Comparison tables: BBOB 2009 noisy testbed in 20-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 [13, 8]. The experimental set-up is described in [12].

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

Table 1: 20-D, running time excess ERT/ERT_{best} on f_{101}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

101 Sphere moderate Gauss

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	0.05	0.28	2.96	18	24.4	29.7	32.8	35.8	37	39.1	ERT_{best}/D
ALPS	**1**	91	100	38	44	51	60	68	79	100	ALPS [15]
AMaLGaM IDEA	**1**	59	57	18	20	21	22	24	26	31	AMaLGaM IDEA [4]
avg NEWUOA	**1**	19	**3.3**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1.1**	avg NEWUOA [23]
BayEDAcG	**1**	93	110	31	32	34	51	53	58	760	BayEDAcG [9]
BFGS	**1**	2.1e4	*11e+1/3e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	14	6.1	**1.8**	**1.9**	**2**	**2.2**	**2.4**	**2.7**	3.3	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	15	4.4	**1.2**	**1.2**	**1.3**	**1.4**	**1.5**	**1.7**	**2.1**	(1+1)-CMA-ES [2]
DASA	**1**	63	22	6	6.3	6.9	8.3	9.8	12	16	DASA [18]
DEPSO	**1**	32	23	10	16	23	35	50	110	*27e-6/2e3*	DEPSO [11]
EDA-PSO	**1**	19	260	120	140	160	180	210	240	290	EDA-PSO [5]
full NEWUOA	**1**	43	5.8	**1.7**	**1.4**	**1.1**	**1.1**	**1**	**1**	**1**	full NEWUOA [23]
GLOBAL	**1**	34	9.1	3.5	5.3	7.1	7.8	8.9	19	250	GLOBAL [20]
iAMaLGaM IDEA	**1**	22	23	7.4	8.1	8.7	10	11	12	15	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	20	17	6.2	7	7.4	8.4	8.9	9.5	11	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	**1**	330	*11e-1/4e3*	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**8.9**	**3.1**	**1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.5**	**1.6**	NEWUOA [23]
(1+1)-ES	**1**	16	4.9	**1.2**	**1.2**	**1.2**	**1.3**	**1.4**	**1.5**	**1.9**	(1+1)-ES [1]
PSO	**1**	15	16	8.6	11	13	16	19	22	28	PSO [6]
PSO_Bounds	**1**	15	91	200	220	230	240	260	300	880	PSO_Bounds [7]
Monte Carlo	**1**	120	*29e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**12**	5.5	**1.6**	**1.6**	**1.7**	**1.9**	**2.1**	**2.4**	**2.9**	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	21	52	43	32	28	110	100	*37e-1/300*	.	SNOBFIT [17]
VNS (Garcia)	**1**	35	8.5	**2.2**	**2.2**	**2.3**	**2.5**	**2.6**	**2.9**	3.5	VNS (Garcia) [10]

Table 2: 20-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best}}$ on f_{102}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

102 Sphere moderate unif

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	0.05	0.29	10.6	19.9	26.8	34.2	40.4	48.9	57.9	70.3	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	61	29	34	41	44	50	52	53	59	ALPS [15]
AMaLGaM IDEA	**1**	46	18	19	21	21	21	20	19	19	AMaLGaM IDEA [4]
avg NEWUOA	**1**	19	**1**	**1.1**	**1**	**1**	**1**	**1**	**1.1**	**1.3**	avg NEWUOA [23]
BayEDAcG	**1**	52	30	27	29	33	34	36	37	430	BayEDAcG [9]
BFGS	**1**	6.4e4	*12e+1/3e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	13	**1.7**	**1.6**	**1.7**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**12**	**1.1**	**1**	**1.1**	**1.1**	**1.2**	**1.1**	**1.1**	**1.6**	(1+1)-CMA-ES [2]
DASA	**1**	72	8.2	7.4	8.5	8.9	11	12	17	34	DASA [18]
DEPSO	**1**	35	6.9	8.8	14	21	37	53	170	*46e-6/2e3*	DEPSO [11]
EDA-PSO	**1**	20	74	460	390	350	330	300	280	270	EDA-PSO [5]
full NEWUOA	**1**	42	**1.7**	**1.7**	**1.4**	**1.2**	**1.1**	**1**	**1**	**1**	full NEWUOA [23]
GLOBAL	**1**	42	3.1	5.4	14	56	*24e-3/600*	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	18	6.1	6.4	7.2	7.5	8	7.9	7.8	8.2	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	19	5.6	6.3	7.5	7.5	7.3	7	6.5	6.4	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	9	800	*25e-1/4e3*	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**9.7**	3.1	6.1	6.8	24	52	510	*31e-5/5e3*	.	NEWUOA [23]
(1+1)-ES	**1**	34	**2.9**	4	6	15	23	67	290	6700	(1+1)-ES [1]
PSO	**1**	19	4.9	370	280	220	190	160	140	120	PSO [6]
PSO_Bounds	**1**	15	21	270	680	570	510	440	390	640	PSO_Bounds [7]
Monte Carlo	**1**	110	*27e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	13	**1.7**	**1.5**	**1.5**	**1.6**	**1.6**	**1.6**	**1.5**	**1.6**	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	35	79	*18e+0/300*	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	36	**2.5**	**2**	**2**	**2**	**2**	**1.9**	**1.9**	**2**	VNS (Garcia) [10]

Table 3: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{103}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

