Comparison tables: BBOB 2010 noisy testbed with BBOB 2009 as reference in 10-D

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2010, see `http://coco.gforge.inria.fr/doku.php?id=bbob-2010`. 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 [11, 7]. The experimental set-up is described in [10].

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 in BBOB-2009 (see [6]) if an algorithm from BBOB-2009 reached the given target function value. The ERT value is given otherwise ($\mathrm{ERT}_{\mathrm{best}}$ is noted as infinite). See [10] for details on how ERT is obtained. Bold entries in the table correspond to values below 3 or the top-three best values.

Table 1: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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$_{\text{best}}$/D	0.10	0.10	2.6	4.0	18	19	19	20	21	23	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	50	13	14	4.3	5.1	6.0	6.7	7.4	8.8	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	14	7.1	7.8	**2.4**	3.2	3.8	4.2	4.6	5.5	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	29	5.6	5.8	**1.9**	**2.5**	**3.0**	3.4	3.8	4.5	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	54	14	13	4.2	5.2	6.1	6.9	7.8	9.3	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	10	5.1	6.0	**2.0**	**2.6**	**3.0**	3.5	3.8	4.7	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	10	4.0	5.0	**1.6**	**2.2**	**2.6**	3.0	3.3	4.1	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	12	**3.0**	**3.9**	**1.3**	**1.7**	**2.0**	**2.3**	**2.6**	**3.2**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	14	4.7	5.4	**1.7**	**2.2**	**2.6**	**3.0**	3.3	4.0	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	20	**2.9**	**3.4**	**0.99**	**1.2**	**1.2**	**1.3**	**1.3**	**1.4**	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	153	253	33	32	8.5	10	11	12	12	14	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**6.6**	5.1	7.2	**2.4**	3.2	3.8	4.5	5.0	6.1	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	11	5.6	7.4	**2.5**	3.4	4.1	4.7	5.2	6.1	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**5.9**	17	33	8.8	12	15	16	18	22	CMA+DE-MOS [13]
NEWUOA	**1**	15	**2.1**	**3.0**	**1.0**	**1.6**	**1.9**	**2.1**	**2.3**	**2.9**	NEWUOA [16]
Basic RCGA	**1**	**7.1**	28	63	28	46	121	229	288	377	Basic RCGA [17]
SPSA	104	177	4405	5820	2316	4151	5693	6382	7916	*34e-5/1e5*	SPSA [9]

Table 2: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best\ 2009}}$ 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	0.10	0.10	2.6	4.1	20	21	23	24	27	30	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	**1**	50	15	15	4.4	5.2	5.7	6.4	6.8	7.9	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	25	7.3	7.7	**2.3**	**2.8**	3.1	3.6	3.7	4.1	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	23	4.9	6.3	**1.9**	**2.3**	**2.6**	**2.9**	3.1	3.5	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	26	22	21	5.8	6.6	7.4	8.2	8.6	12	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	21	5.8	6.4	**2.0**	**2.5**	**2.9**	3.2	3.4	3.8	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	7.7	4.6	5.1	**1.6**	**1.9**	**2.2**	**2.6**	**2.7**	3.1	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	14	**3.6**	**4.4**	**1.3**	**1.6**	**1.9**	**2.1**	**2.2**	**2.5**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	17	4.7	**4.9**	**1.6**	**2.0**	**2.2**	**2.5**	**2.7**	**3.0**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	31	**2.9**	**3.2**	**0.89**	**1.1**	**1.2**	**1.3**	**1.4**	**1.7**	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	147	242	35	32	8.9	10	10	11	11	11	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	10	5.0	6.9	**2.2**	**2.8**	3.3	3.7	4.0	4.4	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**6.0**	5.3	7.2	**2.3**	**2.9**	3.3	3.8	4.0	4.4	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**5.9**	19	32	8.3	11	13	13	15	16	CMA+DE-MOS [13]
NEWUOA	**1**	18	**3.5**	7.9	8.0	30	48	81	146	547	NEWUOA [16]
Basic RCGA	**1**	**4.1**	26	57	26	42	102	193	234	285	Basic RCGA [17]
SPSA	124	183	1.56e5	3.44e5	*21e+0/1e5*	.	.	.	.	.	SPSA [9]

