Comparison tables: BBOB 2010 noisy testbed in 20-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 [10, 6]. The experimental set-up is described in [9].

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 [9] 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: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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
$\mathrm{ERT}_{\mathrm{best}}$/D	0.05	2.5	9.3	18	24	30	33	36	38	42	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	**1**	12	5.5	4.0	3.9	4.0	4.3	4.5	4.8	5.4	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	5.8	**2.9**	**2.2**	**2.1**	**2.1**	**2.3**	**2.4**	**2.6**	**2.9**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	5.1	**2.4**	**1.8**	**1.7**	**1.8**	**1.9**	**2.0**	**2.2**	**2.4**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	11	5.2	3.7	3.4	3.5	3.7	4.0	4.4	4.9	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	4.3	**2.3**	**1.8**	**1.8**	**1.9**	**2.0**	**2.2**	**2.4**	**2.7**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	3.2	**1.9**	**1.5**	**1.5**	**1.5**	**1.7**	**1.8**	**1.9**	**2.2**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**3.0**	**1.6**	**1.2**	**1.2**	**1.2**	**1.3**	**1.4**	**1.5**	**1.7**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.6	**1.9**	**1.4**	**1.4**	**1.5**	**1.6**	**1.7**	**1.9**	**2.1**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**2.1**	**1.1**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	319	16	13	8.8	7.5	6.8	6.7	6.7	6.8	7.1	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1.7**	**2.0**	**1.8**	**1.8**	**2.0**	**2.2**	**2.4**	**2.6**	3.0	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.8**	**1.9**	**1.7**	**1.8**	**1.9**	**2.2**	**2.3**	**2.6**	**3.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	5.0	9.1	7.0	6.1	7.1	8.2	8.1	8.6	10	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	**1**	**1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.4**	**1.5**	NEWUOA [15]
Basic RCGA	**1**	3.7	12	16	67	188	256	281	304	323	Basic RCGA [16]
SPSA	172	15	26638	*25e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 2: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	0.05	2.8	11	21	27	34	40	49	60	79	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	11	5.5	3.9	4.0	4.1	4.6	5.1	5.1	8.7	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	5.5	**2.7**	**2.0**	**2.0**	**1.9**	**1.9**	**1.8**	**1.7**	**1.6**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	4.5	**2.1**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.4**	**1.3**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	15	6.5	4.5	4.7	6.1	8.4	13	18	44	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	3.5	**2.2**	**1.7**	**1.8**	**1.7**	**1.8**	**1.7**	**1.6**	**1.6**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**2.9**	**1.7**	**1.3**	**1.4**	**1.4**	**1.4**	**1.4**	**1.3**	**1.3**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**2.0**	**1.3**	**1**	**1.1**	**1.1**	**1.1**	**1.1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**2.9**	**1.6**	**1.3**	**1.4**	**1.4**	**1.5**	**1.4**	**1.4**	**1.4**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**2.0**	**1**	**1.0**	**1**	**1**	**1**	**1**	**1.1**	**1.1**	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	291	13	11	7.4	6.6	5.8	5.4	4.9	4.4	3.9	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1.1**	**1.6**	**1.5**	**1.7**	**1.7**	**1.8**	**1.7**	**1.7**	**1.6**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.5**	**1.8**	**1.6**	**1.7**	**1.7**	**1.8**	**1.8**	**1.7**	**1.6**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	4.8	10	6.1	5.5	6.1	6.6	5.9	5.4	5.4	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	3.1	5.9	6.8	24	52	509	*31e-5/5e3*	.	NEWUOA [15]
Basic RCGA	**1**	3.1	12	14	61	168	202	205	193	173	Basic RCGA [16]
SPSA	218	22	*43e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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	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	2.7	7.6	20	29	36	44	53	61	77	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	13	7.6	3.9	3.4	3.3	3.3	3.2	3.2	3.2	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	5.4	3.3	**1.8**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	4.1	**2.8**	**1.6**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	11	6.3	3.3	**2.9**	**3.0**	3.1	3.0	3.0	**3.0**	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	3.9	**2.7**	**1.6**	**1.5**	**1.5**	**1.6**	**1.6**	**1.6**	**1.6**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**2.9**	**2.2**	**1.3**	**1.3**	**1.3**	**1.4**	**1.4**	**1.4**	**1.4**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**2.4**	**1.8**	**1.0**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.3	**2.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**2.0**	**1.3**	**1**	**2.2**	29	977	*14e-4/1e4*	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	305	15	16	7.8	6.1	5.4	4.9	4.7	4.7	4.8	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1.5**	**2.3**	**1.6**	**1.6**	**1.7**	**1.7**	**1.8**	**1.8**	**1.9**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.4**	**2.4**	**1.6**	**1.6**	**1.6**	**1.7**	**1.8**	**1.8**	**1.8**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	3.5	10	6.3	5.1	5.7	6.2	6.5	6.6	6.9	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	**1**	**1.1**	6.4	63	1836	*48e-4/5e3*	.	.	NEWUOA [15]
Basic RCGA	**1**	**2.7**	14	14	78	329	316	295	276	241	Basic RCGA [16]
SPSA	352	65	54	32	33	48	125	26503	*37e-5/1e5*	.	SPSA [8]

