Comparison tables: BBOB 2009 function testbed in 5-D

The BBOBies

November 20, 2009

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

1 Sphere

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.2	0.2	2.2	2.44	2.44	2.44	2.44	2.44	2.44	2.44	ERT_{best}/D
ALPS	**1**	**1.6**	9.2	140	300	490	680	850	1e3	1400	ALPS [17]
AMaLGaM IDEA	**1**	**1.5**	5.5	16	29	44	58	72	87	120	AMaLGaM IDEA [4]
avg NEWUOA	**1**	3.3	**1.5**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	avg NEWUOA [31]
BayEDAcG	**1**	**1.2**	5.2	46	92	130	170	280	390	560	BayEDAcG [10]
BFGS	**1**	3.4	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	BFGS [30]
Cauchy EDA	**1**	24	41	90	170	240	310	400	460	600	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.1**	3.2	9	15	21	27	33	40	53	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.3**	**2.3**	5.9	9.7	14	17	21	25	32	(1+1)-CMA-ES [2]
DASA	**1**	5.2	23	44	59	71	88	110	120	150	DASA [19]
DEPSO	**1**	**1.3**	8.1	26	48	77	110	130	170	220	DEPSO [12]
DIRECT	**1**	**1**	**2**	7	19	31	44	62	84	150	DIRECT [25]
EDA-PSO	**1**	**1.1**	3.2	20	320	890	1500	2100	2700	3800	EDA-PSO [6]
full NEWUOA	**1**	**2.9**	**1.9**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	full NEWUOA [31]
G3-PCX	**1**	**1.5**	5.2	12	15	19	25	31	35	45	G3-PCX [26]
simple GA	**1**	**1.5**	8.7	360	1200	2100	2900	4100	5400	8300	simple GA [22]
GLOBAL	**1**	**1.3**	6.8	26	28	30	32	33	35	39	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.4**	**2.5**	9.8	19	28	36	47	56	73	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**2.8**	6	6.3	6.7	6.7	6.8	6.8	6.8	6.8	LSfminbnd [28]
LSstep	**1**	140	92	120	130	130	130	130	130	130	LSstep [28]
MA-LS-Chain	**1**	**1.3**	7.8	25	47	60	74	90	120	140	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1.8**	**2.5**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	MCS (Neum) [18]
NELDER (Han)	**1**	**1.7**	**1.5**	3.3	5.4	7.2	9.2	11	13	17	NELDER (Han) [16]
NELDER (Doe)	**1**	**2.3**	**1.5**	3.4	5.6	7.4	9.5	11	13	17	NELDER (Doe) [5]
NEWUOA	**1**	**2.4**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	NEWUOA [31]
(1+1)-ES	**1**	**1.2**	**2.3**	5	8.4	11	15	18	22	28	(1+1)-ES [1]
POEMS	**1**	240	110	130	380	760	1200	1600	2100	2900	POEMS [20]
PSO	**1**	**1.3**	3.7	22	55	110	180	240	320	450	PSO [7]
PSO_Bounds	**1**	**1.2**	3.8	41	210	430	730	980	1300	1900	PSO_Bounds [8]
Monte Carlo	**1**	**1.4**	7.5	1700	6.8e5	*10e-2/1e6*	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**2.9**	**2.9**	4.2	5.5	6.8	8.7	10	12	15	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.5**	**2.8**	7	14	18	23	29	34	44	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.6**	7.4	18	25	31	38	45	50	64	VNS (Garcia) [11]

Table 2: 05-D, running time excess ERT/ERT_{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_{best}/D	9.71	14.9	16.7	17.5	17.7	17.9	18	18.2	18.4	18.8	ERT_{best}/D
ALPS	45	55	73	95	120	150	170	190	210	260	ALPS [17]
AMaLGaM IDEA	5.2	5.3	7.1	10	13	15	17	19	21	24	AMaLGaM IDEA [4]
avg NEWUOA	**1.2**	**2**	6.4	21	41	56	75	92	110	150	avg NEWUOA [31]
BayEDAcG	32	38	41	46	52	58	64	79	84	95	BayEDAcG [10]
BFGS	3.3	3.4	**3.8**	**5.6**	**6.2**	**6.5**	**6.6**	**6.8**	**6.9**	**7.1**	BFGS [30]
Cauchy EDA	35	35	42	49	58	71	80	91	100	120	Cauchy EDA [24]
BIPOP-CMA-ES	11	11	13	16	18	19	20	20	21	22	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	5.6	6.6	9.4	11	12	13	14	14	14	15	(1+1)-CMA-ES [2]
DASA	10	8.6	9.7	12	13	15	17	19	21	26	DASA [19]
DEPSO	11	11	13	16	21	24	28	32	37	44	DEPSO [12]
DIRECT	4.2	4.3	5.7	7.2	8.4	10	14	16	22	380	DIRECT [25]
EDA-PSO	8.6	58	140	210	290	360	420	490	550	690	EDA-PSO [6]
full NEWUOA	**1.5**	**2.7**	6.9	19	36	50	69	87	100	130	full NEWUOA [31]
G3-PCX	15	30	69	150	220	280	340	410	470	620	G3-PCX [26]
simple GA	180	230	330	460	610	770	1300	1500	2200	2500	simple GA [22]
GLOBAL	7.1	5.4	6.3	6.9	7.3	7.5	7.8	8	8.2	**8.5**	GLOBAL [23]
iAMaLGaM IDEA	4.4	4.7	6.2	8.1	10	12	13	14	15	17	iAMaLGaM IDEA [4]
LSfminbnd	**1.5**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSfminbnd [28]
LSstep	25	17	16	16	16	15	15	15	15	15	LSstep [28]
MA-LS-Chain	7.9	10	13	16	22	27	32	36	41	49	MA-LS-Chain [21]
MCS (Neum)	**1.3**	**1**	**1.1**	**1.5**	**2.2**	**3.2**	**4.7**	**5.7**	**6.5**	29	MCS (Neum) [18]
NELDER (Han)	**2.4**	**2.7**	5	6.8	7.4	7.7	7.9	8.1	8.3	8.6	NELDER (Han) [16]
NELDER (Doe)	**2**	**2.5**	4.9	8.1	8.9	9.3	9.6	9.8	10	10	NELDER (Doe) [5]
NEWUOA	**1**	**1.8**	5.7	22	45	60	85	100	130	170	NEWUOA [31]
(1+1)-ES	110	1600	5600	1.6e4	3e4	4.6e4	1.9e5	2.6e5	8e5	*19e-4/1e6*	(1+1)-ES [1]
POEMS	150	160	210	270	330	380	440	470	520	630	POEMS [20]
PSO	19	25	32	41	49	59	68	78	89	110	PSO [7]
PSO_Bounds	47	83	150	190	260	300	400	590	860	1200	PSO_Bounds [8]
Monte Carlo	1800	1.2e5	*11e+1/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.2**	8.6	13	100	140	140	150	190	190	240	Rosenbrock [27]
IPOP-SEP-CMA-ES	5.4	5.7	7.2	8.5	9.4	10	11	11	12	13	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	15	14	18	20	24	24	25	26	26	27	VNS (Garcia) [11]

Table 3: 05-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	0.2	2.92	143	324	327	328	329	330	330	331	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.5**	**2**	5.7	12	22	24	26	28	29	33	ALPS [17]
AMaLGaM IDEA	**1.5**	**2.1**	4.5	65	480	500	510	520	520	520	AMaLGaM IDEA [4]
avg NEWUOA	3.3	4.8	**3**	130	*40e-1/6e3*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1.2**	**1.7**	**2.7**	*29e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	7.4	56	110	*21e+0/4e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	35	25	6.7	2200	*26e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	3.5	**1.5**	**1.4**	16	140	140	140	140	140	140	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.2**	**1.3**	9.1	440	*30e-1/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	8.7	18	**1.2**	**1.6**	**10**	**10**	**10**	**10**	**10**	**11**	DASA [19]
DEPSO	**1.4**	**2.9**	3.7	29	30	30	30	*23e-1/2e3*	.	.	DEPSO [12]
DIRECT	**1**	**2.6**	45	300	*30e-1/2e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1.4**	**2.2**	12	170	860	860	860	860	870	870	EDA-PSO [6]
full NEWUOA	4.3	3.7	4.2	160	*20e-1/7e3*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**2**	3	84	2100	*30e-1/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1.1**	**1.6**	19	18	25	34	43	53	110	200	simple GA [22]
GLOBAL	**1.2**	**2.4**	3.3	*50e-1/500*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.2**	**1.4**	**1.4**	33	180	180	180	190	190	190	iAMaLGaM IDEA [4]
LSfminbnd	11	**2.7**	**1**	52	*21e-1/4e3*	.	.	.	.	.	LSfminbnd [28]
LSstep	81	62	**2.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSstep [28]
MA-LS-Chain	**1**	**1.3**	**1**	6.4	32	32	32	32	32	**32**	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.2**	24	220	210	210	210	210	210	MCS (Neum) [18]
NELDER (Han)	**1**	**1.3**	5.4	280	1500	1500	1500	1500	1500	1400	NELDER (Han) [16]
NELDER (Doe)	**2.1**	**1**	**1.5**	33	270	270	270	270	270	270	NELDER (Doe) [5]
NEWUOA	3	**1.5**	6.1	230	*40e-1/5e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1.8**	**2.3**	16	310	3900	3800	3800	3800	3800	3800	(1+1)-ES [1]
POEMS	170	70	3.8	9.7	35	39	42	45	47	54	POEMS [20]
PSO	**1.4**	**1.7**	52	55	280	270	280	280	280	280	PSO [7]
PSO_Bounds	**1.5**	**1.6**	7.6	26	38	63	64	65	70	95	PSO_Bounds [8]
Monte Carlo	**1**	**2.1**	6800	*83e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	5.7	39	24	390	*70e-1/9e3*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**2.2**	**2.3**	**1.2**	12	96	96	96	97	97	97	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1.6**	**2.5**	**2.5**	**5.2**	**11**	**11**	**12**	**16**	**22**	40	VNS (Garcia) [11]