Table 3: 10-D, running time excess ERT/$\text{ERT}_{\text{best 2009}}$ 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	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT_{best}/D	0.10	0.10	2.6	4.7	13	14	36	36	36	36	ERT_{best}/D
(1,2)-CMA-ES	**1**	34	14	12	6.4	7.4	3.6	4.3	5.2	6.8	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	27	6.8	6.4	3.3	4.0	**2.1**	**2.5**	**3.0**	3.8	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	16	6.1	6.0	3.0	3.5	**1.7**	**2.1**	**2.4**	3.1	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	26	12	11	5.5	6.3	3.1	3.8	4.7	6.1	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	16	5.8	5.7	**3.0**	3.6	**1.8**	**2.2**	**2.6**	3.5	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	13	4.7	4.6	**2.6**	**3.1**	**1.5**	**1.9**	**2.2**	**2.9**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	14	**3.5**	**3.4**	**1.9**	**2.2**	**1.1**	**1.4**	**1.6**	**2.1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	17	4.8	4.4	**2.4**	**2.8**	**1.4**	**1.7**	**2.1**	**2.7**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	31	**3.0**	**2.9**	**1.8**	6.8	25	100	1518	*39e-6/8e3*	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	121	223	32	25	12	12	5.5	6.6	7.7	10	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**7.8**	4.9	6.0	3.5	4.2	**2.1**	**2.6**	3.1	4.0	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	11	5.0	6.0	3.4	4.2	**2.1**	**2.6**	3.1	4.0	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**5.9**	16	28	13	17	8.4	11	13	18	CMA+DE-MOS [13]
NEWUOA	**1**	15	**2.3**	**3.6**	5.2	29	95	243	1050	*15e-5/6e3*	NEWUOA [16]
Basic RCGA	**1**	**5.3**	33	55	43	74	83	157	201	253	Basic RCGA [17]
SPSA	105	725	112	109	57	88	1065	4244	*18e-5/1e5*	.	SPSA [9]

Table 4: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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
ERT$_{\text{best}}$/D	9.4	30	61	999	1664	1842	1936	2015	2076	2201	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	4.6	3.5	3.8	43	*24e-1/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**2.4**	**2.7**	**2.1**	11	41	78	74	71	*72e-2/1e4*	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**2.0**	**2.0**	**1.5**	15	26	76	72	70	*16e-1/1e4*	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	7.1	4.9	3.2	26	*15e-1/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1.8**	**2.5**	**2.1**	7.4	87	*56e-2/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.5**	**0.98**	**1.3**	32	41	77	73	70	68	64	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.1**	**1.8**	**1.2**	13	43	*92e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1.6**	**1.8**	**1.4**	8.2	26	77	*40e-2/1e4*	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**0.51**	**0.78**	**0.74**	7.1	22	*67e-2/8e3*	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	10	4.7	3.5	38	23	21	20	19	18	17	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1.9**	**1.2**	**1.2**	**2.0**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**	**1.1**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1.9**	**1.9**	**2.2**	**1.6**	**1.1**	**1.1**	**1.1**	**1.0**	**1.0**	**0.99**	IPOP-CMA-ES [15]
CMA+DE-MOS	6.3	4.4	3.9	**3.5**	**2.5**	**2.6**	**2.8**	**2.7**	**2.7**	**2.7**	CMA+DE-MOS [13]
NEWUOA	**0.51**	**1.6**	5.4	4.6	47	*55e-2/5e3*	.	.	.	.	NEWUOA [16]
Basic RCGA	8.1	11	74	*73e-1/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	41	24	*70e+0/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 5: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	9.0	33	95	2149	7015	7257	7422	7734	7819	7973	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	5.5	5.1	4.5	15	20	*21e-1/1e4*	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**2.7**	**1.9**	**1.7**	10	*19e-1/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1.9**	**2.7**	**1.8**	7.5	6.2	20	*14e-1/1e4*	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	5.5	6.0	5.6	32	21	*35e-1/1e4*	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**2.0**	**1.9**	**1.3**	7.5	9.5	*15e-1/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.6**	**1.9**	**1.1**	12	10	*20e-1/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.2**	**1.9**	**1.4**	6.6	10	*59e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1.6**	**1.6**	**1.1**	6.2	3.8	10	19	*38e-2/1e4*	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**0.64**	**1.7**	**2.5**	**5.1**	**3.7**	16	*88e-2/8e3*	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	11	5.0	**2.5**	304	93	90	88	85	84	176	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1.8**	**1.2**	**1.0**	**2.0**	**0.64**	**0.63**	**0.63**	**0.61**	**0.61**	**0.61**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**2.1**	**1.4**	**2.2**	**2.4**	**0.82**	**0.82**	**0.82**	**0.80**	**0.80**	**0.81**	IPOP-CMA-ES [15]
CMA+DE-MOS	7.5	3.9	**2.4**	13	3.9	**3.8**	**3.7**	**3.6**	**3.6**	**3.5**	CMA+DE-MOS [13]
NEWUOA	**0.35**	**1.2**	11	10	*52e-1/5e3*	.	.	.	.	.	NEWUOA [16]
Basic RCGA	10	10	45	328	*61e-1/5e4*	.	.	.	.	.	Basic RCGA [17]
SPSA	29	20	*70e+0/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 6: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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$_{\text{best}}$/D	9.0	19	29	342	771	819	850	874	897	937	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	5.6	6.9	8.3	4.6	**2.5**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**2.4**	**2.5**	3.2	**2.2**	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**2.4**	3.2	3.2	**1.5**	**0.85**	**0.89**	**0.90**	**0.91**	**0.91**	**0.90**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	4.8	8.0	8.1	7.9	4.1	4.1	4.1	4.1	4.0	4.0	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**2.0**	**2.3**	**2.5**	**1.5**	**0.85**	**0.88**	**0.90**	**0.91**	**0.91**	**0.92**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.8**	**2.1**	**2.2**	**1.4**	**0.77**	**0.80**	**0.81**	**0.82**	**0.82**	**0.82**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.2**	**1.1**	**1.8**	**0.84**	**0.48**	**0.50**	**0.51**	**0.51**	**0.52**	**0.52**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1.9**	**2.3**	**2.5**	**1.6**	**0.85**	**0.86**	**0.86**	**0.87**	**0.87**	**0.87**	(1,4s)-CMA-ES [3]
avg NEWUOA	**0.56**	**0.67**	**1.3**	5.4	19	162	*13e-2/9e3*	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	9.2	6.6	6.6	3.0	**1.6**	**1.7**	**1.7**	**1.8**	**1.9**	**2.1**	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1.9**	**1.9**	**2.4**	**1.7**	**0.96**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1.8**	**2.4**	**2.8**	**2.0**	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	IPOP-CMA-ES [15]
CMA+DE-MOS	7.3	6.9	7.9	3.3	**1.8**	**1.8**	**1.9**	**1.9**	**2.0**	**2.1**	CMA+DE-MOS [13]
NEWUOA	**0.38**	**0.86**	**1.6**	7.5	14	26	*11e-2/7e3*	.	.	.	NEWUOA [16]
Basic RCGA	7.5	15	138	463	443	888	*66e-1/5e4*	.	.	.	Basic RCGA [17]
SPSA	165	1194	22845	*16e+0/1e5*	.	.	.	.	.	.	SPSA [9]