103 Sphere moderate Cauchy

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.28	1e+01 3.27	1e+00 19.8	1e-01 31.4	1e-02 52.1	1e-03 65.7	1e-04 80.2	1e-05 94.7	1e-07 123	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	90	93	36	36	3600	*81e-4/2e5*	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	61	62	18	15	11	19	51	81	110	AMaLGaM IDEA [4]
avg NEWUOA	**1**	19	**3**	**1**	**2**	20	660	*14e-4/1e4*	.	.	avg NEWUOA [23]
BayEDAcG	**1**	73	100	28	29	25	26	25	23	*95e-8/2e3*	BayEDAcG [9]
BFGS	**1**	510	46	8.8	5.9	3.5	**2.8**	**2.3**	**1.9**	**1.5**	BFGS [22]
BIPOP-CMA-ES	**1**	15	5.5	**1.7**	**1.5**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	15	3.7	**1.1**	**2.5**	12	690	*16e-4/1e4*	.	.	(1+1)-CMA-ES [2]
DASA	**1**	64	17	6.6	87	5800	*75e-4/4e5*	.	.	.	DASA [18]
DEPSO	**1**	42	20	9.5	38	*34e-3/2e3*	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	29	250	110	110	*28e-3/1e5*	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	44	5.2	**1.6**	**1.1**	**1.2**	7.8	29	97	550	full NEWUOA [23]
GLOBAL	**1**	120	17	4.1	4	**2.4**	**2**	**1.6**	**1.4**	**1.1**	GLOBAL [20]
iAMaLGaM IDEA	**1**	20	20	6.3	7.6	9.7	21	34	160	420	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	19	14	5.4	5.7	4.7	6	9.3	35	480	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	**1**	31	26	15	35	83	91	450	MCS (Neum) [16]
NEWUOA	**1**	**9.5**	**2.3**	**1.1**	5.9	44	1200	*48e-4/5e3*	.	.	NEWUOA [23]
(1+1)-ES	**1**	15	3.4	**1.2**	**1.7**	21	4300	*42e-5/1e6*	.	.	(1+1)-ES [1]
PSO	**1**	**14**	14	460	1700	*66e-3/1e5*	.	.	.	.	PSO [6]
PSO_Bounds	**1**	17	88	2700	*51e-2/1e5*	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	160	*28e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	15	5	**1.4**	**1.3**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	25	8.9	**1.5**	**1**	**1**	**1.7**	**2.6**	3.5	8.6	SNOBFIT [17]
VNS (Garcia)	**1**	37	7.7	**1.9**	**1.6**	**1.2**	**1.3**	**1.2**	**1.3**	**1.3**	VNS (Garcia) [10]

Table 4: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{104}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

104 Rosenbrock moderate Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}$/D	5.1	48.2	1180	4280	8570	8900	9120	9290	9470	9810	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	72	21	60	19	12	17	24	72	120	*31e-5/2e5*	ALPS [15]
AMaLGaM IDEA	30	7	**4.7**	**1.9**	**1**	**1**	**1**	**1**	**1**	**1**	AMaLGaM IDEA [4]
avg NEWUOA	**1.8**	**1.4**	11	*98e-1/1e4*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	57	16	*26e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*13e+4/1e3*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	4.6	**1.2**	10	**3.2**	**1.7**	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**2.9**	**2.1**	28	*12e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	18	11	**2.8**	3.6	4.3	22	44	160	*24e-5/6e5*	.	DASA [18]
DEPSO	17	8.2	*19e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	230	47	*16e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	3.2	**1.2**	20	*13e+0/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	5.3	**2.2**	**1**	**1**	**1.7**	**1.7**	*82e-1/900*	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	15	**3**	32	9.6	4.9	4.8	**4.7**	**4.6**	**4.6**	**4.5**	iAMaLGaM IDEA [4]
MA-LS-Chain	14	3.9	590	*14e+0/1e5*	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	79	*20e+1/4e3*	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1.5**	68	*17e+0/6e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**2.9**	**1**	45	440	770	*12e-1/1e6*	.	.	.	.	(1+1)-ES [1]
PSO	1400	330	340	*17e+0/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	94	670	1200	330	*72e+0/1e5*	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*91e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	4.1	21	*17e+0/1e4*	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	*63e+2/300*	.	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	5.6	**1**	*15e+0/7e5*	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 5: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{105}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

105 Rosenbrock moderate unif

Δftarget ERT$_{\text{best}}$/D	1e+03 10.2	1e+02 59	1e+01 9590	1e+00 30500	1e-01 31600	1e-02 32100	1e-03 32500	1e-04 32800	1e-05 33000	1e-07 33500	Δftarget ERT$_{\text{best}}$/D
ALPS	39	18	8.3	**4**	**5.5**	**9.7**	**21**	**110**	*60e-4/2e5*	.	ALPS [15]
AMaLGaM IDEA	15	5.1	120	46	**45**	**57**	**57**	**56**	**56**	**56**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1.6**	7.2	*12e+0/1e4*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	30	16	*33e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*15e+4/1e3*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**2.3**	**1.5**	**2.7**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1.5**	**1.7**	15	*17e+0/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	11	14	**1.4**	**4.6**	51	*26e-2/5e5*	.	.	.	.	DASA [18]
DEPSO	8.7	6.9	*20e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	120	40	*17e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1.5**	**1**	7.2	*14e+0/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**2.7**	**2.5**	**1**	*27e+0/700*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	7.3	**2.3**	1500	*13e+0/1e6*	.	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	7.4	4.4	150	49	*15e+0/1e5*	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	77	*19e+1/4e3*	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1.5**	7.2	*24e+0/5e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**2.1**	4.3	340	*13e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	7.6	7.1	68	*18e+0/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	44	960	*78e+0/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*88e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1.8**	6	*18e+0/1e4*	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	370	*32e+2/300*	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**2.9**	33	*16e+0/7e5*	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 6: 20-D, running time excess ERT/ERT_{best} on f_{106}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

106 Rosenbrock moderate Cauchy

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	5.97	24.8	574	1080	1190	1240	1270	1300	1320	1370	ERT_{best}/D
ALPS	62	41	76	130	940	*12e-2/2e5*	.	.	.	.	ALPS [15]
AMaLGaM IDEA	25	12	640	1300	1200	1200	1500	1500	1500	1400	AMaLGaM IDEA [4]
avg NEWUOA	**1.6**	**1.6**	8.1	*74e-1/1e4*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	52	42	*51e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	810	*91e+1/4e3*	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	4.2	**2.6**	**1**	**1.3**	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**2.4**	**1.7**	15	*62e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	13	7.8	**2.8**	12	320	*76e-3/9e5*	.	.	.	.	DASA [18]
DEPSO	14	13	*25e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	200	95	*16e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**2.5**	**1.7**	3.3	12	28	*97e-2/1e4*	.	.	.	.	full NEWUOA [23]
GLOBAL	5.3	4.6	**1.9**	5.4	*22e-1/1e3*	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	12	5.5	130	6100	1.2e4	*47e-1/1e6*	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	11	8	8.2	18	29	160	1100	*15e-3/1e5*	.	.	MA-LS-Chain [19]
MCS (Neum)	190	*20e+1/4e3*	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	7	31	*49e-1/8e3*	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**2.3**	**1.2**	8	210	*42e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
PSO	14	630	2400	*17e+0/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	110	140	2500	*18e+0/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*98e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	3.3	**1.6**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	150	*22e+2/300*	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	5	**2.4**	**1**	**3.1**	**3**	**2.9**	**2.8**	**2.8**	**2.8**	**2.7**	VNS (Garcia) [10]