Table 4: 05-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	0.2	3.77	162	327	338	352	363	370	377	381	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.1**	4.4	7.1	28	59	58	58	58	59	63	ALPS [17]
AMaLGaM IDEA	**1.8**	3.4	5.8	2e4	*20e-1/1e6*	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	5.4	10	14	*50e-1/8e3*	.	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1.7**	6.3	5.8	*69e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	3	67	170	*24e+0/4e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	7.6	39	85	*78e-1/5e4*	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1.1**	**2.9**	**2.7**	*20e-1/4e5*	.	.	.	.	.	.	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.6**	15	460	*30e-1/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	15	13	**1**	**1.8**	**5.9**	**5.7**	**5.6**	**5.6**	**5.7**	**5.9**	DASA [19]
DEPSO	**1.8**	5.2	3.3	*30e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**2.5**	190	110	250	*11e+0/2e4*	.	.	.	.	DIRECT [25]
EDA-PSO	**1.1**	3.5	14	2e3	*20e-1/1e5*	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	3.9	**2.8**	12	*30e-1/1e4*	.	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1.5**	4.6	76	2200	*50e-1/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1.9**	5	18	20	**26**	**33**	41	49	58	190	simple GA [22]
GLOBAL	**1.3**	4.9	8.3	*11e+0/600*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.7**	**2.3**	3.9	2.1e4	*20e-1/1e6*	.	.	.	.	.	iAMaLGaM IDEA [4]
LSfminbnd	21	3	7.8	*42e-1/5e3*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	320	58	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	LSstep [28]
MA-LS-Chain	**1.5**	3.8	**1.7**	35	180	170	160	160	160	160	MA-LS-Chain [21]
MCS (Neum)	**1**	**2.3**	4.1	*20e-1/1e4*	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	3.1	**1.4**	26	*30e-1/1e5*	.	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1.9**	**1**	7.1	900	870	840	810	790	780	770	NELDER (Doe) [5]
NEWUOA	4.1	27	27	300	*60e-1/7e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	3.3	**2**	25	3700	2e4	1.9e4	1.9e4	1.8e4	1.8e4	1.8e4	(1+1)-ES [1]
POEMS	210	67	4.5	17	45	47	47	**49**	**52**	**57**	POEMS [20]
PSO	**1.7**	**2.7**	**3**	140	4200	4e3	3900	3800	3700	3700	PSO [7]
PSO_Bounds	**1.6**	3.2	8	30	64	110	110	110	110	140	PSO_Bounds [8]
Monte Carlo	**1.3**	3.4	1.6e4	*12e+0/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	5.1	33	57	*99e-1/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.5**	**2.1**	**1**	*37e-1/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**2**	5.6	**2.5**	**16**	39	38	**39**	50	54	130	VNS (Garcia) [11]

Table 5: 05-D, running time excess 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	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	0.2	0.293	2	2	2	2	2	2	2	2	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.5**	64	130	160	160	160	160	160	160	ALPS [17]
AMaLGaM IDEA	**1**	**2**	19	28	29	29	29	29	29	29	AMaLGaM IDEA [4]
avg NEWUOA	**1**	4.1	**1.8**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	avg NEWUOA [31]
BayEDAcG	**1**	**1.7**	38	76	320	320	320	320	320	320	BayEDAcG [10]
BFGS	**1**	5.9	**1.9**	**3**	3.1	3.1	3.1	3.1	3.1	3.1	BFGS [30]
Cauchy EDA	**1**	29	39	41	41	41	41	41	41	41	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.5**	4.5	6.5	6.6	6.6	6.6	6.6	6.6	6.6	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**2**	**2.3**	3.1	3.2	3.2	3.2	3.2	3.2	3.2	(1+1)-CMA-ES [2]
DASA	**1**	45	28	36	40	43	49	52	55	63	DASA [19]
DEPSO	**1**	**2**	22	37	41	41	41	41	41	41	DEPSO [12]
DIRECT	**1**	4.5	9.2	12	13	13	13	13	13	13	DIRECT [25]
EDA-PSO	**1**	**1**	10	16	16	16	16	17	17	17	EDA-PSO [6]
full NEWUOA	**1**	**1.5**	**2.2**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	full NEWUOA [31]
G3-PCX	**1**	**1.8**	14	25	27	28	28	28	28	28	G3-PCX [26]
simple GA	**1**	**1.9**	480	2100	4e3	6300	9200	1.2e4	1.7e4	3.4e4	simple GA [22]
GLOBAL	**1**	**2.3**	32	33	34	34	34	34	34	34	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.4**	7.1	11	12	12	12	12	12	12	iAMaLGaM IDEA [4]
LSfminbnd	**1**	18	13	14	14	14	14	14	14	14	LSfminbnd [28]
LSstep	**1**	180	140	160	160	160	160	160	160	160	LSstep [28]
MA-LS-Chain	**1**	**1.5**	53	69	70	71	71	71	71	71	MA-LS-Chain [21]
MCS (Neum)	**1**	3	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**1**	3.9	**2.5**	4.1	4.2	4.2	4.2	4.2	4.2	4.2	NELDER (Han) [16]
NELDER (Doe)	**1**	3.1	**1.9**	**2.4**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	NELDER (Doe) [5]
NEWUOA	**1**	**2.9**	**1.3**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	NEWUOA [31]
(1+1)-ES	**1**	3	**2**	**2.4**	**2.5**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	(1+1)-ES [1]
POEMS	**1**	350	150	200	210	220	220	220	220	220	POEMS [20]
PSO	**1**	**1.7**	10	14	16	16	16	16	16	16	PSO [7]
PSO_Bounds	**1**	**1.6**	9.2	15	16	16	16	16	16	16	PSO_Bounds [8]
Monte Carlo	**1**	**1.6**	4300	*37e-1 /1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	11	4	4.2	4.2	4.2	4.2	4.2	4.2	4.2	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	5.7	4.8	6.6	6.8	6.9	6.9	6.9	6.9	6.9	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**2.2**	13	15	15	15	15	15	15	15	VNS (Garcia) [11]

Table 6: 05-D, running time excess ERT/ERT_{best} on f_6, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

6 Attractive sector

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	2.28	3.2	22.8	42.7	56.2	80.7	116	149	208	266	ERT_{best}/D
ALPS	31	32	20	28	40	41	39	39	34	37	ALPS [17]
AMaLGaM IDEA	6.6	5.7	3.2	4.3	5.7	5.7	5.2	5	4.3	4.5	AMaLGaM IDEA [4]
avg NEWUOA	**1.2**	**2.6**	**1.3**	**1.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2.4**	**2.5**	avg NEWUOA [31]
BayEDAcG	8.8	10	250	*13e+0/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.9**	4.9	3	3.3	3.4	**3**	**2.5**	**2.3**	**2**	7.8	BFGS [30]
Cauchy EDA	49	230	92	69	68	58	47	43	35	34	Cauchy EDA [24]
BIPOP-CMA-ES	**2.5**	5.2	**2.3**	**2.1**	**2.2**	**1.9**	**1.7**	**1.6**	**1.3**	**1.3**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.6**	3.3	**1.4**	**1.4**	**1.6**	**1.7**	**1.6**	**1.5**	**1.6**	**1.8**	(1+1)-CMA-ES [2]
DASA	21	21	7.8	9	50	99	110	100	81	150	DASA [19]
DEPSO	6.3	8.3	5.5	6.4	8	8	7.1	7	6.3	9.7	DEPSO [12]
DIRECT	**2.5**	**2.2**	**2.3**	28	790	1200	*22e-2/2e4*	.	.	.	DIRECT [25]
EDA-PSO	5	4.9	11	51	81	85	79	75	65	68	EDA-PSO [6]
full NEWUOA	**1.5**	3.6	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1.4**	full NEWUOA [31]
G3-PCX	7.2	7.1	**2.4**	**3**	4.8	5.1	4.7	5.6	5.1	5.5	G3-PCX [26]
simple GA	60	81	66	150	380	3700	1.2e4	9700	*24e-3/1e5*	.	simple GA [22]
GLOBAL	12	10	**2.9**	**2.1**	**2**	**2.9**	**2.2**	**2.7**	3.6	35	GLOBAL [23]
iAMaLGaM IDEA	**3**	3.6	**2.1**	**2.3**	3.1	3.1	**2.7**	**2.6**	**2.2**	**2.3**	iAMaLGaM IDEA [4]
LSfminbnd	9.1	14	96	110	130	150	110	110	82	65	LSfminbnd [28]
LSstep	160	200	410	290	300	420	600	490	*21e-2/1e4*	.	LSstep [28]
MA-LS-Chain	12	11	4.8	6.8	7.9	7.4	5.8	5.1	4.1	3.7	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**2.7**	47	41	61	71	63	46	54	MCS (Neum) [18]
NELDER (Han)	**1.7**	**2.4**	**1**	**1.9**	**2.8**	**2.6**	**2.3**	**2.3**	**2**	**2.6**	NELDER (Han) [16]
NELDER (Doe)	**2.3**	11	5.1	5.6	5.6	4.9	5.3	6.6	5.6	8.5	NELDER (Doe) [5]
NEWUOA	**1.4**	**2.8**	**1.7**	**2.4**	3.6	3.6	3.3	3.2	**2.7**	**2.9**	NEWUOA [31]
(1+1)-ES	**1.7**	3.4	**1.6**	**1.5**	**1.7**	**1.5**	**1.3**	**1.2**	**1**	**1**	(1+1)-ES [1]
POEMS	95	80	27	46	52	50	46	42	37	37	POEMS [20]
PSO	5.2	5.3	4.7	9	11	12	11	12	10	11	PSO [7]
PSO_Bounds	4.4	4.4	14	49	85	100	98	92	78	92	PSO_Bounds [8]
Monte Carlo	290	480	300	5.7e4	*14e-1/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**3**	**2.6**	**2.2**	**2.8**	**2.4**	**2.2**	4.3	3.8	**2.8**	**2.4**	Rosenbrock [27]
IPOP-SEP-CMA-ES	**2.4**	7	**2.8**	**2.5**	**2.7**	**2.4**	**2.2**	**2**	**1.6**	**1.5**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	7.7	12	3.7	**2.7**	**2.9**	**2.5**	**2**	**1.8**	**1.5**	**1.4**	VNS (Garcia) [11]

Table 7: 05-D, running time excess ERT/ERT_{best} on f_7, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

