4*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1.1**	**1.6**	800	*51e-1/5e4*	.	.	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1**	57	85	120	*88e-3/1e5*	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1.9**	84	*90e-1/2e3*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.1**	**2.1**	**1.6**	3.3	**1.4**	**2.9**	3.1	4.8	6.5	9.1	iAMaLGaM IDEA [4]
LSfminbnd	**1**	15	210	*66e-1/1e4*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	**1.1**	230	*19e+0/1e4*	.	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1.1**	3.4	**2.5**	6.1	12	49	260	*13e-3/5e4*	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	57	*51e-1/4e3*	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	3.5	510	8400	*32e-1/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1.1**	**2.8**	72	3500	*34e-1/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1.1**	99	560	*51e-1/4e4*	.	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**2**	10	2.8e5	*14e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
POEMS	**2.1**	530	19	28	42	130	240	450	*24e-3/1e5*	.	POEMS [20]
PSO	**1**	**1.7**	3.5	2400	2e3	*11e-1/1e5*	.	.	.	.	PSO [7]
PSO_Bounds	**1.1**	**2.5**	10	140	580	880	*38e-2/1e5*	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.4**	3300	*72e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	8700	*40e+0/1e4*	.	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	3.3	4.4	**2.8**	**1.2**	**1.1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**2.7**	**1.7**	**1.1**	**1.8**	22	93	1500	*85e-6/6e6*	.	VNS (Garcia) [11]

Table 19: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}/D$	0.1	0.1	0.1	0.1	1060	98400	1.37e5	1.37e5	1.38e5	1.39e5	$\mathrm{ERT}_{\mathrm{best}}/D$
ALPS	**1**	**1**	410	7.7e4	550	*74e-3/5e5*	.	.	.	.	ALPS [17]
AMaLGaM IDEA	**1**	**1.1**	160	**7300**	83	**7.7**	**8.8**	**8.7**	**8.7**	**8.6**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	48	7.1e5	*83e-2/1e5*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.3**	210	*20e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1.7**	1.9e4	*51e-1/8e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	6.8	1400	3.4e6	*14e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	52	9400	**9.8**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	63	8.7e4	*55e-2/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1.1**	7100	1.5e7	*13e-1/1e6*	.	.	.	.	.	DASA [19]
DEPSO	**1**	**1**	210	*29e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1**	**16**	*11e-2/1e4*	.	.	.	.	DIRECT [25]
EDA-PSO	**1**	**1.1**	130	3.7e5	1300	*73e-2/1e5*	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**1.4**	150	1.4e5	*11e-1/1e4*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.1**	3.6e4	1.5e6	*16e-1/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1.1**	1e3	1.7e5	290	*14e-2/1e5*	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1.2**	370	1.2e5	*15e-1/2e3*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	78	2.5e5	370	**73**	**110**	**110**	**110**	**110**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	3.1	200	1.4e6	*18e-1/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	**1**	55	2700	*17e-1/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.1**	120	8600	87	*13e-2/5e4*	.	.	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	*16e-3/4e3*	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	28	2.8e4	*24e-2/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.1**	**24**	1.2e4	*26e-2/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**2.1**	27	3.2e5	*63e-2/1e5*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.5**	6500	2.8e7	*18e-1/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	380	2500	2.1e5	1400	*57e-2/1e5*	.	.	.	.	POEMS [20]
PSO	**1**	**1.3**	110	3.7e5	*51e-2/1e5*	.	.	.	.	.	PSO [7]
PSO_Bounds	**1**	**1.1**	120	9.2e5	*57e-2/1e5*	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.1**	500	*31e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**2.5**	6.5e5	*24e+0/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	54	1.6e4	17	*10e-2/1e4*	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.4**	220	3.1e4	1900	*60e-3/5e6*	.	.	.	.	VNS (Garcia) [11]