Table 7: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{107}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

107 Sphere Gauss

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	0.05	8.85	429	679	811	1050	1370	2170	2620	3250	ERT$_{\text{best}}$/D
ALPS	**1**	**2.8**	**9.2**	67	820	3500	*14e-2/2e5*	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	3	10	**25**	**43**	**38**	**36**	**27**	**23**	**21**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	110	*64e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	3.2	**2.4**	**22**	*15e-1/2e3*	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	350	*11e+1/1e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	4.8	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	320	*75e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	1800	*64e+0/3e5*	.	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	6.4	*38e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	820	3500	*25e+0/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	320	*68e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	7.5	*82e+0/400*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1.5**	19	100	93	75	59	37	37	**39**	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	11	27	**41**	**46**	**44**	**34**	**34**	230	MA-LS-Chain [19]
MCS (Neum)	**1**	19	*64e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	96	*57e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	140	*34e+0/1e6*	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	1700	*48e+0/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	15	*64e+0/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	4.8	*27e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	260	24	31	180	*11e-1/1e4*	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	3.5	*65e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	130	260	7600	*27e-1/7e5*	.	.	.	.	.	VNS (Garcia) [10]

Table 8: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{108}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

108 Sphere unif

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	0.05	19.4	2900	4860	10200	19800	22300	25400	31500	44900	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.4**	*24e+0/2e5*	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1.3**	**30**	**160**	***48e-2/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	700	*11e+1/9e3*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	10	*72e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	120	*11e+1/800*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	11	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	190	*80e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	870	*64e+0/3e5*	.	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	43	*81e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	3400	*91e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	1600	*11e+1/1e4*	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	4.5	*80e+0/300*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	20	**76**	**270**	**670**	***85e-2/1e6***	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	*21e+0/1e5*	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	19	*69e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	260	*91e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	120	*41e+0/1e6*	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	3400	*95e+0/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	5900	*10e+1/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**2.2**	*28e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	420	*72e+0/1e4*	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**2.5**	*67e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	630	*37e+0/7e5*	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 9: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{109}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

109 Sphere Cauchy

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	0.05	0.28	16.6	31.6	56.9	84	114	150	179	248	ERT$_{\text{best}}$/D
ALPS	**1**	70	20	*18e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	61	9.1	26	46	67	63	53	65	69	AMaLGaM IDEA [4]
avg NEWUOA	**1**	19	17	*25e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	93	20	23	25	27	24	100	*26e-5/2e3*	.	BayEDAcG [9]
BFGS	**1**	6700	610	490	560	380	280	210	180	130	BFGS [22]
BIPOP-CMA-ES	**1**	14	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	12	11	*16e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	960	4.2e4	*12e+0/3e5*	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	49	7.2	97	*99e-2/2e3*	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	25	2500	*74e-1/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	93	23	*29e-1/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	50	**3**	190	*25e-1/400*	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	25	4	8.5	20	63	310	440	430	370	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	20	3.9	4.9	860	*54e-3/1e5*	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	20	280	980	670	490	*13e-1/4e3*	.	.	MCS (Neum) [16]
NEWUOA	**1**	**9.8**	17	*33e-1/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	20	5.7	3800	*72e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	15	2600	*61e-1/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	41	2.4e4	*17e+0/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	100	*28e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**11**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	23	16	*94e-1/300*	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	37	**1.6**	**1.4**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	VNS (Garcia) [10]

Table 10: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{110}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

110 Rosenbrock Gauss

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	185	1270	nan	nan	nan	nan	nan	nan	nan	nan	ERT$_{\text{best}}$/D
ALPS	5.7	53	***56e+0/2e5***	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1.4**	**1.8**	***18e+0/1e6***	.	.	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	*55e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	3.7	**1.8**	***70e+0/2e3***	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*14e+4/600*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	***17e+0/1e6***	.	.	.	.	.	.	.	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	*46e+3/1e4*	.	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	*28e+3/3e5*	.	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	*72e+2/2e3*	.	.	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	44	92	***11e+1/1e5***	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	*65e+3/1e4*	.	.	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	*46e+3/300*	.	.	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1.1**	5.7	***18e+0/1e6***	.	.	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	3.4	11	***28e+0/1e5***	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	*14e+3/4e3*	.	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	*19e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	*11e+3/1e6*	.	.	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	430	*85e+1/1e5*	.	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	3500	*58e+2/1e5*	.	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*80e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	18	14	***60e+0/1e4***	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	*36e+3/300*	.	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	25	130	***47e+0/7e5***	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 11: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{111}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

111 Rosenbrock unif

Δftarget ERT$_{\text{best}}$/D	1e+03 1020	1e+02 4350	1e+01 nan	1e+00 nan	1e-01 nan	1e-02 nan	1e-03 nan	1e-04 nan	1e-05 nan	1e-07 nan	Δftarget ERT$_{\text{best}}$/D
ALPS	350	*99e+1/2e5*	.	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**7.4**	**12**	***23e+0/1e6***	.	.	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	*94e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	29	*22e+2/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*15e+4/400*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	***18e+0/1e6***	.	.	.	.	.	.	.	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	*44e+3/1e4*	.	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	*35e+3/3e5*	.	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	*77e+3/2e3*	.	.	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	*36e+3/1e5*	.	.	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	*11e+4/1e4*	.	.	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	*58e+3/200*	.	.	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**18**	**33**	***27e+0/1e6***	.	.	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	1500	*17e+2/1e5*	.	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	*21e+3/4e3*	.	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	*63e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	*15e+3/1e6*	.	.	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	*51e+3/1e5*	.	.	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	*48e+3/1e5*	.	.	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*94e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	24	*15e+2/1e4*	.	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	*34e+3/300*	.	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	*76e+2/7e5*	.	.	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 12: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{112}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

112 Rosenbrock Cauchy

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	6.61	43.3	1280	3210	3480	3610	3680	3740	3810	3910	ERT$_{\text{best}}$/D
ALPS	59	40	*21e+0/2e5*	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	23	7.5	260	780	930	920	1200	1200	1200	1200	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	**3**	*20e+0/1e4*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	45	23	*48e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*14e+4/2e3*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	3.3	**2.2**	**1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**2.3**	3.7	*20e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	13	84	*18e+0/4e5*	.	.	.	.	.	.	.	DASA [18]
DEPSO	12	18	*37e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	180	54	*27e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**2.2**	4.1	*19e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	4.4	**2.3**	**2.2**	*34e+0/500*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	11	3.3	540	560	520	500	490	480	480	460	iAMaLGaM IDEA [4]
MA-LS-Chain	10	4.6	*16e+0/1e5*	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	240	*20e+1/4e3*	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**2.6**	*29e+0/5e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**2.2**	**2.7**	5300	*15e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	12	1200	*78e+0/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	88	1.5e4	*24e+1/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*76e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**2.9**	**1**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	87	*15e+2/300*	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	4.6	**1.4**	**1.2**	**2.6**	**2.6**	**2.6**	**2.6**	**2.5**	**2.5**	**2.5**	VNS (Garcia) [10]