7 Step-ellipsoid

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.2	1.24	4.72	64.7	234	290	314	314	314	319	ERT_{best}/D
ALPS	**1.1**	**2.3**	33	10	5.7	7.7	9	9	9	9.7	ALPS [17]
AMaLGaM IDEA	**1.3**	**2.8**	5.6	**1**	**1.2**	**1.8**	**2.3**	**2.3**	**2.3**	**2.4**	AMaLGaM IDEA [4]
avg NEWUOA	**1.1**	**2.5**	4.4	5.9	13	130	*17e-3/8e3*	.	.	.	avg NEWUOA [31]
BayEDAcG	**1.5**	**2.4**	20	31	120	99	*73e-2/2e3*	.	.	.	BayEDAcG [10]
BFGS	3	14	*32e+0/100*	.	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	10	31	33	4.9	**2.4**	**2.9**	**2.9**	**2.9**	**2.9**	3.4	Cauchy EDA [24]
BIPOP-CMA-ES	**1.7**	**2.2**	5	**1.5**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.6**	3.5	5.3	**2**	**2.1**	3.1	3.1	3.1	3.1	(1+1)-CMA-ES [2]
DASA	24	43	230	280	1100	2e4	*16e-3/8e5*	.	.	.	DASA [19]
DEPSO	**1.2**	6.5	14	**3**	5	7.2	8.3	8.3	8.3	8.5	DEPSO [12]
DIRECT	**1**	**1**	**2.8**	**1.7**	120	*41e-3/2e4*	.	.	.	.	DIRECT [25]
EDA-PSO	**1.3**	**1.7**	22	24	13	17	18	18	18	19	EDA-PSO [6]
full NEWUOA	**1.7**	3.3	**1**	**1.2**	4	14	24	24	24	23	full NEWUOA [31]
G3-PCX	**1.3**	**2.5**	19	18	45	150	410	410	410	410	G3-PCX [26]
simple GA	**1.4**	3.5	50	35	57	240	520	520	520	520	simple GA [22]
GLOBAL	**1.6**	**2.9**	12	5.7	10	*82e-2/400*	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.2**	**2.3**	3.8	**1.9**	**3**	**2.9**	3.7	3.7	3.7	3.7	iAMaLGaM IDEA [4]
LSfminbnd	3.8	17	49	64	100	510	*40e-2/1e4*	.	.	.	LSfminbnd [28]
LSstep	28	190	370	700	640	*19e-1/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1.1**	3.5	8.4	3.2	13	13	24	24	24	24	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.3**	**2.8**	5.9	13	140	*25e-3/1e4*	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1.1**	**1.6**	27	33	56	120	310	310	310	300	NELDER (Han) [16]
NELDER (Doe)	**1.4**	**1.3**	**1.4**	7.5	15	39	71	71	71	71	NELDER (Doe) [5]
NEWUOA	**1.5**	**2.2**	9.9	13	60	*32e-2/6e3*	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1.9**	**2.6**	5.6	6.8	100	370	810	810	810	790	(1+1)-ES [1]
POEMS	400	180	74	15	9.2	11	21	21	21	22	POEMS [20]
PSO	**1.1**	4	11	9.5	590	480	540	540	540	530	PSO [7]
PSO_Bounds	**1.3**	**2.3**	9.4	13	170	140	130	130	130	130	PSO_Bounds [8]
Monte Carlo	**1.3**	**2.9**	39	1200	*38e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	11	220	1200	670	*13e+0/3e3*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.1**	**2.5**	6	**1.8**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	3.5	11	**1.6**	6.8	6.6	7.8	7.8	7.8	7.8	VNS (Garcia) [11]

Table 8: 05-D, running time excess ERT/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
ERT_{best}/D	3.56	8.77	14.7	54.6	67.3	74.5	78.2	80.2	82	84.4	ERT_{best}/D
ALPS	11	32	51	49	100	150	180	210	250	340	ALPS [17]
AMaLGaM IDEA	3.1	4.3	5.2	6.1	7.7	8.1	8.5	8.9	9.1	9.7	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	**1.6**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	avg NEWUOA [31]
BayEDAcG	5.5	11	140	*45e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.1**	**2.4**	**2.1**	**1.8**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	BFGS [30]
Cauchy EDA	24	32	49	31	33	33	34	36	37	40	Cauchy EDA [24]
BIPOP-CMA-ES	**2.7**	3.6	3.2	3.7	4.5	4.7	4.8	5	5.1	5.4	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.1**	**2.1**	**2.1**	5.1	5	4.9	4.9	4.9	4.9	5	(1+1)-CMA-ES [2]
DASA	16	21	19	160	390	700	1e3	1500	2e3	3300	DASA [19]
DEPSO	4.7	7.2	12	18	*23e-2/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**2.5**	**2.8**	4.1	5.7	22	56	100	150	190	290	DIRECT [25]
EDA-PSO	3.7	10	72	100	200	300	400	520	620	840	EDA-PSO [6]
full NEWUOA	**2.3**	**2.2**	**1.6**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	full NEWUOA [31]
G3-PCX	5.5	5.3	4.6	20	18	17	17	16	16	16	G3-PCX [26]
simple GA	8.4	110	190	840	*78e-2/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	11	7.4	5	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.2**	GLOBAL [23]
iAMaLGaM IDEA	**2.3**	**2.8**	3.4	7.5	7.6	7.7	7.7	8	8.1	8.4	iAMaLGaM IDEA [4]
LSfminbnd	5.5	9.1	10	290	450	1900	*34e-1/1e4*	.	.	.	LSfminbnd [28]
LSstep	78	64	64	95	330	910	1800	1800	*53e-2/1e4*	.	LSstep [28]
MA-LS-Chain	5.8	7.3	8.7	7.2	9.6	10	11	11	11	12	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.4**	**1.5**	**1**	**1**	**1**	**1.1**	**1.1**	**1.1**	**1.1**	MCS (Neum) [18]
NELDER (Han)	**1.3**	**1.6**	**1.6**	3.7	3.3	3.2	3.1	3.1	3.1	3.2	NELDER (Han) [16]
NELDER (Doe)	**1.1**	**2.3**	**2.1**	**2.4**	**2.4**	**2.3**	**2.3**	**2.3**	**2.4**	**2.4**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**1**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	NEWUOA [31]
(1+1)-ES	**2.7**	22	15	240	230	240	260	290	320	380	(1+1)-ES [1]
POEMS	67	40	69	180	200	390	750	2100	5500	1.8e4	POEMS [20]
PSO	3.8	7.1	13	150	200	310	470	620	780	1100	PSO [7]
PSO_Bounds	5.1	12	30	470	920	1200	1400	3e3	*12e-5/1e5*	.	PSO_Bounds [8]
Monte Carlo	10	220	2e4	*64e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.3**	53	32	23	22	23	25	27	30	36	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.7**	**2.8**	3.5	5.8	6.8	6.7	6.8	6.8	6.9	7.1	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	8.9	5.9	5.1	6.6	7.7	21	46	48	47	46	VNS (Garcia) [11]

Table 9: 05-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	0.2	0.2	6.92	25.4	42.8	52.7	60.1	64.8	67.1	73.8	ERT_{best}/D
ALPS	140	1100	91	92	130	200	260	310	370	560	ALPS [17]
AMaLGaM IDEA	53	140	9.1	23	18	17	16	16	16	15	AMaLGaM IDEA [4]
avg NEWUOA	20	56	**2.4**	3.1	**2.1**	**1.8**	**1.7**	**1.6**	**1.6**	**1.5**	avg NEWUOA [31]
BayEDAcG	81	350	38	*39e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	31	84	3.6	**3**	**2**	**1.8**	**1.6**	**1.5**	**1.5**	**1.4**	BFGS [30]
Cauchy EDA	400	910	71	54	45	42	41	41	42	43	Cauchy EDA [24]
BIPOP-CMA-ES	28	98	5.8	8.7	7.2	6.7	6.4	6.2	6.3	6.2	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	30	86	4.2	7.7	5.9	5.3	5	4.9	4.9	4.7	(1+1)-CMA-ES [2]
DASA	330	7500	230	6700	4800	4600	4800	5300	6600	8900	DASA [19]
DEPSO	100	370	22	150	*10e-1/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	3.2	4.2	48	56	130	140	150	310	DIRECT [25]
EDA-PSO	70	410	250	210	270	470	700	1100	1300	2800	EDA-PSO [6]
full NEWUOA	33	72	**2.6**	**2.7**	**1.9**	**1.7**	**1.5**	**1.5**	**1.4**	**1.3**	full NEWUOA [31]
G3-PCX	94	380	14	18	14	12	11	11	10	9.8	G3-PCX [26]
simple GA	100	3800	420	5.6e4	*17e-1/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	210	340	11	4.6	3.2	**3**	**2.8**	**2.7**	**2.7**	**2.7**	GLOBAL [23]
iAMaLGaM IDEA	42	120	7	22	15	14	13	12	12	12	iAMaLGaM IDEA [4]
LSfminbnd	60	330	13	130	180	440	*25e-3/1e4*	.	.	.	LSfminbnd [28]
LSstep	2e3	1.3e4	520	5600	*19e-1/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	84	260	18	20	17	17	17	16	16	16	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	MCS (Neum) [18]
NELDER (Han)	**13**	62	3.1	13	8.2	6.9	6.2	5.9	5.8	5.4	NELDER (Han) [16]
NELDER (Doe)	21	56	**2.4**	3.1	**2.5**	**2.3**	**2.1**	**2.1**	**2.1**	**2**	NELDER (Doe) [5]
NEWUOA	16	**28**	**1.8**	3.6	**2.5**	**2.1**	**1.9**	**1.9**	**1.9**	**1.7**	NEWUOA [31]
(1+1)-ES	29	64	**2.9**	100	80	99	130	160	200	270	(1+1)-ES [1]
POEMS	1200	1700	140	130	290	590	1100	1900	1.1e4	*39e-6/1e5*	POEMS [20]
PSO	66	290	25	940	680	790	1100	1400	2400	2800	PSO [7]
PSO_Bounds	69	360	220	1500	1600	1800	4e3	1.1e4	2.2e4	2e4	PSO_Bounds [8]
Monte Carlo	180	1.3e4	4.1e4	*58e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	32	150	5.3	9.8	10	14	14	14	14	14	Rosenbrock [27]
IPOP-SEP-CMA-ES	43	230	9.8	11	9.9	8.8	8.3	8	8	7.7	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	60	250	11	18	14	12	11	11	11	10	VNS (Garcia) [11]