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	40	2089	6734	7032	7207	7310	7389	7451	7567	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	12	7.3	36	*14e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	5.8	**1.4**	16	22	*12e+0/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	4.8	**2.8**	7.2	*12e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	11	6.1	67	*14e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	5.0	**2.3**	9.4	*13e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.7	**1**	6.9	*97e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**3.3**	**1.2**	5.5	22	21	*91e-1/1e4*	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	3.7	**1.4**	12	*12e+0/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.8**	**1.7**	6.5	*98e-1/1e4*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	20	3.8	**1**	**2.9**	**2.8**	**2.8**	**2.7**	**2.7**	**2.7**	**2.7**	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	4.5	**1.1**	**2.8**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	4.7	**1.2**	**4.2**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	IPOP-CMA-ES [14]
CMA+DE-MOS	20	3.6	20	6.2	6.0	5.9	5.8	5.7	5.7	5.6	CMA+DE-MOS [12]
NEWUOA	**1**	**1.9**	39	*17e+0/6e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	24	12	*18e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	71	*14e+1/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

Table 5: 20-D, running time excess ERT/$\mathrm{ERT}_{\mathrm{best}}$ 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	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	10	79	11367	13185	13727	14025	14234	14400	14561	14883	$\mathrm{ERT}_{\mathrm{best}}$/D
(1,2)-CMA-ES	5.5	**3.0**	13	11	*17e+0/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**3.0**	**1.3**	**2.2**	*12e+0/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**2.4**	**1.4**	5.8	*13e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	7.3	5.0	13	*16e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**2.6**	**1.2**	6.2	*13e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**2.1**	**2.2**	5.8	*13e+0/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.7**	**1**	**2.2**	*13e+0/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1.9**	**2.0**	4.1	*15e+0/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1.2**	6.1	*12e+0/1e4*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	10	**1.8**	59	*13e+0/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**2.2**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**2.1**	**1.9**	**1.6**	**1.8**	**1.8**	**1.8**	**1.7**	**1.7**	**1.7**	**1.7**	IPOP-CMA-ES [14]
CMA+DE-MOS	10	**1.6**	7.7	**6.8**	**6.6**	**6.4**	**6.4**	**6.3**	**6.2**	**6.1**	CMA+DE-MOS [12]
NEWUOA	**1.5**	5.4	*24e+0/5e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	13	7.3	*18e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	55	*14e+1/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