Table 7: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	0.10	0.10	95	225	387	521	735	960	1134	1430	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	512	199	*11e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	22	15	632	*35e-1/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	53	22	646	*54e-1/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	415	702	*14e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	127	36	*54e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	30	12	139	*21e-1/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	170	10	*34e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	20	36	299	*54e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	32	227	*15e+0/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	113	194	**1.3**	**1.3**	**2.1**	**3.4**	**3.3**	**5.2**	**5.9**	17	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**6.1**	**0.97**	**1.1**	**1.4**	**1.3**	**1.1**	**0.89**	**0.96**	**0.94**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	10	**0.85**	**0.86**	**0.93**	**1.1**	**1.0**	**0.96**	**0.90**	**0.82**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**5.9**	16	64	45	36	30	24	21	17	CMA+DE-MOS [13]
NEWUOA	**1**	15	130	*23e+0/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**2.4**	3.3	3.4	**2.9**	3.4	4.7	5.7	6.3	**6.4**	Basic RCGA [17]
SPSA	82	145	14817	*28e+0/1e5*	.	.	.	.	.	.	SPSA [9]

Table 8: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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
ERT$_{\text{best}}$/D	0.10	0.10	1002	3143	4759	7751	10929	13571	17900	30809	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	1016	*28e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	1587	*26e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	926	*29e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	758	*27e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	924	67	*18e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	965	149	*17e+0/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	707	33	*16e+0/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	896	*22e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	1432	*27e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	11234	22743	**4.5**	**3.5**	**4.3**	**4.4**	**4.6**	**4.9**	**7.5**	**12**	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	376	**1.0**	**0.63**	**0.98**	**0.88**	**0.98**	**1.0**	**1.1**	**0.88**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**63**	**0.78**	**0.64**	**0.69**	**0.77**	**0.70**	**0.82**	**0.78**	**0.77**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**5.9**	46	479	*74e-1/1e5*	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	593	*28e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**5.1**	4.6	225	*21e-1/5e4*	.	.	.	.	.	Basic RCGA [17]
SPSA	3022	8166	5.7	22	*78e-2/1e5*	.	.	.	.	.	SPSA [9]

Table 9: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	0.10	0.10	2.8	29	50	82	116	146	179	242	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	55	15	**2.5**	**2.8**	**2.3**	**2.2**	**2.2**	**2.3**	**2.5**	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	31	6.0	**1.2**	**1.1**	**1.1**	**0.98**	**1.0**	**1.0**	**1.1**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	28	5.8	**1.0**	**0.94**	**0.83**	**0.77**	**0.79**	**0.78**	**0.75**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	55	14	**2.6**	**2.4**	**1.9**	**1.8**	**1.8**	**2.0**	**2.1**	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	16	5.4	**1.1**	**1.1**	**1.0**	**1.1**	**1.1**	**1.1**	**1.2**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	13	**4.2**	**0.84**	**0.83**	**0.83**	**0.82**	**0.81**	**0.83**	**0.87**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	12	**3.4**	**0.69**	**0.66**	**0.55**	**0.52**	**0.52**	**0.52**	**0.53**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	19	4.4	**0.99**	**0.94**	**0.83**	**0.77**	**0.77**	**0.76**	**0.77**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	20	11	38	665	*31e-2/7e3*	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	125	202	31	4.7	3.5	485	*49e-4/1e5*	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	10	4.5	**1.2**	**1.2**	**1.1**	**1.1**	**1.2**	**1.2**	**1.2**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**6.3**	**4.4**	**1.1**	**1.1**	**1.1**	**1.0**	**1.0**	**1.1**	**1.1**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**5.9**	16	4.6	4.8	4.5	4.9	5.0	5.3	5.6	CMA+DE-MOS [13]
NEWUOA	**1**	16	12	77	*57e-2/4e3*	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**4.4**	28	10	12	23	47	48	46	41	Basic RCGA [17]
SPSA	101	733	495	368	13065	*36e-2/1e5*	.	.	.	.	SPSA [9]