Table 10: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	20.6	34.1	69.9	100	115	121	125	129	166	176	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	29	54	88	320	890	2e3	5300	2e4	*21e-5/1e6*	.	ALPS [17]
AMaLGaM IDEA	**2.7**	**2.6**	**1.9**	**1.9**	**2**	**2.3**	**2.5**	**2.7**	**2.3**	**2.6**	AMaLGaM IDEA [4]
avg NEWUOA	**1.2**	**2.2**	3.1	4.6	6.6	8.1	10	12	11	14	avg NEWUOA [31]
BayEDAcG	400	840	*28e+2/2e3*	.	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.7**	**1.5**	**1**	**1**	**1**	**1**	**1**	**1**	**1.1**	23	BFGS [30]
Cauchy EDA	16	16	11	9	9.4	11	12	13	11	13	Cauchy EDA [24]
BIPOP-CMA-ES	5.1	5.1	3.5	**2.9**	**2.7**	**2.7**	**2.8**	**2.8**	**2.3**	**2.4**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	3.2	3.8	**2.5**	**2.2**	**2**	**2.1**	**2.1**	**2.1**	**1.7**	**1.7**	(1+1)-CMA-ES [2]
DASA	99	1100	6900	1.8e4	3.9e4	5.9e4	1.2e5	1.1e5	9e4	*47e-1/1e6*	DASA [19]
DEPSO	18	78	210	*88e+0/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	8.8	57	110	140	280	*15e-2/2e4*	.	.	.	.	DIRECT [25]
EDA-PSO	71	130	890	1400	3900	1.2e4	*21e-1/1e5*	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**2**	3.6	6.2	8.7	10	13	15	13	17	full NEWUOA [31]
G3-PCX	3.3	7.2	22	27	36	41	49	57	51	64	G3-PCX [26]
simple GA	130	500	2400	*15e+0/1e5*	.	.	.	.	.	.	simple GA [22]
GLOBAL	3.8	**3**	**1.9**	**1.6**	**1.8**	**1.9**	**2**	**2.2**	**1.7**	**1.7**	GLOBAL [23]
iAMaLGaM IDEA	**2.2**	**2.2**	**1.8**	**1.6**	**1.7**	**1.9**	**2**	**2.2**	**1.8**	**2**	iAMaLGaM IDEA [4]
LSfminbnd	160	780	*25e+1/1e4*	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	1200	*25e+2/1e4*	.	.	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	7.1	9.9	9	9.3	8.6	8.6	8.8	8.7	6.9	6.9	MA-LS-Chain [21]
MCS (Neum)	53	110	280	*17e+0/1e4*	.	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1.1**	**1.2**	**1.4**	**1.3**	**1.4**	**1.4**	**1.5**	**1.5**	**1.2**	**1.2**	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.2**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**	**1**	**1**	NELDER (Doe) [5]
NEWUOA	**1.5**	**2.6**	3.1	5.5	8.1	11	14	17	16	21	NEWUOA [31]
(1+1)-ES	34	130	700	2500	4500	5900	1.4e4	5.8e4	*67e-5/1e6*	.	(1+1)-ES [1]
POEMS	41	170	790	2500	*45e-1/1e5*	.	.	.	.	.	POEMS [20]
PSO	15	120	1700	3300	*10e+0/1e5*	.	.	.	.	.	PSO [7]
PSO_Bounds	290	1200	3800	1.5e4	*20e+0/1e5*	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	990	4.7e4	*10e+1/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	11	25	24	44	40	38	37	36	29	37	Rosenbrock [27]
IPOP-SEP-CMA-ES	10	12	7.4	5.6	5.1	5	5	5	4	3.9	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	6.6	6.2	4.5	3.5	3.4	3.4	3.5	3.5	**2.8**	**2.8**	VNS (Garcia) [11]

Table 11: 05-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	2.48	4.88	28.5	40.4	153	195	235	270	293	335	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	15	23	54	340	300	540	810	1100	1800	2.2e4	ALPS [17]
AMaLGaM IDEA	4.5	5.4	**2.1**	**2.7**	**1**	**1**	**1**	**1**	**1**	**1.1**	AMaLGaM IDEA [4]
avg NEWUOA	**2.6**	11	5.4	7.2	**2.7**	**2.6**	**2.8**	**2.9**	3.1	3.4	avg NEWUOA [31]
BayEDAcG	9.1	15	160	*15e+0/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.1**	**1.8**	**1**	**1**	**1.1**	**1.9**	8.2	21	200	*32e-6/8e3*	BFGS [30]
Cauchy EDA	25	51	18	17	6	5.5	5.3	5.4	5.6	5.9	Cauchy EDA [24]
BIPOP-CMA-ES	6.4	15	8.4	7.2	**2.2**	**1.8**	**1.6**	**1.5**	**1.4**	**1.3**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	4	7	6.5	6.6	**2.1**	**1.8**	**1.5**	**1.4**	**1.3**	**1.2**	(1+1)-CMA-ES [2]
DASA	11	12	1900	5200	2300	2800	3200	4200	9700	4.5e4	DASA [19]
DEPSO	11	22	140	*10e+0/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	5.8	15	87	2200	*19e-1/2e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	8.9	30	110	650	970	2400	6200	5500	*70e-3/1e5*	.	EDA-PSO [6]
full NEWUOA	**2.7**	20	11	14	5.4	4.9	5.3	5.5	5.9	6.5	full NEWUOA [31]
G3-PCX	7.6	7.9	55	110	45	44	49	52	56	61	G3-PCX [26]
simple GA	15	34	340	7100	9400	*21e-1/1e5*	.	.	.	.	simple GA [22]
GLOBAL	13	10	4	5.5	3.5	5.1	5	4.8	5	8.5	GLOBAL [23]
iAMaLGaM IDEA	6.1	6.6	3.4	**3.8**	**1.2**	**1.1**	**1**	**1**	**1**	**1**	iAMaLGaM IDEA [4]
LSfminbnd	**2.7**	320	*61e+0/1e4*	.	.	.	.	.	.	.	LSfminbnd [28]
LSstep	3.6	750	4900	*73e+0/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	7.9	8.7	15	19	6.7	5.6	4.9	4.4	4.2	3.8	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	82	460	*13e-1/1e4*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**2.9**	**2.7**	**3.2**	5	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.6**	NELDER (Han) [16]
NELDER (Doe)	4.4	3.4	4.5	4.7	**1.5**	**1.4**	**1.2**	**1.2**	**1.1**	**1.2**	NELDER (Doe) [5]
NEWUOA	**1.7**	5.9	3.5	4.7	**1.8**	**1.7**	**1.8**	**1.8**	**2**	**2.2**	NEWUOA [31]
(1+1)-ES	**2.8**	6700	6400	9300	3700	3800	6700	2.8e4	*90e-5/1e6*	.	(1+1)-ES [1]
POEMS	88	61	230	510	270	350	630	800	940	2200	POEMS [20]
PSO	8.2	13	91	240	120	140	160	190	240	390	PSO [7]
PSO_Bounds	7.2	21	430	1400	1e3	1e3	1100	1600	1500	1400	PSO_Bounds [8]
Monte Carlo	7.4	30	730	1.1e5	*11e-1/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.2**	12	120	88	26	21	18	16	14	13	Rosenbrock [27]
IPOP-SEP-CMA-ES	18	33	16	14	4.2	3.4	**2.9**	**2.6**	**2.5**	**2.2**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	11	34	11	8.7	**2.5**	**2.1**	**1.8**	**1.6**	**1.6**	**1.5**	VNS (Garcia) [11]

Table 12: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}/\mathrm{D}$	13.3	15.9	21.6	53.6	74.1	82.6	92.3	233	261	299	$\mathrm{ERT}_{\mathrm{best}}/\mathrm{D}$
ALPS	100	120	130	170	540	1400	4200	1.4e4	2.7e4	*24e-5/1e6*	ALPS [17]
AMaLGaM IDEA	8.8	9.2	10	6.7	8.6	9.8	11	4.9	5.1	5.2	AMaLGaM IDEA [4]
avg NEWUOA	**1.1**	**1.8**	3.5	**2.8**	**2.8**	**2.9**	**3**	**1.3**	**1.3**	**1.4**	avg NEWUOA [31]
BayEDAcG	46	46	96	260	390	*71e-1/2e3*	.	.	.	.	BayEDAcG [10]
BFGS	**1.1**	**1**	**1.1**	**1**	**1**	**1**	**1**	**1.3**	**2**	49	BFGS [30]
Cauchy EDA	66	75	79	41	35	37	38	17	17	17	Cauchy EDA [24]
BIPOP-CMA-ES	5.1	6.3	11	7.4	7.4	7.5	7.7	3.4	3.3	3.3	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.8**	3.4	4	**2.9**	3.5	3.9	4.1	**1.9**	**1.9**	**1.9**	(1+1)-CMA-ES [2]
DASA	17	17	1.2e4	5.4e4	5.9e4	1.8e5	*32e-1/1e6*	.	.	.	DASA [19]
DEPSO	23	33	55	47	120	*95e-2/2e3*	.	.	.	.	DEPSO [12]
DIRECT	6.6	8	8.5	8.7	19	39	110	96	380	*21e-6/2e4*	DIRECT [25]
EDA-PSO	310	390	1100	3e3	8900	*21e-1/1e5*	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**1.5**	3.7	**2.6**	**2.7**	3	3.3	**1.6**	**1.6**	**1.7**	full NEWUOA [31]
G3-PCX	4	4.2	14	11	13	13	12	5.3	5.2	5.1	G3-PCX [26]
simple GA	520	620	930	2400	1.9e4	*11e-1/1e5*	.	.	.	.	simple GA [22]
GLOBAL	5.6	5	4.6	**2.7**	**2.4**	3	5	**3**	3.1	3.4	GLOBAL [23]
iAMaLGaM IDEA	5.5	6.1	6.9	4.3	4	4.3	4.7	**2.1**	**2.1**	**2.3**	iAMaLGaM IDEA [4]
LSfminbnd	3.4	3.6	310	1200	1900	*68e-1/1e4*	.	.	.	.	LSfminbnd [28]
LSstep	23	26	460	1200	*57e-1/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	11	11	11	13	16	15	16	6.9	6.7	6.5	MA-LS-Chain [21]
MCS (Neum)	**1.2**	**1.1**	**1**	18	17	15	22	22	26	56	MCS (Neum) [18]
NELDER (Han)	**1.4**	**1.7**	**2.3**	**2.2**	**2.2**	**2.2**	**2.3**	**1**	**1**	**1**	NELDER (Han) [16]
NELDER (Doe)	**1.6**	**2.4**	4.4	**2.9**	**2.7**	**2.7**	**2.7**	**1.2**	**1.1**	**1.2**	NELDER (Doe) [5]
NEWUOA	**1.1**	**1.5**	3.5	**2.6**	**2.5**	**2.5**	**2.6**	**1.1**	**1.1**	**1.1**	NEWUOA [31]
(1+1)-ES	**2.6**	1200	2.1e4	6.1e4	1.9e5	*23e-1/1e6*	.	.	.	.	(1+1)-ES [1]
POEMS	180	210	1900	2900	8900	*17e-1/1e5*	.	.	.	.	POEMS [20]
PSO	28	35	750	3800	5400	7900	1.5e4	*41e-1/1e5*	.	.	PSO [7]
PSO_Bounds	120	180	1900	2500	5500	1.7e4	*46e-1/1e5*	.	.	.	PSO_Bounds [8]
Monte Carlo	*19e+3/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1.4**	**1.4**	98	63	91	100	95	46	42	48	Rosenbrock [27]
IPOP-SEP-CMA-ES	4.6	6.2	12	11	9.1	8.7	8.6	3.7	3.5	3.3	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	6.9	9	19	12	10	9.7	9.4	4	3.8	3.6	VNS (Garcia) [11]