Table 13: 20-D, running time excess ERT/ERT_{best} on f_{113}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

113 Step-ellipsoid Gauss

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	0.59	89.7	2510	18200	28000	29400	29400	29400	29400	29600	ERT_{best}/D
ALPS	3.8	8.7	34	*58e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	4.6	**1.8**	**2.7**	**1.2**	**1.2**	**2**	**2**	**2**	**2**	**2**	AMaLGaM IDEA [4]
avg NEWUOA	430	*29e+1/9e3*	.	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	3.6	6.3	*19e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	240	*58e+1/1e3*	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	6.7	**2.9**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	430	*22e+1/1e4*	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	2700	*20e+1/3e5*	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	7.4	52	*14e+1/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	5.8	1100	*86e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	830	*38e+1/1e4*	.	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1.7**	*28e+1/400*	.	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**2.9**	**1**	**5.1**	**4.3**	**4.1**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	iAMaLGaM IDEA [4]
MA-LS-Chain	**2.4**	6.1	26	*62e-1/1e5*	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	58	630	*22e+1/4e3*	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	300	*24e+1/4e3*	.	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	100	1.6e5	*13e+1/1e6*	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**2.8**	3400	*15e+1/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**2.6**	1.6e4	*20e+1/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	3.9	1e4	*95e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	27	70	12	*21e+0/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	7.5	*32e+1/300*	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	74	1100	*12e+0/6e5*	.	.	.	.	.	.	VNS (Garcia) [10]

Table 14: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{114}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

114 Step-ellipsoid unif

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	0.59	1660	10400	55900	72300	78500	78500	78500	78500	79100	ERT$_{\text{best}}$/D
ALPS	3.7	49	*70e+0/2e5*	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	3.2	**3.2**	**12**	**34**	**62**	**89**	**89**	**89**	**89**	**89**	AMaLGaM IDEA [4]
avg NEWUOA	700	*44e+1/9e3*	.	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**2.8**	*32e+1/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	220	*67e+1/700*	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	78	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	510	*34e+1/1e4*	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	2300	*27e+1/3e5*	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	32	*49e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	3.6	*30e+1/1e5*	.	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	1e3	*53e+1/1e4*	.	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**2.5**	*36e+1/300*	.	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**2.8**	**12**	**42**	**260**	***27e-1/1e6***	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	3.2	13	*67e+0/1e5*	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	210	*30e+1/4e3*	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	370	*47e+1/4e3*	.	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	230	*16e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	80	*26e+1/1e5*	.	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	1.2e4	*37e+1/1e5*	.	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	3.5	1500	*11e+1/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	2700	45	*17e+1/1e4*	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	7.4	*37e+1/300*	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	910	*11e+1/6e5*	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 15: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{115}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

115 Step-ellipsoid Cauchy

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	0.53	10	120	1510	4590	6330	6340	6340	6340	6450	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	4.1	20	320	*54e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	3.3	11	**2.1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	AMaLGaM IDEA [4]
avg NEWUOA	7.2	**1.5**	110	*93e-1/1e4*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**2.6**	22	22	*90e-1/2e3*	.	.	.	.	.	.	BayEDAcG [9]
BFGS	1900	*62e+1/2e3*	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	3.2	**1.7**	**1**	6.5	3.9	**3**	**3**	**3**	**3**	**3**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	3.9	6.2	*21e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	21	560	*41e+0/3e5*	.	.	.	.	.	.	.	DASA [18]
DEPSO	3.2	6.6	19	*93e-1/2e3*	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**2.7**	40	3500	*16e+0/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	17	4.3	120	*10e+0/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	3.5	4.5	*29e+0/300*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**2.4**	4.5	**1.3**	**1.7**	**2.4**	7	7	7	7	6.9	iAMaLGaM IDEA [4]
MA-LS-Chain	**2.4**	4.7	5.7	470	*15e-1/1e5*	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	160	*72e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	3.3	**1**	240	*18e+0/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	7.5	8.3	1.2e5	*14e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**2.1**	390	*32e+0/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**2.7**	19	*47e+0/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	3.1	2.5e5	*11e+1/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**2.5**	**1.8**	**1.3**	**1**	**1.9**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	IPOP-SEP-CMA-ES [21]
SNOBFIT	3.3	180	*14e+1/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1.1**	**2.4**	4.6	100	350	1200	1200	1200	1200	1200	VNS (Garcia) [10]

Table 16: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{116}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

116 Ellipsoid Gauss

Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D	1e+03 1810	1e+02 9510	1e+01 24900	1e+00 34700	1e-01 44600	1e-02 50200	1e-03 51700	1e-04 52800	1e-05 54000	1e-07 56200	Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	9.8	*30e+1/2e5*	.	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	**1**	**1**	**1**	**1**	**1.2**	**1.4**	**1.4**	**1.4**	AMaLGaM IDEA [4]
avg NEWUOA	*20e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	*24e+2/2e3*	.	.	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*55e+3/700*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1.1**	**1.7**	**1.4**	**1.2**	**1.1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	*16e+3/1e4*	.	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	*95e+2/3e5*	.	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	*16e+3/2e3*	.	.	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	780	*41e+2/1e5*	.	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	*23e+3/1e4*	.	.	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	*23e+3/300*	.	.	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**2.4**	**5.4**	**3.7**	**2.9**	**2.5**	**2.5**	**2.5**	**2.5**	**2.4**	**2.6**	iAMaLGaM IDEA [4]
MA-LS-Chain	25	*57e+1/1e5*	.	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	*12e+3/4e3*	.	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	*22e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	*59e+2/1e6*	.	.	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	*60e+2/1e5*	.	.	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	*72e+2/1e5*	.	.	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*44e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	26	*13e+2/1e4*	.	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	*18e+3/300*	.	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	670	*14e+2/5e5*	.	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 17: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{117}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