Table 10: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	35	141	1122	3.32e6	7.03e6	1.64e7	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*50e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	41	159	*16e+1/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	123	1016	*44e+1/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*65e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	36	229	*11e+1/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	8.0	29	*64e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	14	35	*79e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	50	472	*21e+1/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	623	*16e+2/7e3*	.	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	14	12	5.7	*76e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1.1**	**2.5**	**0.94**	*55e-1/1e6*	.	.	.	.	.	.	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**0.95**	**1.4**	**0.92**	*57e-1/1e6*	.	.	.	.	.	.	IPOP-CMA-ES [15]
CMA+DE-MOS	8.6	9.0	12	**0.47**	*74e-1/1e5*	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	101	*83e+1/4e3*	.	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**3.8**	**5.2**	**2.7**	*85e-1/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	67	886	*10e+1/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 11: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	384	1951	8293	∞	∞	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	380	*68e+2/1e4*	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	371	*45e+2/1e4*	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*76e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*65e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*46e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	121	*21e+2/1e4*	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	120	*43e+2/1e4*	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	388	*46e+2/1e4*	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	263	*10e+3/7e3*	.	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	11	5.3	**7.9**	*93e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**0.79**	**0.47**	**0.72**	*70e-1/9e5*	.	.	.	.	.	.	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**0.63**	**0.57**	**0.85**	*70e-1/1e6*	.	.	.	.	.	.	IPOP-CMA-ES [15]
CMA+DE-MOS	17	17	15	*89e-1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	*74e+2/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**0.93**	**0.57**	25	*10e+0/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	9.2	35	*87e+0/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 12: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	10	39	88	1158	1611	1739	1824	1891	1946	2044	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	5.2	**3.0**	**2.0**	6.3	5.8	5.9	7.3	7.3	8.4	9.4	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**2.0**	**1.4**	**1.4**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1.6**	**1.1**	**1.8**	**0.83**	**0.78**	**0.81**	**0.82**	**0.82**	**0.81**	**0.81**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	3.6	**2.5**	10	8.6	9.4	13	15	15	14	24	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1.6**	**1.5**	**1.5**	**2.1**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.8**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.4**	**1.0**	**1.1**	**1.3**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.0**	**0.92**	**0.81**	**0.56**	**0.50**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1.6**	**1.2**	**0.87**	**1.1**	**0.99**	**0.98**	**0.99**	**0.99**	**0.98**	**0.98**	(1,4s)-CMA-ES [3]
avg NEWUOA	**0.54**	**0.83**	10	98	71	*42e-1/8e3*	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	9.0	3.3	**2.2**	*77e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1.6**	**0.92**	**0.83**	**0.95**	**0.92**	**0.97**	**0.98**	**0.99**	**0.99**	**0.98**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1.6**	**0.88**	**0.76**	**1.2**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	IPOP-CMA-ES [15]
CMA+DE-MOS	6.4	3.4	**2.8**	**1.9**	**1.9**	**2.4**	**3.0**	**3.0**	**3.0**	**3.0**	CMA+DE-MOS [13]
NEWUOA	**0.37**	**0.39**	27	*81e-1/5e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	7.8	9.2	52	646	*77e-1/5e4*	.	.	.	.	.	Basic RCGA [17]
SPSA	127	468	16041	*29e+0/1e5*	.	.	.	.	.	.	SPSA [9]

Table 13: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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$_{\text{best}}$/D	0.10	15	447	2763	10288	10882	10898	10898	10898	11235	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	71	99	*37e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	10	17	29	*97e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	151	16	335	*16e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	10	203	*50e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**2.9**	18	70	*13e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.2	9.2	18	*77e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	30	13	11	*77e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	34	21	156	*19e+0/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	4.9	59	*40e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	306	5.1	12	63	*11e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	8.6	**1.3**	**0.77**	**0.61**	**0.31**	**0.33**	**0.33**	**0.33**	**0.33**	**0.32**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	5.7	**3.1**	**1.1**	**0.71**	**0.66**	**0.65**	**0.66**	**0.66**	**0.66**	**0.64**	IPOP-CMA-ES [15]
CMA+DE-MOS	**2.6**	4.9	23	13	**5.9**	**5.6**	**5.6**	**5.6**	**5.6**	**5.4**	CMA+DE-MOS [13]
NEWUOA	32	47	*39e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**2.7**	**2.7**	**3.0**	**4.5**	21	*53e-2/5e4*	.	.	.	.	Basic RCGA [17]
SPSA	188	7.8	*32e+0/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 14: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	0.10	31	3661	12781	33069	38641	39025	39025	39025	40649	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	515	382	*98e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	244	402	*97e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	247	294	*83e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	516	536	*11e+1/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	229	285	*82e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	270	91	*58e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	678	160	*79e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	398	375	*88e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	104	242	*82e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	28455	402	16	**56**	*41e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	136	**7.5**	**0.60**	**0.44**	**0.45**	**0.43**	**0.44**	**0.44**	**0.44**	**0.43**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**3.6**	**6.3**	**0.66**	**0.66**	**0.60**	**0.60**	**0.62**	**0.62**	**0.62**	**0.61**	IPOP-CMA-ES [15]
CMA+DE-MOS	**2.6**	38	*21e+0/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	32	114	*88e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**3.1**	**10**	**4.0**	*57e-1/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	11115	267	46	*14e+0/1e5*	.	.	.	.	.	.	SPSA [9]