Table 13: 05-D, running time excess 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	0.56	8.88	26.4	38.9	50	63.9	262	305	350	451	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**2.7**	43	50	83	280	440	570	2300	3900	*76e-7/1e6*	ALPS [17]
AMaLGaM IDEA	3.3	5.8	4.2	4.6	**4.9**	**4.9**	**1.5**	**1.5**	**1.4**	**1.4**	AMaLGaM IDEA [4]
avg NEWUOA	4	**1**	4.5	8.1	42	67	68	450	390	*15e-4/9e3*	avg NEWUOA [31]
BayEDAcG	**1.9**	38	170	350	*19e+0/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	4.6	**1.2**	**1**	**1**	**1**	**1**	4.8	24	140	*37e-6/1e4*	BFGS [30]
Cauchy EDA	54	31	21	24	25	25	7.4	7.5	7.3	7.3	Cauchy EDA [24]
BIPOP-CMA-ES	3.4	3.8	3.9	5.4	5.9	5.4	**1.6**	**1.6**	**1.5**	**1.7**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**2.6**	**2.1**	4.4	6.3	6.1	6.3	**1.9**	**2.9**	3.2	3.1	(1+1)-CMA-ES [2]
DASA	54	51	200	640	2500	7800	5e3	1.4e4	*23e-4/1e6*	.	DASA [19]
DEPSO	**2.1**	8.7	11	350	280	240	*21e-1/2e3*	.	.	.	DEPSO [12]
DIRECT	**1.6**	4.7	7	21	34	140	42	57	120	*12e-6/2e4*	DIRECT [25]
EDA-PSO	3.4	47	150	390	2e3	1e4	*64e-3/1e5*	.	.	.	EDA-PSO [6]
full NEWUOA	5.5	**1**	**1.8**	6.7	23	85	97	*19e-4/1e4*	.	.	full NEWUOA [31]
G3-PCX	3.3	3.9	14	60	150	340	120	260	590	*15e-5/5e4*	G3-PCX [26]
simple GA	**2.6**	120	240	730	4400	2.2e4	*20e-2/1e5*	.	.	.	simple GA [22]
GLOBAL	3.4	7.4	4.2	6.1	11	*19e-2/300*	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.9**	3.1	**2.6**	**3**	**3.2**	**3.3**	**1**	**1**	**1**	**1**	iAMaLGaM IDEA [4]
LSfminbnd	14	15	33	150	540	1100	*19e-2/1e4*	.	.	.	LSfminbnd [28]
LSstep	250	140	550	1100	2900	*22e+0/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1.8**	9.9	8.3	21	24	19	5.1	4.8	5.3	4.9	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.6**	41	210	460	2300	550	*21e-2/1e4*	.	.	MCS (Neum) [18]
NELDER (Han)	**2.2**	**1.2**	**2**	3.8	5.3	4.9	**1.3**	**1.3**	**1.2**	**1.3**	NELDER (Han) [16]
NELDER (Doe)	**2.9**	**1.7**	**2.4**	**2.4**	5.3	6.1	**1.9**	**2.5**	3.9	5	NELDER (Doe) [5]
NEWUOA	**2.6**	**1.8**	3.1	9.3	35	55	54	120	330	*17e-4/8e3*	NEWUOA [31]
(1+1)-ES	4.3	11	20	30	110	250	160	350	1500	7200	(1+1)-ES [1]
POEMS	310	57	87	660	5600	1e4	*22e-2/1e5*	.	.	.	POEMS [20]
PSO	3	8.7	1600	1e4	2.8e4	*57e-1/1e5*	.	.	.	.	PSO [7]
PSO_Bounds	**1.3**	20	350	2400	5700	1e4	5400	*81e-2/1e5*	.	.	PSO_Bounds [8]
Monte Carlo	**1.9**	960	*30e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	8.6	3.1	7.6	13	26	49	39	56	63	290	Rosenbrock [27]
IPOP-SEP-CMA-ES	3.1	**2.9**	9	11	12	11	**2.8**	**2.7**	**2.5**	**2.3**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1.9**	6.2	4.8	5.6	6.6	6.2	**1.9**	**1.9**	**1.9**	**2.1**	VNS (Garcia) [11]

Table 14: 05-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	0.2	0.2	1.96	8.17	11.6	18	27.7	42.2	50.3	95.1	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.3**	**2.5**	32	66	72	75	130	390	1e4	ALPS [17]
AMaLGaM IDEA	**1**	**1.5**	**2.1**	4.5	6.1	6.6	5.8	5	5.2	3.8	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.7**	**2.1**	**1**	**1**	**1**	**1.2**	**1.8**	5	1e3	avg NEWUOA [31]
BayEDAcG	**1**	**1.4**	**3**	100	220	250	1e3	*12e-2/2e3*	.	.	BayEDAcG [10]
BFGS	**1**	3.4	**2.2**	**1.7**	**1.8**	**1.5**	**1.3**	**1**	**1**	350	BFGS [30]
Cauchy EDA	**1**	18	23	29	40	40	33	28	28	19	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1.3**	**1.1**	**2.8**	3.7	4	4.6	4.3	5.4	4.5	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**2.2**	**1.8**	**1.9**	**2.3**	**2.3**	**2.6**	3.3	4	3.2	(1+1)-CMA-ES [2]
DASA	**1**	18	19	18	20	21	49	460	3500	*12e-7/1e6*	DASA [19]
DEPSO	**1**	**1.5**	**2.6**	6.9	8.9	11	17	45	*47e-6/2e3*	.	DEPSO [12]
DIRECT	**1**	**1**	**1**	3.7	4.8	7.4	23	370	1900	*62e-6/2e4*	DIRECT [25]
EDA-PSO	**1**	**1.5**	**1.4**	7.1	96	190	210	190	300	*22e-7/1e5*	EDA-PSO [6]
full NEWUOA	**1**	**2.8**	**2.7**	**1.1**	**1.1**	**1**	**1**	**1.4**	3.2	26	full NEWUOA [31]
G3-PCX	**1**	**1.1**	**1.7**	3.5	3.5	3.6	5	9.7	26	390	G3-PCX [26]
simple GA	**1**	**1.8**	**2.1**	91	270	310	350	3300	*13e-5/1e5*	.	simple GA [22]
GLOBAL	**1.1**	**1.7**	**2.2**	7.7	5.9	4.4	3.3	**2.6**	3.6	*59e-7/300*	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.3**	**1.4**	**2.7**	4.3	4.5	4.1	3.5	3.6	**2.7**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	3.7	5.9	4.5	4.3	7.4	70	1700	*35e-5/1e4*	.	LSfminbnd [28]
LSstep	**1**	28	120	96	97	180	*35e-4/1e4*	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.3**	**2**	7.2	11	11	11	13	16	12	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.4**	**2.8**	**2.7**	**2.5**	**2.8**	3.4	230	*10e-6/1e4*	MCS (Neum) [18]
NELDER (Han)	**1**	**1.3**	**1.1**	**1.2**	**1.5**	**1.5**	**1.4**	**1.2**	**1.3**	**1**	NELDER (Han) [16]
NELDER (Doe)	**1**	**2.3**	**1.1**	**1.1**	**1.4**	**1.6**	**1.7**	**1.6**	**1.6**	**1.3**	NELDER (Doe) [5]
NEWUOA	**1**	**1.8**	**1.7**	**1**	**1**	**1**	**1.2**	**1.9**	5.5	2500	NEWUOA [31]
(1+1)-ES	**1**	3	**2.1**	**1.8**	**2.1**	**2.2**	5.6	66	1100	*12e-7/1e6*	(1+1)-ES [1]
POEMS	**1**	180	110	42	81	130	140	130	630	*31e-7/1e5*	POEMS [20]
PSO	**1**	**1.4**	**1.9**	5.6	15	21	30	50	220	*90e-8/1e5*	PSO [7]
PSO_Bounds	**1**	**1.7**	**1.9**	12	45	74	140	200	410	*14e-7/1e5*	PSO_Bounds [8]
Monte Carlo	**1**	**1.1**	**1.2**	100	7.6e4	*93e-3/1e6*	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	7.9	**2.4**	**1.2**	**1.3**	**1.5**	4.6	23	26	43	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.5**	**1.6**	3	3.6	3.6	5.3	9	9.5	6.4	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.2**	3.3	5.5	5.4	5.3	5.3	5.4	7	5.5	VNS (Garcia) [11]