Table 6: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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$_{\text{best}}$/D	6.0	25	314	639	722	767	786	804	818	844	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	10	6.2	4.2	6.6	6.4	6.7	6.7	6.7	6.6	6.6	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	4.8	**2.0**	**1.6**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.0**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	4.2	**2.0**	**1.3**	**2.0**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.8**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	8.9	4.2	4.0	6.6	6.4	6.3	6.2	6.2	6.2	6.2	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	4.0	3.3	**1.8**	**2.6**	**2.5**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.6	**2.0**	**1.2**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**2.6**	**1.5**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	3.3	**2.0**	**1.2**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.6**	**1.6**	15	*74e-1/1e4*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	17	5.8	3.9	4.2	4.1	4.0	4.1	4.1	4.2	23	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	3.6	**1.7**	**1.4**	**1.3**	**1.4**	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	3.8	**1.8**	**1.9**	**2.4**	**2.4**	**2.4**	**2.5**	**2.5**	**2.5**	**2.5**	IPOP-CMA-ES [14]
CMA+DE-MOS	18	6.0	3.6	15	14	14	13	13	13	13	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	13	53	*49e-1/8e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	21	21	*17e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	305	2006	*52e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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	11	295	554	876	1131	1310	1573	1795	2120	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	337	*83e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	118	*67e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	167	*61e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	776	*87e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	160	*67e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	96	*54e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	115	*56e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	201	*70e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	84	*64e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	327	**4.1**	**1**	**1**	**1.3**	**1.8**	**2.2**	**3.0**	**3.1**	**4.0**	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	6.7	**1.2**	**1.2**	**1.2**	**1.3**	**1.6**	**1.9**	**1.9**	**1.8**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**3.3**	**1.6**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	20	158	196	130	102	91	76	67	57	CMA+DE-MOS [12]
NEWUOA	**1**	75	*57e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**2.5**	**2.3**	4.4	6.5	7.1	7.0	6.9	6.7	Basic RCGA [16]
SPSA	213	632	*65e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 8: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	0.05	8.1	2080	4253	6653	11323	17250	22700	29520	45791	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	1646	*11e+1/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	1932	*10e+1/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	1428	*98e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	1383	*94e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	1669	*93e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	1446	*96e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	1588	*95e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	1707	*10e+1/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	1677	*11e+1/9e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	18344	275	**3.4**	**3.4**	**3.6**	**2.9**	**2.8**	**4.2**	**6.5**	*13e-6/1e5*	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**34**	**1.0**	**1.1**	**1.5**	**1.5**	**1.4**	**1.8**	**1.6**	**1.4**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	36	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**11**	*43e+0/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	624	*91e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	*22e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	9320	217	16	*59e-1/1e5*	.	.	.	.	.	.	SPSA [8]

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	2.8	15	26	38	52	65	79	94	123	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	11	3.9	4.3	4.1	4.3	4.3	4.3	4.3	4.5	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	5.7	**1.9**	**1.8**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.9**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	3.6	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.4**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	11	3.7	3.5	3.5	3.4	3.5	3.6	3.5	3.6	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	3.5	**1.4**	**1.7**	**1.9**	**2.0**	**2.0**	**2.1**	**2.2**	**2.4**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**2.0**	**1.2**	**1.3**	**1.5**	**1.6**	**1.7**	**1.7**	**1.7**	**1.8**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**2.6**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	3.3	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.4**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1.9**	19	*25e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	325	14	7.8	6.7	5.5	27060	*19e-3/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1.3**	**1.2**	**1.5**	**1.7**	**1.9**	**2.0**	**2.1**	**2.1**	**2.2**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.6**	**1.2**	**1.5**	**1.6**	**1.8**	**1.9**	**2.0**	**2.0**	**2.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	5.1	6.7	5.1	6.5	7.0	7.3	7.7	7.9	8.1	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	19	*33e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	3.5	8.1	13	176	206	195	183	167	140	Basic RCGA [16]
SPSA	311	56	59	2870	7702	*30e-2/1e5*	.	.	.	.	SPSA [8]

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	156	771	∞	∞	∞	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*62e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	*72e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*56e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*65e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*63e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	*35e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	*55e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	*53e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	*55e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	3.1	**1.4**	*18e+0/1e5*	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1.5**	**1**	*17e+0/1e6*	.	.	.	.	.	.	.	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.8**	*17e+0/1e6*	.	.	.	.	.	.	.	IPOP-CMA-ES [14]
CMA+DE-MOS	58	32	*19e+0/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	*19e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1.6**	**1.0**	*20e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	176	*42e+1/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