Table 15: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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
ERT$_{\text{best}}$/D	0.10	3.8	40	290	859	1232	1260	1260	1260	1281	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	22	6.7	11	253	*23e-1/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**2.8**	4.3	**2.5**	16	174	*69e-2/1e4*	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	11	3.1	**2.0**	14	*65e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	7.5	9.3	14	*27e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	4.1	**2.5**	3.1	15	173	*75e-2/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	4.5	**1.8**	**1.2**	15	78	*61e-2/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**2.7**	**1.9**	**1.6**	**10**	**50**	*39e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	6.9	**2.5**	**2.7**	18	164	*69e-2/1e4*	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	7.0	**2.6**	4.2	386	*24e-1/7e3*	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	185	13	3.9	953	*13e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	3.5	**1.9**	**0.91**	**1.3**	**1.5**	**1.5**	**1.4**	**1.4**	**1.4**	**1.5**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	3.5	**2.0**	**1.0**	**3.7**	**5.3**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	IPOP-CMA-ES [15]
CMA+DE-MOS	**2.6**	8.1	3.4	53	93	**122**	**120**	**120**	**120**	**118**	CMA+DE-MOS [13]
NEWUOA	11	**2.4**	19	*41e-1/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**2.6**	6.2	37	45	269	579	566	566	566	557	Basic RCGA [17]
SPSA	177	41	34	*31e-1/1e5*	.	.	.	.	.	.	SPSA [9]

Table 16: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	105	1652	7144	10554	10911	11251	11584	11938	12316	16727	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	1414	*59e+2/1e4*	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	683	*24e+2/1e4*	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*28e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*55e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	131	*99e+1/1e4*	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	39	*36e+1/1e4*	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	122	*90e+1/1e4*	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	220	*13e+2/1e4*	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	974	*35e+2/7e3*	.	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	790	426	*70e+1/1e5*	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**2.9**	**0.87**	**0.34**	**0.38**	**0.42**	**0.42**	**0.43**	**0.44**	**0.44**	**0.35**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**4.4**	**1.9**	**0.98**	**0.94**	**1.0**	**1.1**	**1.1**	**1.1**	**1.1**	**0.84**	IPOP-CMA-ES [15]
CMA+DE-MOS	24	14	**6.2**	**5.3**	**5.1**	**5.0**	**4.9**	**4.8**	**4.6**	**3.4**	CMA+DE-MOS [13]
NEWUOA	*28e+2/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**6.6**	**12**	32	*23e+0/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	4342	*29e+2/1e5*	.	.	.	.	.	.	.	.	SPSA [9]

Table 17: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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 ERT$_{\text{best}}$/D	1e+03 2241	1e+02 10129	1e+01 22785	1e+00 39931	1e-01 48902	1e-02 62584	1e-03 65419	1e-04 68653	1e-05 71653	1e-07 79447	Δftarget ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*44e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	*55e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*51e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*76e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*32e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	*33e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	*32e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	*39e+2/1e4*	.	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	*46e+2/7e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	114	*13e+2/1e5*	.	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**0.58**	**0.50**	**0.36**	**0.33**	**0.42**	**0.36**	**0.38**	**0.39**	**0.40**	**0.47**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**0.88**	**0.71**	**0.73**	**0.72**	**0.71**	**0.60**	**0.63**	**0.65**	**0.66**	**0.70**	IPOP-CMA-ES [15]
CMA+DE-MOS	20	50	**70**	*21e+1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	27	*51e+2/4e3*	.	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1.2**	**10**	*12e+1/5e4*	.	.	.	.	.	.	.	Basic RCGA [17]
SPSA	662	*24e+2/1e5*	.	.	.	.	.	.	.	.	SPSA [9]

Table 18: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	11	31	135	324	434	530	610	651	707	806	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	12	11	7.4	8.4	9.1	9.4	11	14	13	22	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	6.3	5.0	**2.9**	**2.7**	**2.4**	**2.2**	**2.0**	**2.0**	**1.9**	**1.8**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	5.1	4.2	**2.5**	**1.7**	**1.6**	**1.5**	**1.4**	**1.4**	**1.4**	**1.3**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	11	12	15	12	17	22	25	41	38	43	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	4.7	4.1	**2.4**	**2.0**	**1.9**	**1.9**	**1.8**	**2.0**	**1.9**	**1.9**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.9	**2.9**	**2.0**	**1.6**	**1.5**	**1.4**	**1.4**	**1.4**	**1.3**	**1.3**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**3.2**	**2.3**	**1.3**	**0.87**	**0.85**	**0.81**	**0.75**	**0.75**	**0.72**	**0.68**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	4.2	3.6	**2.1**	**1.5**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**	**1.1**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.0**	**3.2**	17	*37e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	18	13	377	1238	3227	*60e-1/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	4.2	3.5	**1.4**	**0.89**	**0.89**	**0.88**	**0.87**	**0.88**	**0.88**	**0.88**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	4.8	5.2	**2.9**	**2.2**	**2.2**	**2.1**	**2.0**	**2.0**	**2.0**	**1.9**	IPOP-CMA-ES [15]
CMA+DE-MOS	12	8.6	3.4	**1.9**	**1.8**	**1.9**	**2.0**	**2.1**	**2.2**	**2.4**	CMA+DE-MOS [13]
NEWUOA	**1.2**	3.9	57	*99e-1/5e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	31	433	1202	*22e+0/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	26	133	11012	*29e+0/1e5*	.	.	.	.	.	.	SPSA [9]