Table 15: 05-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	0.2	2.6	102	1860	3870	3950	4010	4080	4150	4270	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1.1**	**1.9**	9.2	9	26	26	26	25	25	25	ALPS [17]
AMaLGaM IDEA	**1.3**	**2.7**	**1.7**	**2.6**	**5.3**	**5.2**	**5.2**	**5.1**	**5.1**	**5**	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	**2**	5.8	46	*30e-1/6e3*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1.2**	**2.7**	4.8	*61e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**2.2**	46	87	*13e+0/3e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	8.7	36	12	190	*24e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.3**	**1.6**	**1.5**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.4**	**2**	10	80	*30e-1/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	15	26	230	1700	*20e-1/1e6*	.	.	.	.	.	DASA [19]
DEPSO	**1**	5.7	7.9	*41e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1.2**	5.4	9.4	*99e-2/2e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1.1**	**2**	20	7.5	24	23	23	24	24	24	EDA-PSO [6]
full NEWUOA	**1.9**	**2.9**	6.3	55	*50e-1/7e3*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1.3**	**2.2**	130	370	*50e-1/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1.1**	**1.9**	35	91	370	360	360	350	350	*15e-1/1e5*	simple GA [22]
GLOBAL	**1**	**2**	6	*90e-1/500*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.1**	**1.8**	**1**	7	9.2	9.1	9	8.9	8.8	8.6	iAMaLGaM IDEA [4]
LSfminbnd	**1**	4	35	*60e-1/1e4*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	**1.1**	80	1400	80	*24e+0/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1.1**	**2.3**	**2.6**	5.3	6	5.9	5.8	5.7	5.6	5.5	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	4	25	38	38	37	36	36	*20e-1/1e4*	MCS (Neum) [18]
NELDER (Han)	**1.7**	**2.5**	20	43	83	81	80	79	77	75	NELDER (Han) [16]
NELDER (Doe)	**1.3**	5	4.5	20	73	72	71	70	69	67	NELDER (Doe) [5]
NEWUOA	**1.9**	7.8	5.8	41	*30e-1/5e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1.3**	**1.7**	28	100	250	240	240	230	230	220	(1+1)-ES [1]
POEMS	**1**	80	15	130	370	370	360	360	350	340	POEMS [20]
PSO	**1.1**	**1.5**	16	220	370	360	350	350	340	330	PSO [7]
PSO_Bounds	**1.3**	**2.3**	170	120	*20e-1/1e5*	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1.2**	**1.7**	6900	*83e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	4.4	190	310	*16e+0/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1.5**	**1.7**	**1.6**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	3.1	**2.4**	5.9	680	690	680	690	680	670	VNS (Garcia) [11]

Table 16: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	0.2	0.24	24.1	122	532	2030	2090	2280	2330	2420	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.7**	**2.5**	8.6	6.3	6.7	13	60	160	830	ALPS [17]
AMaLGaM IDEA	**1**	**1.4**	3	15	12	5	4.9	**5.6**	**5.5**	**5.4**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.2**	**2.6**	12	47	*35e-2/8e3*	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.2**	5.7	*35e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	4.2	150	960	*49e-1/8e3*	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	3.4	5.6	1200	*15e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1.1**	3	**3.6**	**2.6**	**1.1**	**1.3**	**1.3**	**1.4**	**1.4**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	**2.5**	10	17	21	31	62	60	*70e-3/1e4*	(1+1)-CMA-ES [2]
DASA	**1**	6.6	4.8	310	980	1200	*24e-3/1e6*	.	.	.	DASA [19]
DEPSO	**1**	**1.2**	11	*42e-1/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**2**	**1.2**	**1.6**	**3.4**	**2.1**	5.9	10	19	40	DIRECT [25]
EDA-PSO	**1**	**1.4**	4.6	210	82	38	53	49	61	61	EDA-PSO [6]
full NEWUOA	**1**	**2.3**	**2.7**	12	29	32	*12e-2/1e4*	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.2**	**1**	22	44	32	350	320	*60e-4/5e4*	.	G3-PCX [26]
simple GA	**1**	**1.3**	**2.1**	84	93	71	150	630	620	600	simple GA [22]
GLOBAL	**1**	**1.3**	**1.4**	**1**	**1**	**1.3**	**3.5**	7	6.8	6.6	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.4**	**1.9**	8.6	5.5	4.4	5.9	6.5	6.4	6.8	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1.3**	3.2	28	130	71	*37e-2/1e4*	.	.	.	LSfminbnd [28]
LSstep	**1**	**1.1**	14	280	*13e-1/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.1**	**2.7**	8.2	18	11	26	51	50	75	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.8**	**1.9**	18	130	*30e-2/1e4*	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**1.5**	4.4	28	23	25	95	200	300	600	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.3**	**1.6**	4.8	9.8	6.3	13	27	59	120	NELDER (Doe) [5]
NEWUOA	**1**	**1.2**	**2.1**	29	*50e-2/7e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.1**	37	88	340	590	2200	6200	*73e-4/1e6*	.	(1+1)-ES [1]
POEMS	**1**	130	12	74	76	58	57	53	52	54	POEMS [20]
PSO	**1**	**1.2**	**2.4**	6.2	59	55	89	310	300	580	PSO [7]
PSO_Bounds	**1**	**1.2**	**2.4**	36	140	140	320	620	*16e-3/1e5*	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.1**	3.5	510	*30e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1.8**	40	1200	*36e-1/1e4*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.1**	**2.1**	5	3.5	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.2**	**2.8**	12	12	9.1	12	16	34	45	VNS (Garcia) [11]

Table 17: 05-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	0.2	0.2	1.04	43	180	572	734	959	1270	1590	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.1**	**2.4**	12	8	4.8	7.1	10	21	68	ALPS [17]
AMaLGaM IDEA	**1**	**1.1**	3.9	**1.5**	**2.7**	**2.6**	**2.7**	**3.5**	**3.4**	**3.5**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.2**	3.1	42	410	*24e-2/1e4*	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.3**	**2.2**	6.7	5.4	4.1	7.5	15	*47e-4/2e3*	.	BayEDAcG [10]
BFGS	**1**	3.4	120	650	*19e-1/4e3*	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	**1**	44	13	7	3.8	4.3	4.3	5.3	13	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.3**	3.4	**1**	**1**	**1**	**1**	**1**	**1**	**1.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1.1**	4.5	27	110	*17e-2/1e4*	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	25	170	380	730	1800	1.9e4	*82e-4/1e6*	.	.	DASA [19]
DEPSO	**1**	**1**	7.6	3.5	**2.8**	3.1	4.5	5.6	12	*31e-4/2e3*	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1.4**	**1.7**	**2.7**	4.4	6.7	9.5	10	DIRECT [25]
EDA-PSO	**1**	**1.1**	**2.4**	27	28	16	18	18	17	19	EDA-PSO [6]
full NEWUOA	**1**	**1.1**	4.9	25	76	250	*13e-2/1e4*	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.1**	**2.2**	130	290	*60e-3/5e4*	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1.3**	5.4	46	36	52	190	320	550	*13e-4/1e5*	simple GA [22]
GLOBAL	**1**	**1.3**	3.5	5	*47e-2/600*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**2.7**	**1.1**	3.8	**2.9**	4.6	5	6.3	6.8	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1.3**	240	64	180	260	*16e-2/1e4*	.	.	.	LSfminbnd [28]
LSstep	**1**	**1.1**	150	680	*26e-1/1e4*	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.2**	3.8	**2.8**	3.1	4.1	9.3	7.5	7.3	11	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1.9**	24	63	*87e-3/1e4*	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**2**	55	170	290	2500	*54e-3/1e5*	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.1**	**1.9**	10	48	*36e-3/2e4*	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**1.2**	**2.3**	40	620	*32e-2/7e3*	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**2**	1200	7900	3.8e4	*48e-2/1e6*	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	140	170	15	14	21	19	17	29	41	POEMS [20]
PSO	**1**	**1.1**	3.3	170	140	160	550	420	510	420	PSO [7]
PSO_Bounds	**1**	**1.1**	3.4	7.9	52	35	51	49	61	120	PSO_Bounds [8]
Monte Carlo	**1**	**1.3**	4	840	*48e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	2700	*57e-1/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.1**	3.8	3.4	**1.3**	**1**	**1**	**1.1**	**1.1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	6.6	**1.6**	4.8	4.8	7.9	9.8	18	82	VNS (Garcia) [11]

Table 18: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_{18}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

18 Schaffer F7, condition 1000

Δftarget	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	0.2	0.24	20.7	75.5	794	1690	1860	2080	2180	2490	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.5**	8.1	14	3.3	14	49	240	420	*53e-7/1e6*	ALPS [17]
AMaLGaM IDEA	**1.1**	**2.1**	**1.6**	**1.7**	**2**	**1.5**	**2.4**	3.1	3.4	**3.1**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	5.4	10	270	*57e-2/3e4*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**2.6**	4.4	9.6	11	8.7	*14e-2/2e3*	.	.	.	BayEDAcG [10]
BFGS	**1.8**	100	57	*51e-1/4e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**2.5**	83	13	12	**2.4**	**2.1**	**2.7**	**2.8**	3.7	8.6	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**2.8**	**1**	3.4	**1**	**1**	**1**	**1.1**	**1.2**	**1.3**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**2.9**	4.9	57	84	*37e-2/1e4*	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1.9**	47	270	930	1600	*64e-3/1e6*	.	.	.	.	DASA [19]
DEPSO	**1.1**	**2.4**	**2.6**	5.5	**2.2**	4.1	*57e-3/2e3*	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1.4**	**2.9**	**1.9**	6.2	6.5	8.1	*44e-6/2e4*	.	DIRECT [25]
EDA-PSO	**1**	**1.3**	3.6	41	8.8	6.4	17	34	41	58	EDA-PSO [6]
full NEWUOA	**1**	8.6	10	84	90	88	*78e-2/1e4*	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.7**	130	800	*12e-1/5e4*	.	.	.	.	.	G3-PCX [26]
simple GA	**1.1**	**2.3**	22	59	34	130	*15e-3/1e5*	.	.	.	simple GA [22]
GLOBAL	**1.1**	**2.4**	3.9	15	14	*12e-1/500*	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1.2**	**2**	**1.1**	**1**	**1.4**	**1.6**	**1.9**	**2.3**	**3.1**	4.8	iAMaLGaM IDEA [4]
LSfminbnd	**1**	3.2	64	71	*31e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	**1.1**	160	150	400	86	*60e-1/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.8**	**2.5**	4.9	**1.3**	23	88	84	160	140	MA-LS-Chain [21]
MCS (Neum)	**1**	**1.5**	19	150	*75e-2/1e4*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1.1**	**2.9**	45	230	320	*17e-2/1e5*	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**2.2**	4.3	28	43	*15e-2/2e4*	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1.2**	5.7	31	1400	*11e-1/2e4*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.9**	3100	3.1e4	*22e-1/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	41	560	18	24	14	71	150	200	300	570	POEMS [20]
PSO	**1**	**2.6**	**2.2**	6.6	110	250	*53e-3/1e5*	.	.	.	PSO [7]
PSO_Bounds	**1.1**	**2.5**	3.8	21	69	72	120	330	*10e-3/1e5*	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.2**	18	9.4e4	*15e-1/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1.1**	2600	3400	*16e+0/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	3	**1.3**	5	**1.6**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1.5**	**2.2**	4.9	3.6	8.6	26	46	300	1200	VNS (Garcia) [11]