117 Ellipsoid unif

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	10100	35500	89300	1.23e5	1.3e5	1.38e5	1.45e5	1.54e5	1.62e5	1.81e5	$\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	*32e+2/2e5*	.	.	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**3.1**	**5.7**	**14**	**17**	***90e-1/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	*24e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	*13e+3/2e3*	.	.	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*49e+3/500*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	*18e+3/1e4*	.	.	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	*12e+3/3e5*	.	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	*26e+3/2e3*	.	.	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	*13e+3/1e5*	.	.	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	*32e+3/1e4*	.	.	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	*26e+3/200*	.	.	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**7.5**	**13**	**36**	**120**	***19e+0/1e6***	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	*36e+2/1e5*	.	.	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	*20e+3/4e3*	.	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	*26e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	*69e+2/1e6*	.	.	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	*15e+3/1e5*	.	.	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	*17e+3/1e5*	.	.	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*44e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	*99e+2/1e4*	.	.	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	*24e+3/300*	.	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	*94e+2/5e5*	.	.	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 18: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{118}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

118 Ellipsoid Cauchy

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	26.3	184	345	589	876	1110	1320	1390	1500	1630	ERT$_{\text{best}}$/D
ALPS	32	340	*46e+0/2e5*	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	6.9	**1.9**	**1.4**	**1.9**	**2.9**	6.8	7.3	7.3	8.8	8.8	AMaLGaM IDEA [4]
avg NEWUOA	**1.3**	7.9	*43e+0/1e4*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	120	*10e+2/2e3*	.	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	*46e+3/2e3*	.	.	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	3.4	**1.4**	**1.9**	**1.8**	**1.6**	**1.6**	**1.5**	**1.6**	**1.6**	**1.6**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	3.8	410	*13e+1/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	240	*32e+1/5e5*	.	.	.	.	.	.	.	.	DASA [18]
DEPSO	18	*55e+1/2e3*	.	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	58	3600	*31e+1/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	7.6	*44e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	3	85	*15e+1/1e3*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	3.9	**1**	**2.4**	4.4	6.9	14	34	40	47	44	iAMaLGaM IDEA [4]
MA-LS-Chain	9	8.8	470	*10e+0/1e5*	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	*26e+2/4e3*	.	.	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1.2**	7.9	*62e+0/6e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	18	*18e+1/1e6*	.	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	600	*56e+1/1e5*	.	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	2600	*78e+1/1e5*	.	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	*53e+2/1e6*	.	.	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	3.5	**2.3**	**2.2**	**1.8**	**1.4**	**1.3**	**1.1**	**1.1**	**1.1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	*54e+2/300*	.	.	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	3.6	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	VNS (Garcia) [10]

Table 19: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{119}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

119 Sum of different powers Gauss

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 139	1e+00 1470	1e-01 1800	1e-02 3160	1e-03 20500	1e-04 47100	1e-05 7e4	1e-07 95100	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	6.4	3.6	55	960	*31e-2/2e5*	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**3.8**	**1**	**6.8**	**12**	**15**	**3.1**	**1.4**	**1**	**1**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	300	*15e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	5.7	**2.7**	**3.9**	*15e-1/2e3*	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	740	*43e+0/1e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	14	**1.6**	**1**	**1**	**1**	**1**	**1**	**1.3**	**1.1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	420	*17e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	2300	2.7e4	*17e+0/3e5*	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	4.6	13	*83e-1/2e3*	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	6.6	680	*95e-1/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	720	1e3	*18e+0/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	5.1	*21e+0/400*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	5.3	4.2	22	**44**	**35**	**7.5**	**3.8**	**2.8**	**2.1**	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	5.7	**2.5**	47	190	*13e-2/1e5*	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	87	*14e+0/4e3*	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	33	400	*18e+0/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	250	7300	*97e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	3.9	1100	*11e+0/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	6.5	2e3	*12e+0/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	5.7	1800	*84e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	21	41	20	83	*16e-1/1e4*	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	4.9	*18e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**3.6**	140	1300	*18e-1/5e5*	.	.	.	.	.	VNS (Garcia) [10]

Table 20: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{120}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

120 Sum of different powers unif

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 1800	1e+00 8940	1e-01 14100	1e-02 42600	1e-03 79600	1e-04 2.7e5	1e-05 3.37e5	1e-07 6.75e5	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	4.9	6.7	*58e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	7.3	**5.5**	**57**	***37e-2/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	760	*29e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1.1**	4.6	*20e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	470	*34e+0/800*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	120	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	990	*20e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	1300	*20e+0/3e5*	.	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	9.7	*31e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	4.2	380	*27e+0/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	3300	*34e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	5.3	*24e+0/300*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	3.7	10	**120**	***39e-2/1e6***	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	6.3	**1.3**	*56e-1/1e5*	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	15	*15e+0/4e3*	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	590	*30e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	420	2500	*11e+0/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	5.3	*27e+0/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	8.5	*25e+0/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1.1**	3.9	120	*81e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	6300	41	*17e+0/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**3.5**	*19e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**3.6**	450	*10e+0/6e5*	.	.	.	.	.	.	VNS (Garcia) [10]

Table 21: 20-D, running time excess ERT/ERT_{best} on f_{121}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

121 Sum of different powers Cauchy

Δftarget ERT_{best}/D	1e+03 0.05	1e+02 0.05	1e+01 12.4	1e+00 38.5	1e-01 71.3	1e-02 172	1e-03 465	1e-04 1100	1e-05 1720	1e-07 2870	Δftarget ERT_{best}/D
ALPS	**1**	4.7	13	*20e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	6.5	6.4	6	47	36	25	13	15	20	AMaLGaM IDEA [4]
avg NEWUOA	**1**	82	49	*40e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	5.3	20	33	43	*58e-3/2e3*	.	.	.	.	BayEDAcG [9]
BFGS	**1**	2500	*33e+0/2e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	23	**1.2**	**1**	**1.2**	**1.1**	**1.1**	**1.2**	**1.3**	**1.9**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	23	33	*32e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	65	7.6e4	*11e+0/3e5*	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	10	7.7	130	*11e-1/2e3*	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	5.7	2e3	*50e-1/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	130	73	*53e-1/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	7.4	4.8	*62e-1/400*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	5.1	3.4	12	57	150	120	75	50	39	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	4.5	3.9	97	9700	*18e-2/1e5*	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	16	*60e-1/4e3*	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	29	31	*52e-1/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1.1**	25	17	*16e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**3.5**	1800	*64e-1/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	4.7	4100	*85e-1/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	3.9	2.6e4	*82e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	15	**1**	**1**	**1**	**1**	**1.2**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	5.7	*16e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**3.6**	**1.8**	**1.2**	**1.3**	**1.1**	**1**	**1.2**	**1.1**	**1.2**	VNS (Garcia) [10]