Table 19: 10-D, running time excess $\mathrm{ERT}/\mathrm{ERT}_{\mathrm{best\ 2009}}$ 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 diff powers Gauss

Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
$\mathrm{ERT}_{\mathrm{best}}/\mathrm{D}$	0.10	0.10	13	312	497	1120	3654	17910	30139	39964	$\mathrm{ERT}_{\mathrm{best}}/\mathrm{D}$
(1,2)-CMA-ES	**1**	42	53	*38e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	7.6	16	143	*17e-1/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	20	15	457	*17e-1/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	35	68	*45e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	5.3	24	222	*18e-1/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	20	16	149	*14e-1/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	12	15	47	*10e-1/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	6.2	19	466	*21e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	25	195	*65e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	144	220	5.2	6.1	6.0	33	*32e-4/1e5*	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**5.1**	**3.5**	**1.2**	**1.5**	**1.3**	**0.67**	**0.31**	**0.27**	**0.28**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	5.3	**1.3**	**1.2**	**1.2**	**0.90**	**1.1**	**0.65**	**0.62**	**0.72**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**3.0**	64	62	69	32	**12**	**2.9**	**1.8**	**1.5**	CMA+DE-MOS [13]
NEWUOA	**1**	11	120	*60e-1/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1.9**	**3.3**	**3.0**	**3.2**	**2.7**	194	*22e-4/5e4*	.	.	Basic RCGA [17]
SPSA	80	117	8904	*10e+0/1e5*	.	.	.	.	.	.	SPSA [9]

Table 20: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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 diff powers 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	0.10	0.10	47	3991	7463	15677	43945	93047	1.27e5	2.50e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	307	893	*12e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	397	315	*11e+0/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	463	251	*97e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	704	275	*95e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**22**	108	*67e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	233	57	*57e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	168	57	*65e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	82	129	*69e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	439	157	*97e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	5333	13323	200	**10**	**13**	**7.6**	*34e-4/1e5*	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	112	**6.2**	**0.69**	**0.70**	**0.75**	**0.54**	**0.44**	**0.57**	**0.54**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	42	**6.6**	**0.60**	**0.57**	**0.74**	**0.64**	**0.60**	**0.63**	**0.55**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**3.0**	38	188	*44e-1/1e5*	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	179	152	*11e+0/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**2.3**	**6.6**	13	*80e-2/5e4*	.	.	.	.	.	Basic RCGA [17]
SPSA	2288	9582	300	*55e-1/1e5*	.	.	.	.	.	.	SPSA [9]

Table 21: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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 diff powers 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	0.10	0.10	7.2	32	63	148	368	694	999	1821	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	20	5.8	3.3	3.0	**2.7**	**2.3**	**2.7**	4.0	80	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	10	**2.4**	**1.3**	**1.2**	**1.0**	**0.95**	**1.1**	**1.4**	**2.0**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	5.1	**1.7**	**0.92**	**0.93**	**0.71**	**0.66**	**0.70**	**0.89**	**1.3**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	17	4.5	**2.9**	**2.4**	**2.1**	**2.6**	4.1	5.8	81	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	9.1	**1.5**	**1.2**	**1.3**	**1.1**	**1.0**	**1.1**	**1.5**	**1.4**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	13	**1.3**	**0.91**	**0.93**	**0.85**	**0.77**	**0.83**	**1.0**	**1.1**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	10	**1.1**	**0.71**	**0.61**	**0.48**	**0.44**	**0.46**	**0.51**	**0.57**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	11	**1.1**	**1.00**	**0.90**	**0.75**	**0.65**	**0.61**	**0.74**	**0.81**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	15	**2.1**	153	1671	*76e-2/7e3*	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	142	200	8.6	5.0	4.1	9513	*20e-3/1e5*	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	7.1	**1.4**	**1.0**	**1.1**	**0.94**	**0.78**	**0.70**	**0.72**	**0.69**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**4.3**	**1.2**	**1.1**	**1.2**	**1.0**	**1.2**	**1.5**	**1.7**	**2.0**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**3.0**	4.2	4.0	4.2	3.7	**2.9**	**2.5**	**2.6**	**2.3**	CMA+DE-MOS [13]
NEWUOA	**1**	7.9	3.4	215	*11e-1/4e3*	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1.9**	3.3	12	12	23	423	*22e-4/5e4*	.	.	Basic RCGA [17]
SPSA	100	206	236	20545	*46e-1/1e5*	.	.	.	.	.	SPSA [9]