Table 19: 05-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	0.2	0.2	0.2	0.2	48.4	21000	24100	24200	24200	24400	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.1**	58	5100	500	15	39	40	40	40	ALPS [17]
AMaLGaM IDEA	**1**	**1.3**	38	1100	360	4.5	4.2	**4.2**	**4.2**	**4.2**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	24	1.6e4	1e3	*55e-3/1e5*	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1.1**	37	2100	*45e-2/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**2.2**	1700	2.2e4	1800	*62e-2/6e3*	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	9.4	300	2.1e4	*48e-2/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	20	2800	160	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	20	4100	970	*19e-2/1e4*	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	4.8	290	6.7e4	4.7e4	*13e-2/1e6*	.	.	.	.	DASA [19]
DEPSO	**1**	**1**	93	3100	*71e-2/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1**	**1.1**	**4.2**	**3.7**	*16e-3/2e4*	.	.	DIRECT [25]
EDA-PSO	**1**	**1.2**	37	6700	1600	71	*66e-3/1e5*	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**2.7**	31	1.1e4	860	6.9	*19e-2/1e4*	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1.1**	39	9.5e4	1.4e4	*50e-2/5e4*	.	.	.	.	G3-PCX [26]
simple GA	**1**	**1.1**	35	1.2e4	700	68	60	*59e-3/1e5*	.	.	simple GA [22]
GLOBAL	**1**	**1.3**	46	7300	*10e-1/900*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1.1**	28	1100	370	10	12	12	12	12	iAMaLGaM IDEA [4]
LSfminbnd	**1**	5.9	54	3e3	*38e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	**1**	29	910	9500	1500	*23e-2/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1.2**	32	1300	250	8.4	*47e-3/2e4*	.	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	*16e-3/1e4*	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**1.3**	12	2900	590	*59e-3/1e5*	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	**1.2**	**12**	**340**	**110**	14	*47e-3/2e4*	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	**1.9**	14	2.7e4	1400	*79e-3/1e5*	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1.3**	100	4.1e5	2.9e5	*49e-2/1e6*	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	200	1e3	7200	1.4e4	*18e-2/1e5*	.	.	.	.	POEMS [20]
PSO	**1**	**1.1**	35	3400	2400	67	60	60	61	61	PSO [7]
PSO_Bounds	**1**	**1.4**	27	1.6e4	2500	70	*80e-3/1e5*	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1.3**	38	1.4e5	*36e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	3.2	1.3e4	7.1e5	*38e-1/1e4*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1.1**	22	1900	160	**2.2**	**3**	**3**	**3**	**3**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	55	7600	1300	20	75	81	130	260	VNS (Garcia) [11]

Table 20: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	2.71	2.96	3.2	170	7620	10300	10900	10900	11000	11100	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	5.3	15	18	7	**1.3**	**1**	**1**	**1.1**	**1.1**	**1.3**	ALPS [17]
AMaLGaM IDEA	3.2	3.8	3.9	29	24	18	17	17	17	17	AMaLGaM IDEA [4]
avg NEWUOA	**1.2**	**1.1**	**1**	8.4	12	8.6	8.2	8.1	8.1	8	avg NEWUOA [31]
BayEDAcG	**2.5**	4	8	*20e-1/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1.1**	**1.5**	**1.8**	**2.5**	10	7.6	7.2	7.2	7.1	7.1	BFGS [30]
Cauchy EDA	44	49	48	460	*11e-1/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**2.2**	**2.9**	3.3	8.2	**2.8**	**2.2**	**2.1**	**2.2**	**2.2**	**2.2**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1.5**	**2.1**	**2.4**	6.4	5.9	4.4	4.1	4.1	4.1	4.1	(1+1)-CMA-ES [2]
DASA	24	29	32	13	47	35	33	33	33	33	DASA [19]
DEPSO	3.6	7.7	8.6	3.2	*24e-2/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	4.5	4.1	3.8	**1.5**	*47e-2/2e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	3.3	4.9	5.7	13	**2.5**	**2**	**2**	**2.1**	**2.3**	**2.5**	EDA-PSO [6]
full NEWUOA	**1.6**	**1.5**	**1.4**	6.4	*47e-2/6e3*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	3.2	7.7	7.4	36	88	66	62	62	61	61	G3-PCX [26]
simple GA	5.5	22	47	21	**1**	**1**	**1.3**	**2.2**	**2.6**	5	simple GA [22]
GLOBAL	4.8	12	17	18	*13e-1/500*	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**2.1**	3	3.2	30	25	19	18	18	18	18	iAMaLGaM IDEA [4]
LSfminbnd	5.8	7	8.2	18	*65e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	110	190	230	41	18	14	13	13	13	13	LSstep [28]
MA-LS-Chain	**2.9**	5.6	5.8	4.1	**1.4**	**1.1**	**1**	**1**	**1**	**1**	MA-LS-Chain [21]
MCS (Neum)	**2.5**	**2.8**	**2.7**	**1**	9.1	6.8	6.4	6.4	6.4	6.3	MCS (Neum) [18]
NELDER (Han)	**1.1**	**1.5**	**1.5**	25	*24e-2/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1.8**	**2.1**	**2.2**	8.5	37	28	26	26	26	26	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**1**	3.3	*43e-2/6e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	3.4	3.9	4	16	43	32	30	30	30	30	(1+1)-ES [1]
POEMS	83	80	78	8.5	14	10	9.9	9.9	10	10	POEMS [20]
PSO	**2.5**	6	8.7	3.1	27	20	19	19	19	18	PSO [7]
PSO_Bounds	3.1	7	8.1	8.6	21	16	15	15	15	16	PSO_Bounds [8]
Monte Carlo	6.7	20	29	9200	*99e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**2.6**	**2.8**	**2.9**	4.6	*47e-2/1e4*	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**2.1**	3	3.3	6.6	**2.3**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	3.7	11	10	7.8	4.3	3.9	4.3	4.5	4.6	5.7	VNS (Garcia) [11]

Table 21: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	0.2	0.2	8.2	231	335	338	341	344	346	351	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	3.4	**2.2**	**2.9**	3.9	4.7	5.6	6.4	8.1	ALPS [17]
AMaLGaM IDEA	**1**	**1**	3	37	34	35	36	38	38	38	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	**1.7**	**2.5**	3.6	3.5	3.5	3.5	3.5	3.5	avg NEWUOA [31]
BayEDAcG	**1**	**1**	4.1	8.6	40	85	84	84	83	82	BayEDAcG [10]
BFGS	**1**	**1**	3.8	**1.4**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**2**	BFGS [30]
Cauchy EDA	**1**	**1**	20	27	190	430	420	420	420	410	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	**2.3**	14	24	25	25	25	25	25	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	4.2	4.6	6.6	6.6	6.5	6.5	6.5	6.4	(1+1)-CMA-ES [2]
DASA	**1**	**1**	10	210	320	320	320	310	310	310	DASA [19]
DEPSO	**1**	**1**	4.2	5.5	4.2	4.7	5	5.3	6.2	6.7	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1**	**1.1**	**1.8**	**2.1**	**2.9**	19	19	DIRECT [25]
EDA-PSO	**1**	**1**	4	160	110	110	120	120	120	120	EDA-PSO [6]
full NEWUOA	**1**	**1**	**2.4**	**2.3**	**2.8**	**2.8**	**2.8**	**2.7**	**2.7**	**2.7**	full NEWUOA [31]
G3-PCX	**1**	**1**	**2.1**	4.7	6.8	6.7	6.7	6.7	6.7	6.6	G3-PCX [26]
simple GA	**1**	**1**	4.6	5.5	61	68	70	77	140	290	simple GA [22]
GLOBAL	**1**	**1**	**2.3**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**2.2**	27	22	22	22	22	22	22	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	30	38	39	45	44	44	44	44	LSfminbnd [28]
LSstep	**1**	**1**	560	120	120	120	130	130	130	130	LSstep [28]
MA-LS-Chain	**1**	**1**	3.6	22	16	16	16	16	16	16	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	3.9	5.1	5.1	5	5	5	5	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	12	8.4	10	10	10	10	9.9	9.8	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**2.9**	**1.5**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**1.1**	**2.2**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.9**	NEWUOA [31]
(1+1)-ES	**1**	**1**	45	19	18	18	18	18	18	18	(1+1)-ES [1]
POEMS	**1**	**1**	34	330	290	290	290	290	290	290	POEMS [20]
PSO	**1**	**1**	**2**	380	260	260	260	260	260	250	PSO [7]
PSO_Bounds	**1**	**1**	3.5	380	340	340	340	340	340	340	PSO_Bounds [8]
Monte Carlo	**1**	**1**	3.2	8.5	270	1.4e4	*14e-3/1e6*	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	9.7	7.9	15	15	15	15	15	15	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	3.6	14	9.9	10	10	10	10	10	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**2.4**	7.5	6.5	6.6	6.9	7.8	8.3	9.1	VNS (Garcia) [11]