Table 22: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ on f_{122}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

122 Schaffer F7 Gauss

Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 34.6	1e+00 2600	1e-01 6980	1e-02 18800	1e-03 39700	1e-04 54200	1e-05 99900	1e-07 2.91e5	Δftarget $\mathrm{ERT}_{\mathrm{best}}$/D
ALPS	**1**	**1.4**	**2.3**	*22e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1.3**	**1.4**	**16**	**19**	**11**	**5.8**	**4.5**	**6.6**	**5.4**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**2.3**	120	*77e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1.1**	**2.4**	*34e-1/2e3*	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	81	660	*13e+0/2e3*	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1.8**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1.5**	150	*82e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	60	1100	*75e-1/3e5*	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1.1**	3.1	*63e-1/2e3*	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1.3**	23	*59e-1/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	7	180	*76e-1/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1.3**	8.4	*92e-1/400*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1.3**	**1**	**44**	**32**	**16**	**10**	**8.7**	**14**	**24**	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1.3**	**1**	*27e-1/1e5*	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	16	*77e-1/4e3*	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	6.8	82	*80e-1/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	37	200	*57e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1.5**	4.7	*67e-1/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1.3**	740	*80e-1/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1.3**	12	*49e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	5.2	65	*44e-1/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1.1**	7.3	*98e-1/300*	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1.2**	3.1	*36e-1/5e5*	.	.	.	.	.	.	VNS (Garcia) [10]

Table 23: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{123}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

123 Schaffer F7 unif

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	0.05	0.05	53.1	26500	74400	1.63e5	2.64e5	4.89e5	1.36e6	7.92e6	ERT$_{\text{best}}$/D
ALPS	**1**	**1.6**	**3.1**	***46e-1/2e5***	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1.4**	**1.9**	**550**	***23e-1/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	130	410	***11e+0/9e3***	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1.4**	14	***83e-1/2e3***	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	35	*14e+0/900*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	5.1	5.7	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	8.5	130	***94e-1/1e4***	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	140	620	***74e-1/3e5***	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1.3**	270	***12e+0/2e3***	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1.4**	5200	***13e+0/1e5***	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**2.6**	250	***99e-1/1e4***	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1.2**	7.3	***99e-1/300***	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1.5**	12	***23e-1/1e6***	.	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1.5**	**1**	***45e-1/1e5***	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	58	***87e-1/4e3***	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	53	170	***10e+0/4e3***	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	53	200	***64e-1/1e6***	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1.3**	730	***92e-1/1e5***	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1.5**	2200	***10e+0/1e5***	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1.1**	7.4	***53e-1/1e6***	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1.5**	150	***77e-1/1e4***	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1.4**	7	***10e+0/300***	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1.2**	410	***58e-1/5e5***	.	.	.	.	.	.	VNS (Garcia) [10]

Table 24: 20-D, running time excess ERT/ERT_{best} on f_{124}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

124 Schaffer F7 Cauchy

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	0.05	0.05	9.61	97.9	2040	3220	6350	14300	19400	4e4	ERT_{best}/D
ALPS	**1**	**1.5**	4.9	*28e-1/2e5*	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1.5**	4.6	11	**3.3**	**5**	**4.5**	**4.3**	**3.3**	**2.3**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	3.3	95	*59e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1.1**	8.7	13	*37e-2/2e3*	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	120	*13e+0/2e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	4.7	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	3.7	14	*51e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	12	470	*69e-1/3e5*	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1.9**	3.6	*28e-1/2e3*	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1.4**	7.6	*60e-1/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1.5**	120	*66e-1/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1.5**	4.1	*69e-1/300*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1.4**	**2.8**	7.8	19	27	17	8.3	**6.2**	**4.3**	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1.3**	**1.2**	1.5e4	*16e-1/1e5*	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	12	*66e-1/4e3*	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	10	91	*66e-1/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	4.3	66	*36e-1/1e6*	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1.2**	160	*54e-1/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1.7**	35	*57e-1/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1.1**	46	*51e-1/1e6*	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	3.3	**1**	**7.1**	**2.2**	**1.9**	**2.2**	**2.4**	*41e-5/1e4*	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1.2**	6.7	*85e-1/300*	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1.2**	**1.9**	**1**	8.1	980	*24e-3/4e5*	.	.	.	VNS (Garcia) [10]

Table 25: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{125}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

125 Griewank-Rosenbrock Gauss

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 0.05	1e+00 0.05	1e-01 0.05	1e-02 6.24e5	1e-03 1.25e6	1e-04 3.12e6	1e-05 4.01e6	1e-07 4.03e6	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1**	**1**	2500	***38e-2/2e5***	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	**1.1**	1e3	***24e-2/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	**1**	490	***45e-2/9e3***	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1**	**1.1**	1800	***50e-2/2e3***	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	**1**	53	*21e-1/2e3*	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1**	**380**	**9.8e6**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1**	**1**	1.9e5	***96e-2/1e4***	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	**1.1**	2.4e7	***11e-1/3e5***	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1**	**1.2**	7800	***81e-2/2e3***	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1**	**1.2**	3.1e5	***40e-2/1e5***	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1**	**1.7**	860	***44e-2/1e4***	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1**	**1.1**	*14e-1/400*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1**	**1.1**	680	***24e-2/1e6***	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	**1.2**	1500	***39e-2/1e5***	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	***25e-3/4e3***	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	**1**	**410**	***49e-2/4e3***	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	**1**	**1**	6.5e5	***75e-2/1e6***	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1**	**1.1**	2.9e5	***72e-2/1e5***	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1**	**1.1**	1.4e6	***86e-2/1e5***	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1**	**1**	5.9e5	***80e-2/1e6***	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	**1**	2e4	***59e-2/1e4***	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1**	**1.1**	1600	***91e-2/300***	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1**	**1**	4.2e4	***44e-2/2e6***	.	.	.	.	.	VNS (Garcia) [10]

Table 26: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{126}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