Table 20: 10-D, running time excess ERT/ERT_{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 ERT_{best}/D	1e+03 2.58	1e+02 3	1e+01 3.19	1e+00 1540	1e-01 55000	1e-02 56700	1e-03 57300	1e-04 57600	1e-05 58100	1e-07 58900	Δftarget ERT_{best}/D
ALPS	31	52	61	**1.5**	10	9.7	9.6	9.6	9.6	9.7	ALPS [17]
AMaLGaM IDEA	8.1	9.6	11	18	270	260	260	260	260	250	AMaLGaM IDEA [4]
avg NEWUOA	**1.5**	**1.3**	**1.2**	37	*12e-1/8e3*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	16	22	30	*27e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.6**	**1.9**	**2.4**	**1.1**	*65e-2/1e4*	.	.	.	.	.	BFGS [30]
Cauchy EDA	110	140	140	*21e-1/5e4*	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	4.4	5.1	5.5	3.6	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.9**	3.2	3.3	3.3	*83e-2/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	27	29	30	**1.9**	270	260	260	260	250	250	DASA [19]
DEPSO	11	14	15	**1.1**	*68e-2/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	7.2	17	16	*14e-1/1e4*	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	15	44	92	7.8	3.8	3.7	3.7	**3.7**	**3.7**	**3.7**	EDA-PSO [6]
full NEWUOA	**2.6**	**2.2**	**2.1**	10	*10e-1/1e4*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	5.8	6	6.1	12	*85e-2/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	130	310	360	3.2	**1.8**	**2**	**2.6**	25	*18e-4/1e5*	.	simple GA [22]
GLOBAL	12	11	11	**2.6**	*11e-1/1e3*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	4.8	5.8	6.2	38	*24e-2/1e6*	.	.	.	.	.	iAMaLGaM IDEA [4]
LSfminbnd	9.6	11	13	3.5	*81e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	200	250	300	8.3	*98e-2/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	7.4	8.5	9.3	**2.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	MA-LS-Chain [21]
MCS (Neum)	4.8	4.6	4.4	**1**	*77e-2/4e3*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1.5**	**1.9**	**2.3**	16	*75e-2/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1.7**	**2.1**	**2.3**	5.7	*81e-2/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**1**	**1.9**	*69e-2/1e4*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**2.7**	3	3.1	7.2	*47e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	95	95	97	**1.1**	12	12	12	12	12	12	POEMS [20]
PSO	6.8	8.9	10	**1.5**	*57e-2/1e5*	.	.	.	.	.	PSO [7]
PSO_Bounds	9.4	29	38	**2**	5.1	7.1	7.1	7.1	7	7.4	PSO_Bounds [8]
Monte Carlo	210	2400	8200	*29e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	3	3.1	3.1	**1.7**	*67e-2/1e4*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	3.4	4.6	4.8	3.1	*55e-2/1e4*	.	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	11	11	11	**1.2**	52	50	50	49	49	51	VNS (Garcia) [11]

Table 21: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	0.1	0.1	13	224	439	449	462	486	507	1130	ERT$_{\text{best}}$/D
ALPS	**1**	**1**	21	**4.5**	5	5.8	6.6	7.3	8	4.6	ALPS [17]
AMaLGaM IDEA	**1**	**1**	27	140	120	120	110	110	100	48	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	3.2	8.2	4.7	4.7	4.5	4.3	4.1	**1.9**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	48	27	32	*19e-1/2e3*	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	4.6	**2.9**	**2.8**	**2.7**	**2.7**	**2.6**	**2.5**	**2**	BFGS [30]
Cauchy EDA	**1**	**1**	79	340	320	310	300	290	280	120	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	5.9	28	16	15	15	14	14	6.3	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	9.7	6.1	5.1	5	4.9	4.6	4.5	**2**	(1+1)-CMA-ES [2]
DASA	**1**	**1**	170	500	430	420	410	390	370	170	DASA [19]
DEPSO	**1**	**1**	11	26	19	19	18	18	17	7.8	DEPSO [12]
DIRECT	**1**	**1**	**2.5**	7.5	17	36	35	33	34	17	DIRECT [25]
EDA-PSO	**1**	**1**	53	1200	920	900	870	830	800	360	EDA-PSO [6]
full NEWUOA	**1**	**1**	4.4	7.3	4.4	4.3	4.2	4	3.8	**1.7**	full NEWUOA [31]
G3-PCX	**1**	**1**	5	13	9	8.8	8.6	8.2	7.8	3.5	G3-PCX [26]
simple GA	**1**	**1**	91	85	95	97	130	120	120	260	simple GA [22]
GLOBAL	**1**	**1**	3.6	**1**	**1**	**1**	**1**	**1**	**1**	**1**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	3.2	49	44	44	43	41	40	18	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	99	100	170	160	160	150	140	65	LSfminbnd [28]
LSstep	**1**	**1**	690	630	330	320	320	300	290	*91e-1/1e4*	LSstep [28]
MA-LS-Chain	**1**	**1**	7.5	66	43	42	41	39	38	17	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	20	10	10	10	9.5	9.1	4.9	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	20	16	16	16	15	14	14	6.2	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	8.4	6	**3.7**	**3.6**	**3.5**	**3.4**	**3.3**	**1.6**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**2.1**	7.4	4.8	4.7	4.6	4.4	4.2	**1.9**	NEWUOA [31]
(1+1)-ES	**1**	**1**	9.8	20	18	18	17	17	16	7.1	(1+1)-ES [1]
POEMS	**1**	**1**	290	1800	1500	1500	1400	1300	1300	580	POEMS [20]
PSO	**1**	**1**	1200	510	340	330	330	310	300	130	PSO [7]
PSO_Bounds	**1**	**1**	560	1200	1500	1500	1400	1300	1300	580	PSO_Bounds [8]
Monte Carlo	**1**	**1**	570	6.3e4	*20e-1/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	16	18	12	12	12	11	11	4.8	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	5.9	14	10	10	9.9	9.5	9.1	4.1	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	10	22	30	46	66	68	68	32	VNS (Garcia) [11]