Table 22: 05-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ 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	0.2	0.2	14.2	77.3	188	196	202	205	208	214	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	6.6	9.3	8.8	13	17	21	24	34	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**3**	19	59	69	69	69	68	67	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	3.4	**2.6**	**2.3**	**2.3**	**2.3**	**2.3**	**2.4**	**2.4**	avg NEWUOA [31]
BayEDAcG	**1**	**1**	13	75	*22e-1/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	3.1	**2.9**	**2.1**	**2.1**	**2**	**2**	**2**	**2.6**	BFGS [30]
Cauchy EDA	**1**	**1**	11	280	780	1700	3500	3400	3400	3300	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	6.9	20	45	43	42	42	41	40	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	**2.8**	7.1	4.7	4.6	4.5	4.5	4.4	4.4	(1+1)-CMA-ES [2]
DASA	**1**	**1**	96	270	130	130	130	140	140	150	DASA [19]
DEPSO	**1**	**1**	6.5	6.3	7.5	10	11	14	16	32	DEPSO [12]
DIRECT	**1**	**1**	**1**	**1**	12	19	22	62	130	400	DIRECT [25]
EDA-PSO	**1**	**1**	6.7	12	89	90	92	95	98	100	EDA-PSO [6]
full NEWUOA	**1**	**1**	4.3	3.7	3	**2.9**	**2.9**	**3**	**3**	3.1	full NEWUOA [31]
G3-PCX	**1**	**1**	12	15	13	12	12	12	12	12	G3-PCX [26]
simple GA	**1**	**1**	6	18	390	650	1500	6900	6800	*24e-3/1e5*	simple GA [22]
GLOBAL	**1**	**1**	3.6	**1.3**	**1**	**1**	**1**	**1**	**1**	**1**	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**1.8**	22	40	41	41	41	41	40	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	13	47	29	60	62	120	120	220	LSfminbnd [28]
LSstep	**1**	**1**	190	180	380	*11e-1/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1**	3.3	15	22	22	22	22	22	22	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	**1**	**1.1**	12	11	11	11	11	15	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	19	13	13	13	13	12	12	12	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**2.5**	**2.5**	**2.1**	**2**	**2**	**2**	**2**	**2.1**	NELDER (Doe) [5]
NEWUOA	**1**	**1**	**2.1**	**2.1**	**2**	**2**	**2.1**	**2.2**	**2.3**	**2.4**	NEWUOA [31]
(1+1)-ES	**1**	**1**	21	37	30	29	29	29	29	30	(1+1)-ES [1]
POEMS	**1**	**1**	470	1100	1300	1200	1200	1200	1200	1200	POEMS [20]
PSO	**1**	**1**	**2.6**	330	470	450	440	430	430	420	PSO [7]
PSO_Bounds	**1**	**1**	510	870	820	820	810	820	820	820	PSO_Bounds [8]
Monte Carlo	**1**	**1**	7.6	73	390	7500	7.1e4	7e4	*93e-4/1e6*	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	19	13	10	10	10	10	10	11	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	7.5	23	60	58	57	57	56	55	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	5.8	16	18	18	18	18	19	20	VNS (Garcia) [11]

Table 23: 05-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

23 Katsuuras

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	0.2	0.2	0.6	104	2850	5580	6330	6480	6610	6850	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1**	**2.2**	21	29	100	3100	*54e-4/1e6*	.	.	ALPS [17]
AMaLGaM IDEA	**1**	**1**	**1.7**	7	**1.8**	**1**	**1**	**1**	**1**	**1**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	6	**2.5**	14	*15e-2/9e3*	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	**1**	**1.8**	62	*12e-1/2e3*	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	**1**	11	31	*69e-2/5e3*	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1**	**1**	**2.2**	230	*68e-2/5e4*	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	**1**	**1.7**	13	3.7	**2.1**	**1.8**	**1.8**	**1.8**	**1.8**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	**1**	4.2	3.3	7.5	26	*11e-2/1e4*	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	9	20	360	*88e-3/1e6*	.	.	.	.	DASA [19]
DEPSO	**1**	**1**	**2**	66	*15e-1/2e3*	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	**1.5**	3.5	5.7	3.7	6	*93e-4/2e4*	.	.	DIRECT [25]
EDA-PSO	**1**	**1**	**2.4**	28	*59e-2/1e5*	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	**1**	5.4	**2**	3.8	*87e-3/1e4*	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	**1**	**2.6**	**2.4**	8.6	60	*44e-3/5e4*	.	.	.	G3-PCX [26]
simple GA	**1**	**1**	**1.5**	59	*49e-2/1e5*	.	.	.	.	.	simple GA [22]
GLOBAL	**1**	**1**	**1.6**	**1**	4.8	*23e-2/1e3*	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	**1**	**2.6**	7.8	**2.1**	**1.3**	**1.2**	**1.2**	**1.1**	**1.1**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	**1**	**1.8**	11	*45e-2/1e4*	.	.	.	.	.	LSfminbnd [28]
LSstep	**1**	**1**	**1.4**	6.6	51	*31e-2/1e4*	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	**1**	**2.6**	**2.5**	**1.7**	4	3.6	3.5	3.4	3.3	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	3.4	**2.4**	51	*16e-2/1e4*	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	**1**	**2.9**	3.5	**2.7**	3.2	4	4.6	4.6	5.6	NELDER (Han) [16]
NELDER (Doe)	**1**	**1**	**1.5**	**1**	**1**	3.6	15	46	*38e-4/2e4*	.	NELDER (Doe) [5]
NEWUOA	**1**	**1**	6.2	**2.4**	7.1	*20e-2/7e3*	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	**1**	3.1	4.8	52	590	*14e-3/1e6*	.	.	.	(1+1)-ES [1]
POEMS	**1**	**1**	13	23	26	22	25	33	33	32	POEMS [20]
PSO	**1**	**1**	**2.2**	20	240	*15e-2/1e5*	.	.	.	.	PSO [7]
PSO_Bounds	**1**	**1**	**2.1**	58	240	*30e-2/1e5*	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	**1**	**2.3**	49	*38e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	**1**	**1.6**	**1.8**	4.6	13	*17e-2/5e3*	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	**1**	3.1	9.7	3.7	**1.9**	**1.7**	**1.7**	**1.7**	**1.6**	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**1**	**1**	9.6	15	26	23	26	25	24	VNS (Garcia) [11]

Table 24: 05-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

24 Lunacek bi-Rastrigin

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	0.2	0.2	324	43300	1.27e6	1.92e6	1.92e6	1.92e6	2.57e6	2.57e6	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	5	8.1	9.6	*75e-2/1e6*	.	.	.	.	.	ALPS [17]
AMaLGaM IDEA	**1**	5.3	3.3	**2.4**	**2.1**	**3.8**	**3.7**	**3.7**	**5.6**	**5.6**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	14	**2**	**2.2**	*30e-1/7e3*	.	.	.	.	.	avg NEWUOA [31]
BayEDAcG	**1**	5.4	15	*11e+0/2e3*	.	.	.	.	.	.	BayEDAcG [10]
BFGS	**1**	160	69	*17e+0/3e3*	.	.	.	.	.	.	BFGS [30]
Cauchy EDA	**1.1**	75	30	*81e-1/5e4*	.	.	.	.	.	.	Cauchy EDA [24]
BIPOP-CMA-ES	**1**	7.8	**2.1**	**1.6**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [15]
(1+1)-CMA-ES	**1**	76	6.7	**1.7**	*39e-1/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	79	250	*32e-1/1e6*	.	.	.	.	.	.	DASA [19]
DEPSO	**1**	5	29	*14e+0/2e3*	.	.	.	.	.	.	DEPSO [12]
DIRECT	**1**	**1**	7.5	**1.9**	*72e-1/2e4*	.	.	.	.	.	DIRECT [25]
EDA-PSO	**1**	3.6	9.7	*61e-1/1e5*	.	.	.	.	.	.	EDA-PSO [6]
full NEWUOA	**1**	21	**2.5**	**1.1**	*31e-1/7e3*	.	.	.	.	.	full NEWUOA [31]
G3-PCX	**1**	4.9	44	*61e-1/5e4*	.	.	.	.	.	.	G3-PCX [26]
simple GA	**1**	7.3	21	*54e-1/1e5*	.	.	.	.	.	.	simple GA [22]
GLOBAL	**1**	6.3	4.2	*91e-1/1e3*	.	.	.	.	.	.	GLOBAL [23]
iAMaLGaM IDEA	**1**	6.3	3.1	**2.2**	**2.2**	**7.5**	**7.5**	**7.5**	**5.6**	**5.6**	iAMaLGaM IDEA [4]
LSfminbnd	**1**	30	9.1	*63e-1/1e4*	.	.	.	.	.	.	LSfminbnd [28]
LSstep	3	360	200	*15e+0/1e4*	.	.	.	.	.	.	LSstep [28]
MA-LS-Chain	**1**	3.8	**2.1**	*52e-1/2e4*	.	.	.	.	.	.	MA-LS-Chain [21]
MCS (Neum)	**1**	**1**	7	3.5	*37e-1/1e4*	.	.	.	.	.	MCS (Neum) [18]
NELDER (Han)	**1**	10	11	5.6	*12e-1/1e5*	.	.	.	.	.	NELDER (Han) [16]
NELDER (Doe)	**1**	4.3	**1**	**1.4**	*15e-1/2e4*	.	.	.	.	.	NELDER (Doe) [5]
NEWUOA	**1**	12	**2.9**	**2.1**	*26e-1/6e3*	.	.	.	.	.	NEWUOA [31]
(1+1)-ES	**1**	14	31	68	*14e-1/1e6*	.	.	.	.	.	(1+1)-ES [1]
POEMS	**1**	620	47	*70e-1/1e5*	.	.	.	.	.	.	POEMS [20]
PSO	**1**	6.5	5.7	*63e-1/1e5*	.	.	.	.	.	.	PSO [7]
PSO_Bounds	**1**	5.2	10	33	*60e-1/1e5*	.	.	.	.	.	PSO_Bounds [8]
Monte Carlo	**1**	4.1	2900	*96e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
Rosenbrock	**1**	200	210	*19e+0/1e4*	.	.	.	.	.	.	Rosenbrock [27]
IPOP-SEP-CMA-ES	**1**	7.5	**1.8**	**1**	*53e-1/1e4*	.	.	.	.	.	IPOP-SEP-CMA-ES [29]
VNS (Garcia)	**1**	**3.4**	3.3	49	13	16	46	200	*69e-4/3e7*	.	VNS (Garcia) [11]

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