Table 22: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	0.10	0.10	5.5	1156	3317	9790	14074	17571	43863	81680	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1.1**	58	*41e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1.6**	13	*28e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1.8**	17	*27e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	17	53	*45e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	4.1	19	*33e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1.2**	21	*26e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	4.1	12	*30e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**2.1**	22	*32e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	3.7	28	*42e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	118	217	11	**2.9**	*10e-1/2e3*	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**2.5**	**1.5**	**0.85**	**0.87**	**0.50**	**0.61**	**0.74**	**0.50**	**0.72**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	**1.6**	**0.61**	**0.89**	**0.63**	**0.67**	**0.63**	**0.58**	**0.80**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1.4**	3.6	42	28	15	**13**	**10**	**4.9**	**3.2**	CMA+DE-MOS [13]
NEWUOA	**1**	**2.5**	45	*47e-1/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1.5**	**2.1**	**1.7**	**6.9**	**8.4**	15	*56e-3/5e4*	.	.	Basic RCGA [17]
SPSA	1.54e5	1.54e5	6624	*76e-1/1e5*	.	.	.	.	.	.	SPSA [9]

Table 23: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	0.10	0.10	4.0	9439	38928	66490	1.29e5	1.99e5	3.33e5	1.03e6	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	1677	*82e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	85	591	*67e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1.2**	674	*65e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	1094	*71e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	143	*56e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	32	215	*46e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1.3**	157	*52e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1.1**	238	*61e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1.3**	181	*68e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	9772	12675	709	*63e-1/5e3*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**27**	**0.66**	**0.65**	**0.76**	**0.79**	**0.79**	**0.79**	**0.72**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**2.0**	**22**	**0.67**	**0.63**	**0.72**	**0.61**	**0.74**	**0.82**	**0.96**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1.4**	202	*42e-1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	31	192	*64e-1/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1.3**	**3.7**	*23e-1/5e4*	.	.	.	.	.	.	Basic RCGA [17]
SPSA	1.14e6	1.15e6	3.51e5	*66e+2/1e5*	.	.	.	.	.	.	SPSA [9]

Table 24: 10-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}\ 2009}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.10	0.10	3.7	61	1045	3430	5289	7378	13712	33136	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	**1**	**1.3**	45	*45e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1.3**	4.8	192	*77e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1.1**	4.3	153	*85e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	361	*47e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	4.1	**2.7**	302	*12e-1/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1.6**	**2.3**	112	*65e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	3.1	**1.7**	74	*55e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.1	24	1113	*15e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	3.5	12	*24e-1/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	112	177	14	**3.5**	33	*13e-2/5e3*	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**1.9**	**1.2**	**1.1**	**1.1**	**1.0**	**1.2**	**0.83**	**0.51**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	3.9	**1.8**	**1.2**	**1.5**	**1.1**	**1.2**	**1.1**	**1.2**	**1.0**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1.4**	3.1	257	15	**7.2**	**5.4**	**4.6**	**3.0**	**1.6**	CMA+DE-MOS [13]
NEWUOA	**1**	5.0	11	*34e-1/4e3*	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1.2**	3.5	13	**13**	11	14	*10e-4/5e4*	.	.	Basic RCGA [17]
SPSA	71512	71549	4897	*76e-1/1e5*	.	.	.	.	.	.	SPSA [9]

Table 25: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	0.10	0.10	0.10	0.10	0.10	1.05e5	2.97e5	6.38e5	6.40e5	6.44e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	2738	*50e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	1214	*39e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	469	*41e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	4806	*54e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	947	*38e-2/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	381	*37e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	500	*34e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	1304	*40e-2/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	5.9	**39**	*19e-2/7e3*	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	129	163	186	372	**2.30e5**	**3.2**	*14e-3/1e5*	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**1**	115	**2.71e5**	**0.66**	**0.57**	**0.40**	**0.41**	**0.41**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	**1**	**94**	**2.69e5**	**0.82**	**0.70**	**0.43**	**0.43**	**0.44**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1**	**1.1**	426	3.25e5	15	*26e-3/1e5*	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	**1**	3.8	**84**	*22e-2/4e3*	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1**	**1.1**	178	4.66e5	*88e-3/5e4*	.	.	.	.	Basic RCGA [17]
SPSA	71510	71522	71531	71588	2.87e6	*12e-2/1e5*	.	.	.	.	SPSA [9]

Table 26: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	0.10	0.10	0.10	0.10	0.10	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	50600	*88e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	30608	*74e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	56376	*84e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	53386	*86e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	10553	*59e-2/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	8849	*56e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**2.9**	8027	*57e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	9144	*72e-2/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	9.4	49115	*89e-2/7e3*	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	2497	3030	3915	13974	4.50e6	*12e-2/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**1**	**304**	**3.12e6**	**1.92e7**	**6.27e7**	*80e-3/3e5*	.	.	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	**1**	558	**3.54e6**	*86e-3/3e5*	.	.	.	.	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1**	**1.1**	**485**	7.12e6	*17e-2/1e5*	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	**1**	29	11670	*66e-2/4e3*	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1**	**1.1**	**147**	**1.11e6**	*12e-2/5e4*	.	.	.	.	Basic RCGA [17]
SPSA	1.40e7	*89e+2/1e5*	.	.	.	.	.	.	.	.	SPSA [9]