Table 22: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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$_{\text{best}}$/D	1e+03 0.1	1e+02 0.1	1e+01 9.79	1e+00 284	1e-01 635	1e-02 662	1e-03 680	1e-04 692	1e-05 830	1e-07 1040	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1**	33	7	12	15	18	24	24	27	ALPS [17]
AMaLGaM IDEA	**1**	**1**	8.8	490	4900	4700	4600	4500	3800	3e3	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	3.6	**2.6**	**2.1**	**2.1**	**2**	**2**	**1.7**	**1.4**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	62	31	*20e-1/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	6.6	3.1	4.4	4.2	4.2	4.1	3.5	5.7	BFGS [30]
Cauchy EDA	**1**	**1**	450	360	*20e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	29	58	200	190	190	180	150	120	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	9.3	3.7	3.4	3.3	3.2	3.2	**2.7**	**2.2**	(1+1)-CMA-ES [2]
DASA	**1**	**1**	320	220	190	190	190	190	160	140	DASA [19]
DEPSO	**1**	**1**	66	47	*51e-1/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**3.5**	5.1	*69e-2/1e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1**	**1**	1600	980	*20e-1/1e5*	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**1**	3.6	**1.1**	**1.9**	**1.8**	**1.8**	**1.8**	**1.5**	**1.3**	full NEWUOA [31]
G3-PCX	**1**	**1**	9.3	5.6	5.6	5.5	5.4	5.3	4.5	3.7	G3-PCX [26]
simple GA	**1**	**1**	130	720	*20e-1/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1**	4.5	**1**	**1**	**1**	**1**	**1**	**1**	**1**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	24	170	1200	1200	1100	1100	930	750	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	170	26	48	47	48	49	42	72	LSfminbnd [28]
LSstep	**1**	**1**	330	89	230	*20e-1/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1**	55	510	540	520	500	490	410	330	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.1**	3.2	6.4	6.1	6	5.9	4.9	12	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**1**	7.4	10	9.6	9.4	9.3	7.8	6.2	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	18	**2.5**	5	4.9	4.9	4.8	4	3.3	NELDER (Doe) [5]
NEWUOA	**1**	**1**	6.7	**1.8**	**2.5**	**2.4**	**2.4**	**2.4**	**2**	**1.7**	NEWUOA [31]
(1+1)-ES	**1**	**1**	47	17	13	13	13	13	11	8.9	(1+1)-ES [1]
POEMS	**1**	**1**	4400	1400	1e3	990	960	940	790	640	POEMS [20]
PSO	**1**	**1**	3700	1400	2200	2100	2100	2e3	1700	1400	PSO [7]
PSO_Bounds	**1**	**1**	740	1400	2200	2100	2100	2100	1700	1400	PSO_Bounds [8]
Monte Carlo	**1**	**1**	2500	*20e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	35	5	5.4	5.3	5.3	5.4	4.7	4.1	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	22	61	220	210	210	200	170	140	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	39	160	1100	1400	1500	1500	1200	980	VNS (Garcia) [11]