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	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	749	3022	∞	∞	∞	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*77e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	*84e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*70e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*77e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*79e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	*71e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	*70e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	*63e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	*94e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	3.3	**3.0**	*20e+0/1e5*	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1.0**	**1**	*18e+0/9e5*	.	.	.	.	.	.	.	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.0**	**1.1**	*18e+0/9e5*	.	.	.	.	.	.	.	IPOP-CMA-ES [14]
CMA+DE-MOS	58	236	*28e+1/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	*63e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**2.7**	*49e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	40	*48e+1/1e5*	.	.	.	.	.	.	.	.	SPSA [8]

Table 12: 20-D, running time excess ERT/ERT_{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_{best}/D	6.6	41	444	1550	1727	1799	1843	1879	1911	1966	ERT_{best}/D
(1,2)-CMA-ES	8.6	5.3	8.8	17	41	40	80	79	78	76	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	4.1	**1.3**	**2.8**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	3.8	**2.4**	**1.7**	**1.4**	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	9.1	4.2	11	23	86	*38e-1/1e4*	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	3.7	**2.6**	4.2	3.4	4.2	4.6	4.6	4.5	4.5	4.5	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.6	**2.4**	**2.2**	**2.6**	**2.5**	**2.5**	**2.5**	**2.5**	**2.6**	**2.5**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**2.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**2.7**	**2.9**	**1.7**	**1.3**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.5**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.3**	3.1	*20e+0/1e4*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	17	4.0	*18e+0/1e5*	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	3.1	**1.3**	**2.4**	**1.7**	**1.8**	**1.8**	**1.9**	**1.9**	**1.9**	**1.9**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	3.6	**2.0**	**2.7**	**2.0**	**2.0**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	IPOP-CMA-ES [14]
CMA+DE-MOS	16	3.3	5.6	7.8	7.6	8.0	8.0	7.9	7.9	7.8	CMA+DE-MOS [12]
NEWUOA	**1**	**2.8**	*29e+0/5e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	18	12	*18e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	163	1405	*53e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 13: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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$_{\text{best}}$/D	1.1	199	1493	4836	7431	8440	8440	8440	8440	8519	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	1080	*51e+1/1e4*	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	141	*26e+1/1e4*	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	302	*31e+1/1e4*	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	1086	*51e+1/1e4*	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	247	*25e+1/1e4*	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	119	240	*14e+1/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	55	*18e+1/1e4*	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	144	*29e+1/1e4*	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	233	*29e+1/9e3*	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	40	**1**	**2.7**	305	*21e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	7.9	**1.2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**5.9**	**1.0**	**1.7**	**2.0**	**2.2**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1.1**	3.9	45	**35**	**38**	**34**	**34**	**34**	**34**	**43**	CMA+DE-MOS [12]
NEWUOA	160	*24e+1/4e3*	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.8**	**1.3**	*23e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	31	472	*98e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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	1.0	1325	6093	19469	38632	48301	48321	48321	48321	49566	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	1308	*67e+1/1e4*	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	1445	*55e+1/1e4*	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	1797	*58e+1/1e4*	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	1095	*53e+1/1e4*	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	1291	*56e+1/1e4*	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	1206	*51e+1/1e4*	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	636	*53e+1/1e4*	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	705	*52e+1/1e4*	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	406	*44e+1/9e3*	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	3792	12	**22**	*74e-1/1e5*	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**41**	**1.0**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	94	**1**	**1**	**1.9**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1.4**	134	*15e+1/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	214	*47e+1/4e3*	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**10**	*46e+0/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	2955	46	*71e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 15: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	0.99	10	130	1771	2494	2874	2877	2877	2877	2931	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	14	10	1114	*16e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	8.0	**2.7**	6.5	*50e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	5.7	**2.2**	11	*52e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	16	10	*21e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	3.5	**2.3**	17	*61e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	3.4	**1.8**	5.5	*40e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	3.2	**1.5**	6.4	*45e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	4.0	**2.3**	24	*65e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	3.8	**1.5**	100	*93e-1/1e4*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	24	7.5	**1.1**	368	*14e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1.7**	**1.8**	**1.3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.6**	**1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	**4.1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1.6**	10	**1.2**	163	583	*17e-1/1e5*	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1.8**	**1**	219	*18e+0/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**2.2**	8.2	13	**89**	**141**	*11e-1/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	24	17	896	*12e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 16: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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	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	1573	5510	8949	9831	10385	10929	11446	11923	12447	13421	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*29e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	*33e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*34e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*29e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*27e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	*24e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	*23e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	*28e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	*20e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	27	129	*26e+1/1e5*	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.7**	**2.3**	**3.2**	**3.8**	**4.3**	**4.2**	**4.1**	**4.1**	**4.0**	**3.9**	IPOP-CMA-ES [14]
CMA+DE-MOS	15	**19**	**15**	**14**	**13**	**13**	**12**	**12**	**11**	**12**	CMA+DE-MOS [12]
NEWUOA	*22e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**2.1**	60	*22e+1/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	*11e+3/1e5*	.	.	.	.	.	.	.	.	.	SPSA [8]