Table 27: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	0.10	0.10	0.10	0.10	0.10	79920	1.35e5	2.06e5	2.08e5	2.11e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	418	*30e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	137	4.77e5	*18e-2/1e4*	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	131	1.43e6	*22e-2/1e4*	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	534	*34e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	116	2.11e5	*15e-2/1e4*	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	78	1.59e5	*11e-2/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	99	1.46e5	*12e-2/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	122	4.70e5	*15e-2/1e4*	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	**1**	**40**	*20e-2/7e3*	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	115	148	159	397	4.47e5	*72e-3/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**1**	**78**	**75310**	**0.40**	**0.57**	**0.49**	**0.49**	**0.50**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	**1**	**66**	**1.08e5**	**0.63**	**0.80**	**0.62**	**0.63**	**0.64**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1**	**1.1**	273	**35137**	**1.0**	*66e-4/1e5*	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	**1**	**2.4**	79	*25e-2/4e3*	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1**	**1.2**	206	2.25e5	*25e-3/5e4*	.	.	.	.	Basic RCGA [17]
SPSA	112	144	652	1.34e5	1.41e7	*59e-2/1e5*	.	.	.	.	SPSA [9]

Table 28: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	0.10	0.10	915	13803	14050	14393	29169	29302	38266	52875	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	155	*15e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	8.5	4.9	**10**	*80e-1/1e4*	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	15	*78e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	77	*20e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	11	*81e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	3.7	**3.2**	*46e-1/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	6.5	**2.2**	*53e-1/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	10	*82e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	32	*21e+0/7e3*	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	124	170	**2.1**	6.9	**6.8**	**8.9**	**5.4**	**10**	**7.5**	13	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**0.65**	29	29	**28**	14	14	11	**7.7**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	**0.47**	29	29	28	**14**	**14**	**11**	**7.7**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1**	52	51	51	106	52	52	40	29	CMA+DE-MOS [13]
NEWUOA	**1**	**1**	*24e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1**	3.3	**4.9**	**5.1**	**5.1**	**2.6**	**4.0**	**3.1**	**4.1**	Basic RCGA [17]
SPSA	79	101	*64e+0/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 29: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	0.10	0.10	5397	1.36e5	1.41e5	1.42e5	1.43e5	1.44e5	1.45e5	1.47e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	*44e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	*34e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	27	*32e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	28	*38e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	13	*21e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	*24e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	*23e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	*28e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	*39e+0/7e3*	.	.	.	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	5487	16432	13	5.3	**10**	**10**	**10**	**10**	**10**	**10**	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**0.69**	**2.5**	**4.0**	**4.0**	**3.9**	**3.9**	**3.9**	**4.9**	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	**0.63**	**5.0**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1**	25	*11e+0/1e5*	.	.	.	.	.	.	CMA+DE-MOS [13]
NEWUOA	**1**	**1**	*39e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [16]
Basic RCGA	**1**	**1**	**4.4**	**2.7**	*65e-1/5e4*	.	.	.	.	.	Basic RCGA [17]
SPSA	1935	9633	*41e+0/1e5*	.	.	.	.	.	.	.	SPSA [9]

Table 30: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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	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	0.10	0.10	48	588	3747	7052	7091	7151	7219	7334	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	12	40	8.1	4.3	4.3	4.3	4.3	4.2	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	10	6.4	**1.6**	**0.83**	**0.83**	**0.82**	**0.82**	**0.81**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	4.4	**2.4**	**0.84**	**0.45**	**0.45**	**0.45**	**0.44**	**0.44**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	11	8.0	**2.6**	**1.6**	**1.8**	**2.3**	3.3	3.3	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	5.1	5.9	**1.5**	**0.82**	**0.82**	**0.82**	**0.81**	**0.81**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	3.8	**5.5**	**1.3**	**0.68**	**0.68**	**0.68**	**0.68**	**0.67**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**2.9**	**2.3**	**0.77**	**0.41**	**0.41**	**0.41**	**0.41**	**0.40**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	5.0	5.7	**1.7**	**0.89**	**0.88**	**0.88**	**0.87**	**0.86**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	**1.9**	6.0	8.6	*41e-2/7e3*	.	.	.	.	avg NEWUOA [16]
CMA-EGS (IPOP,r1)	108	153	**2.5**	121	41	40	198	*15e-2/1e5*	.	.	CMA-EGS (IPOP,r1) [8]
IPOP-aCMA-ES	**1**	**1**	**2.3**	309	49	26	26	25	25	25	IPOP-aCMA-ES [12]
IPOP-CMA-ES	**1**	**1**	3.6	582	126	67	67	66	66	65	IPOP-CMA-ES [15]
CMA+DE-MOS	**1**	**1**	324	378	81	43	43	42	42	41	CMA+DE-MOS [13]
NEWUOA	**1**	**1**	**2.6**	11	8.0	8.8	8.7	*14e-1/4e3*	.	.	NEWUOA [16]
Basic RCGA	**1**	**1**	53	55	11	5.8	6.1	6.2	9.3	23	Basic RCGA [17]
SPSA	121	152	1111	*73e-1/1e5*	.	.	.	.	.	.	SPSA [9]

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