Table 23: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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 ERT$_{\text{best}}$/D	1e+03 0.1	1e+02 0.1	1e+01 0.28	1e+00 91.5	1e-01 1640	1e-02 18400	1e-03 20400	1e-04 20600	1e-05 20900	1e-07 21400	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1**	**1.7**	42	1e3	*14e-2/5e5*	.	.	.	.	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**1.6**	10	**1**	**1**	**1**	**1**	**1**	**1**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	11	**2.6**	*21e-2/1e4*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.3**	*16e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	17	130	*11e-1/5e3*	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	**1**	**2.3**	1700	*11e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	**2**	21	**2.7**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	3.4	**2.9**	*22e-2/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	5	28	4300	*15e-2/1e6*	.	.	.	.	DASA [19]
DEPSO	**1**	**1**	**1.7**	*18e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**2.1**	**2.1**	*65e-2/1e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1**	**1**	**1.7**	590	*87e-2/1e5*	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**1**	13	**2.9**	44	*19e-2/1e4*	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1**	**1.8**	4.9	98	*19e-2/4e4*	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1**	**1.4**	390	*85e-2/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1**	**2.1**	**1**	*32e-2/700*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.8**	5.7	**3.6**	**1.1**	**1**	**1**	**1**	**1**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	**2.1**	26	*66e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	**1**	**1**	**1.2**	31	*51e-2/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1**	**2**	**2.3**	17	38	35	*44e-3/5e4*	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	3.4	15	*56e-2/4e3*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**1**	5.7	40	80	*59e-3/1e5*	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.7**	**1.4**	11	*97e-3/2e4*	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**1**	7.5	3.6	*34e-2/7e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1**	4.4	7.6	2900	*14e-2/1e6*	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	**1**	15	31	19	36	69	*63e-3/1e5*	.	.	POEMS [20]
PSO	**1**	**1**	**1.7**	91	*42e-2/1e5*	.	.	.	.	.	PSO [7]
PSO_Bounds	**1**	**1**	**1.5**	130	*67e-2/1e5*	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**1.6**	530	*61e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	**2.1**	**2.2**	*32e-2/5e3*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	**2.4**	17	12	*11e-2/1e4*	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**2.6**	18	34	140	420	680	670	650	VNS (Garcia) [11]

Table 24: 10-D, running time excess ERT/ERT$_{\text{best}}$ 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 ERT$_{\text{best}}$/D	1e+03 0.1	1e+02 6.64	1e+01 9880	1e+00 1.04e5	1e-01 7.47e6	1e-02 7.48e6	1e-03 7.48e6	1e-04 7.48e6	1e-05 7.48e6	1e-07 7.48e6	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	24	10	*44e-1/5e5*	.	.	.	.	.	.	ALPS [17]
AMaLGaM IDEA	**1**	5.5	18	**8.3**	***78e-2/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.4**	*21e+0/8e3*	.	.	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	19	*37e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	350	*81e+0/4e3*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	51	*27e+0/5e4*	.	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.2**	**2.7**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	8.6	14	*20e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	1300	*31e+0/1e6*	.	.	.	.	.	.	.	DASA [19]
DEPSO	**1**	6.8	*38e+0/2e3*	.	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	5.9	*19e+0/1e4*	.	.	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1**	56	*23e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**2.6**	*16e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	16	*31e+0/5e4*	.	.	.	.	.	.	.	G3-PCX [26]
simple GA	**1**	120	*14e+0/1e5*	.	.	.	.	.	.	.	simple GA [22]
GLOBAL	**1**	7.2	*62e+0/1e3*	.	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	4.2	4.2	**4.2**	***66e-2/1e6***	.	.	.	.	.	iAMaLGaM IDEA [4]
LSfminbnd	**1**	20	*33e+0/1e4*	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	3	170	*49e+0/1e4*	.	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	5.7	*11e+0/5e4*	.	.	.	.	.	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	15	*30e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	8.2	22	*11e+0/1e5*	.	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	4.7	**2.6**	*96e-1/2e4*	.	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**1**	*26e+0/7e3*	.	.	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	140	740	*17e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	48	140	*19e+0/1e5*	.	.	.	.	.	.	POEMS [20]
PSO	**1**	8.1	140	*20e+0/1e5*	.	.	.	.	.	.	PSO [7]
PSO_Bounds	**1**	22	140	*22e+0/1e5*	.	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	820	*60e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	1e4	*12e+1/1e4*	.	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**2.2**	**1**	*91e-1/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	4.8	3.7	*21e-1/8e6*	.	.	.	.	.	.	VNS (Garcia) [11]

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