Table 17: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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
ERT$_{\text{best}}$/D	4001	16080	32666	42568	52736	60110	64804	70428	76496	1.02e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	*30e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	*30e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	*30e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	*28e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	*29e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	*30e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	*32e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	*31e+3/1e4*	.	.	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	*24e+3/9e3*	.	.	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	*75e+2/1e5*	.	.	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1.7**	**1.6**	**1.5**	**1.7**	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.3**	IPOP-CMA-ES [14]
CMA+DE-MOS	373	*22e+2/1e5*	.	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	*26e+3/4e3*	.	.	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**27**	*14e+2/5e4*	.	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	*13e+3/1e5*	.	.	.	.	.	.	.	.	.	SPSA [8]

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	33	130	283	462	623	731	834	887	921	977	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	5.2	4.6	5.6	13	29	64	87	166	160	*11e-2/1e4*	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**2.6**	**1.9**	**2.0**	**2.2**	**2.1**	**2.3**	**2.3**	**2.4**	**2.4**	**2.4**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**2.5**	**1.4**	**1.5**	**1.7**	**1.6**	**1.7**	**1.8**	**1.8**	**1.8**	**1.7**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	4.6	4.2	6.2	18	19	26	88	*13e-3/1e4*	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**2.4**	**1.5**	**2.1**	**2.5**	**3.0**	3.2	3.0	3.1	3.2	3.4	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1.9**	**1.3**	**1.5**	**1.5**	**1.7**	**1.9**	**1.9**	**2.0**	**2.0**	**2.0**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1.6**	**1**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1.9**	**1.4**	**1.4**	**1.5**	**1.6**	**1.8**	**1.8**	**1.9**	**1.9**	**1.9**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1.0**	11	*43e+0/1e4*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	6.6	3.5	3.7	1409	*21e-1/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**2.2**	**1.2**	**1**	**1**	**1**	**1**	**1**	**1.0**	**1.0**	**1.1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	3.2	**2.5**	**2.4**	**2.3**	**2.3**	**2.4**	**2.3**	**2.4**	**2.4**	**2.5**	IPOP-CMA-ES [14]
CMA+DE-MOS	4.9	**2.9**	**2.3**	**2.7**	**2.7**	**2.8**	**2.7**	**2.8**	**2.9**	**3.0**	CMA+DE-MOS [12]
NEWUOA	**1**	11	*62e+0/6e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	37	513	*10e+1/5e4*	.	.	.	.	.	.	.	Basic RCGA [16]
SPSA	16	260	*63e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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 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
ERT$_{\text{best}}$/D	0.05	0.26	177	848	1234	2527	8644	13755	17218	26577	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	432	*21e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	62	404	*13e+0/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	80	397	*14e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	163	*20e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	101	*15e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	13	247	*13e+0/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	40	*13e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	141	394	*15e+0/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	59	*15e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	352	106	**1**	**2.3**	**2.2**	**4.9**	167	*19e-4/1e5*	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**3.5**	**1.2**	**1.1**	**1.2**	**1.2**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	6.0	**1.5**	**1**	**1**	**1**	**1.4**	**2.0**	**2.4**	**3.5**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	7.4	38	41	26	**14**	**11**	**11**	**19**	CMA+DE-MOS [12]
NEWUOA	**1**	6.5	311	*18e+0/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.0**	**1.4**	**2.8**	3.5	8.7	*57e-4/5e4*	.	.	.	Basic RCGA [16]