126 Griewank-Rosenbrock unif

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	0.05	0.05	0.05	0.05	0.05	nan	nan	nan	nan	nan	ERT$_{\text{best}}$/D
ALPS	**1**	**1**	**1**	2500	***57e-2/2e5***	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	**1**	**1300**	***31e-2/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	120	2.6e6	***16e-1/9e3***	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1**	**1**	3.3e4	***94e-2/2e3***	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	**1**	23	*17e-1/1e3*	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1**	5800	***30e-2/5e5***	.	.	.	.	.	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1**	**1**	1.4e6	***11e-1/1e4***	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	81	7.7e7	***12e-1/3e5***	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1**	**1.1**	*13e-1/2e3*	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1**	**1.2**	2.3e6	***10e-1/1e5***	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1**	310	*16e-1/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1**	**1.1**	*14e-1/300*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1**	**1.1**	5700	***34e-2/1e6***	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	**1.1**	2500	***52e-2/1e5***	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	***25e-3/4e3***	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	4.2	1.3e5	***12e-1/4e3***	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	**1**	**1**	3.1e6	***85e-2/1e6***	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1**	**1.1**	3.1e6	***10e-1/1e5***	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1**	**1**	*14e-1/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1**	**1.1**	3.2e5	***76e-2/1e6***	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	**1**	1.8e5	***89e-2/1e4***	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1**	**1**	**1400**	***86e-2/300***	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1**	**1**	1.3e6	***67e-2/2e6***	.	.	.	.	.	VNS (Garcia) [10]

Table 27: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{127}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

127 Griewank-Rosenbrock Cauchy

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	0.05	0.05	0.05	0.05	0.05	79500	2.22e5	3.4e5	3.63e5	3.71e5	ERT$_{\text{best}}$/D
ALPS	**1**	**1**	**1.3**	1400	*46e-2/2e5*	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	**1.1**	760	1.5e6	**13**	***83e-4/1e6***	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	7.7	220	*43e-2/9e3*	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1**	**1.1**	1600	*42e-2/2e3*	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	**1**	140	*20e-1/2e3*	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1**	**180**	**9e5**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1**	**1**	3e4	*81e-2/1e4*	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	**1**	7.5e7	*11e-1/3e5*	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1**	**1.1**	950	*65e-2/2e3*	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1**	**1.1**	9.7e5	*73e-2/1e5*	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1**	**1**	1400	*44e-2/1e4*	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1**	**1.1**	*15e-1/300*	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1**	**1**	560	3.3e6	**19**	**67**	**44**	**41**	**40**	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	**1.1**	420	*43e-2/1e5*	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	**1**	**1**	**1**	*25e-3/4e3*	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	3.7	250	*45e-2/4e3*	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	**1**	**1.3**	2.8e4	*62e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1**	**1**	1.2e6	*86e-2/1e5*	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1**	**1.1**	2.3e6	*99e-2/1e5*	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1**	**1.3**	5.2e5	*79e-2/1e6*	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	**1**	**180**	**1.7e5**	*83e-3/1e4*	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1**	**1.1**	1700	*87e-2/300*	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1**	**1**	350	1.1e6	*45e-3/2e6*	.	.	.	.	VNS (Garcia) [10]

Table 28: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{128}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

128 Gallagher Gauss

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 7020	1e+00 6.69e5	1e-01 8.61e5	1e-02 8.61e5	1e-03 8.61e5	1e-04 8.62e5	1e-05 8.62e5	1e-07 8.62e5	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1**	240	5.3	**4.3**	*34e+0/2e5*	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	**16**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	*69e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1**	*45e+0/2e3*	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	**1**	*75e+0/1e3*	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1**	*66e+0/1e4*	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	*61e+0/3e5*	.	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1**	*66e+0/2e3*	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1**	*73e+0/1e5*	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1**	*71e+0/1e4*	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1**	*69e+0/400*	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1**	62	**4.9**	17	**17**	**17**	**17**	**17**	**17**	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	210	*30e+0/1e5*	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	*66e+0/4e3*	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	*70e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	**1**	*34e+0/1e6*	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1**	*67e+0/1e5*	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1**	*72e+0/1e5*	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1**	*24e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	**21**	*65e+0/1e4*	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1**	*68e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1**	2e3	*35e+0/1e6*	.	.	.	.	.	.	VNS (Garcia) [10]

Table 29: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{129}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

129 Gallagher unif

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 3.91e5	1e+00 2.07e6	1e-01 2.08e6	1e-02 2.08e6	1e-03 2.09e6	1e-04 2.1e6	1e-05 2.1e6	1e-07 2.12e6	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1**	***32e+0/2e5***	.	.	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	**18**	**7.1**	***23e+0/1e6***	.	.	.	.	.	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	***74e+0/9e3***	.	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1**	***69e+0/2e3***	.	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	**1**	***76e+0/900***	.	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1**	***70e+0/1e4***	.	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	***58e+0/3e5***	.	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1**	***72e+0/2e3***	.	.	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1**	***70e+0/1e5***	.	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1**	***75e+0/1e4***	.	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1**	***68e+0/300***	.	.	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1**	***31e+0/1e6***	.	.	.	.	.	.	.	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	***27e+0/1e5***	.	.	.	.	.	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	***67e+0/4e3***	.	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	***73e+0/4e3***	.	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	**1**	***48e+0/1e6***	.	.	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1**	***67e+0/1e5***	.	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1**	***70e+0/1e5***	.	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1**	***24e+0/1e6***	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	***69e+0/1e4***	.	.	.	.	.	.	.	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1**	***67e+0/300***	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1**	***56e+0/7e5***	.	.	.	.	.	.	.	VNS (Garcia) [10]

Table 30: 20-D, running time excess ERT/ERT$_{\text{best}}$ on f_{130}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

130 Gallagher Cauchy

Δftarget ERT$_{\text{best}}$/D	1e+03 0.05	1e+02 0.05	1e+01 245	1e+00 4660	1e-01 12600	1e-02 12600	1e-03 12700	1e-04 12700	1e-05 12800	1e-07 12900	Δftarget ERT$_{\text{best}}$/D
ALPS	**1**	**1**	17	760	*21e-1/2e5*	.	.	.	.	.	ALPS [15]
AMaLGaM IDEA	**1**	**1**	7.1	220	81	83	83	83	83	85	AMaLGaM IDEA [4]
avg NEWUOA	**1**	**1**	6.6	*45e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [23]
BayEDAcG	**1**	**1**	10	*99e-1/2e3*	.	.	.	.	.	.	BayEDAcG [9]
BFGS	**1**	**1**	140	*75e+0/2e3*	.	.	.	.	.	.	BFGS [22]
BIPOP-CMA-ES	**1**	**1**	**1.9**	33	**14**	**14**	**14**	**14**	**14**	**14**	BIPOP-CMA-ES [14]
(1+1)-CMA-ES	**1**	**1**	**2.5**	*25e-1/1e4*	.	.	.	.	.	.	(1+1)-CMA-ES [2]
DASA	**1**	**1**	7500	*19e+0/3e5*	.	.	.	.	.	.	DASA [18]
DEPSO	**1**	**1**	6.3	**6.3**	*62e-1/2e3*	.	.	.	.	.	DEPSO [11]
EDA-PSO	**1**	**1**	5700	*49e+0/1e5*	.	.	.	.	.	.	EDA-PSO [5]
full NEWUOA	**1**	**1**	19	*70e-1/1e4*	.	.	.	.	.	.	full NEWUOA [23]
GLOBAL	**1**	**1**	**1**	**1**	*72e-1/300*	.	.	.	.	.	GLOBAL [20]
iAMaLGaM IDEA	**1**	**1**	5.6	74	38	42	67	91	130	320	iAMaLGaM IDEA [4]
MA-LS-Chain	**1**	**1**	24	87	**32**	**38**	120	*21e-1/1e5*	.	.	MA-LS-Chain [19]
MCS (Neum)	**1**	**1**	37	*12e+0/4e3*	.	.	.	.	.	.	MCS (Neum) [16]
NEWUOA	**1**	**1**	9.1	*77e-1/4e3*	.	.	.	.	.	.	NEWUOA [23]
(1+1)-ES	**1**	**1**	4.2	200	*74e-2/1e6*	.	.	.	.	.	(1+1)-ES [1]
PSO	**1**	**1**	1600	*17e+0/1e5*	.	.	.	.	.	.	PSO [6]
PSO_Bounds	**1**	**1**	5700	*50e+0/1e5*	.	.	.	.	.	.	PSO_Bounds [7]
Monte Carlo	**1**	**1**	*25e+0/1e6*	.	.	.	.	.	.	.	Monte Carlo [3]
IPOP-SEP-CMA-ES	**1**	**1**	**2**	**1.7**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-SEP-CMA-ES [21]
SNOBFIT	**1**	**1**	*62e+0/300*	.	.	.	.	.	.	.	SNOBFIT [17]
VNS (Garcia)	**1**	**1**	69	78	48	48	**48**	**48**	**48**	**47**	VNS (Garcia) [10]

References

[1] Anne Auger. Benchmarking the (1+1)-ES with one-fifth success rule on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2453–2458.

[2] Anne Auger and Nikolaus Hansen. Benchmarking the (1+1)-CMA-ES on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2467–2472.

[3] Anne Auger and Raymond Ros. Benchmarking the pure random search on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2485–2490.

[4] Peter A. N. Bosman, Jörn Grahl, and Dirk Thierens. AMaLGaM IDEAs in noisy black-box optimization benchmarking. In Rothlauf [24], pages 2351–2358.

[5] Mohammed El-Abd and Mohamed S. Kamel. Black-box optimization benchmarking for noiseless function testbed using an EDA and PSO hybrid. In Rothlauf [24], pages 2263–2268.

[6] Mohammed El-Abd and Mohamed S. Kamel. Black-box optimization benchmarking for noiseless function testbed using particle swarm optimization. In Rothlauf [24], pages 2269–2274.

[7] Mohammed El-Abd and Mohamed S. Kamel. Black-box optimization benchmarking for noiseless function testbed using PSO_Bounds. In Rothlauf [24], pages 2275–2280.

[8] S. Finck, N. Hansen, R. Ros, and A. Auger. Real-parameter black-box optimization benchmarking 2009: Presentation of the noisy functions. Technical Report 2009/21, Research Center PPE, 2009.

[9] Marcus R. Gallagher. Black-box optimization benchmarking: results for the BayEDAcG algorithm on the noisy function testbed. In Rothlauf [24], pages 2383–2388.

[10] Carlos García-Martínez and Manuel Lozano. A continuous variable neighbourhood search based on specialised EAs: application to the noisy BBO-benchmark 2009 testbed. In Rothlauf [24], pages 2367–2374.

[11] José García-Nieto, Enrique Alba, and Javier Apolloni. Particle swarm hybridized with differential evolution: black box optimization benchmarking for noisy functions. In Rothlauf [24], pages 2343–2350.

[12] N. Hansen, A. Auger, S. Finck, and R. Ros. Real-parameter black-box optimization benchmarking 2009: Experimental setup. Technical Report RR-6828, INRIA, 2009.

[13] N. Hansen, S. Finck, R. Ros, and A. Auger. Real-parameter black-box optimization benchmarking 2009: Noisy functions definitions. Technical Report RR-6869, INRIA, 2009.

[14] Nikolaus Hansen. Benchmarking a bi-population CMA-ES on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2397–2402.

[15] Gregory S. Hornby. The Age-Layered Population Structure (ALPS) evolutionary algorithm, July 2009. Noisy testbed.

[16] Waltraud Huyer and Arnold Neumaier. Benchmarking of MCS on the noisy function testbed. `http://www.mat.univie.ac.at/~neum/papers.html`, 2009. P. 988.

[17] Waltraud Huyer and Arnold Neumaier. Benchmarking of SNOBFIT on the noisy function testbed. `http://www.mat.univie.ac.at/~neum/papers.html`, 2009. P. 987.

[18] Peter Korosec and Jurij Silc. A stigmergy-based algorithm for black-box optimization: noisy function testbed. In Rothlauf [24], pages 2375–2382.

[19] Daniel Molina, Manuel Lozano, and Francisco Herrera. A memetic algorithm using local search chaining for black-box optimization benchmarking 2009 for noisy functions. In Rothlauf [24], pages 2359–2366.

[20] László Pál, Tibor Csendes, Mihály Csaba Markót, and Arnold Neumaier. BBO-benchmarking of the GLOBAL method for the noisy function testbed. `http://www.mat.univie.ac.at/~neum/papers.html`, 2009. P. 985.

[21] Raymond Ros. Benchmarking sep-CMA-ES on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2441–2446.

[22] Raymond Ros. Benchmarking the BFGS algorithm on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2415–2420.

[23] Raymond Ros. Benchmarking the NEWUOA on the BBOB-2009 noisy testbed. In Rothlauf [24], pages 2429–2434.

[24] Franz Rothlauf, editor. *Genetic and Evolutionary Computation Conference, GECCO 2009, Proceedings, Montreal, Québec, Canada, July 8-12, 2009, Companion Material.* ACM, 2009.