SPSA	282	70	*19e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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 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	0.05	0.18	1115	5339	10424	24158	53265	1.15e5	1.47e5	2.73e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	974	*29e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	1216	*34e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	943	*33e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	1353	*28e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	1273	*29e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	515	*30e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	792	*35e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	1144	*32e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	214	*29e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	12827	5698	**7.6**	**9.3**	**6.9**	**8.0**	*16e-3/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	104	**1**	**1.1**	**1.1**	**1.5**	**1.2**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**68**	**1.1**	**1**	**1**	**1**	**1**	**1.2**	**1.6**	**1.7**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.5**	73	*92e-1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	168	*30e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	7.7	*61e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	10758	8824	373	*12e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 21: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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 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	0.05	0.26	14	31	50	90	190	379	669	1513	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	42	4.2	4.3	4.2	4.3	4.6	5.3	10	*35e-7/1e4*	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	32	**1.9**	**1.7**	**1.7**	**1.8**	**2.0**	**2.0**	**2.1**	12	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	26	**1.7**	**1.5**	**1.5**	**1.4**	**1.4**	**1.5**	**1.5**	10	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	42	3.9	3.6	3.8	3.7	3.8	4.5	10	*44e-7/1e4*	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	12	**1.6**	**1.9**	**2.0**	**2.1**	**2.1**	**2.3**	**2.6**	3.9	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	5.1	**1.2**	**1.4**	**1.5**	**1.7**	**1.8**	**1.8**	**1.9**	**2.3**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	8.4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	4.6	**1.3**	**1.3**	**1.3**	**1.3**	**1.4**	**1.3**	**1.5**	**1.9**	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	16	43	*40e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	301	93	7.1	6.8	7.7	*46e-3/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	3.9	**1.1**	**1.3**	**1.6**	**1.9**	**1.9**	**1.7**	**1.5**	**1.2**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**3.4**	**1.1**	**1.3**	**1.6**	**2.1**	**2.8**	3.3	3.5	3.7	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	5.8	4.2	5.3	6.5	6.2	6.7	5.7	4.2	CMA+DE-MOS [12]
NEWUOA	**1**	5.6	27	*52e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.0**	4.4	13	51	145	*41e-4/5e4*	.	.	.	Basic RCGA [16]
SPSA	210	171	10888	*10e+0/1e5*	.	.	.	.	.	.	SPSA [8]

Table 22: 20-D, running time excess ERT/ERT_{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	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	56	2099	5147	10376	22158	35019	65608	1.87e5	ERT_{best}/D
(1,2)-CMA-ES	**1**	25	61	*87e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	7.9	28	*67e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	6.0	18	*78e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	78	*88e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	9.2	48	*69e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	7.4	21	*68e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	8.5	27	*75e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	7.3	20	*77e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**2.3**	77	*77e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
IPOP-aCMA-ES	**1**	6.0	**1.4**	**1**	**1.3**	**1.2**	**1**	**1**	**1**	**1.3**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**2.0**	**1.2**	**1.1**	**1**	**1**	**1.1**	**1.0**	**1.4**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.1**	3.0	104	97	*14e-1/1e5*	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	6.8	50	*80e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.1**	**1**	**8.3**	**10**	**11**	*98e-3/5e4*	.	.	.	Basic RCGA [16]
SPSA	1.00e6	1.00e6	3583	*11e+0/1e5*	.	.	.	.	.	.	SPSA [8]

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	340	18974	45008	1.12e5	2.13e5	3.46e5	6.75e5	1.47e7	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	148	204	*12e+0/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	*12e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	215	210	*12e+0/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	245	98	*13e+0/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	103	102	*11e+0/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	43	*10e+0/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	113	77	*11e+0/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	120	126	*12e+0/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	128	63	*11e+0/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
IPOP-aCMA-ES	**1**	**1.3**	**1**	**1.0**	**1.5**	**1.1**	**1.2**	**1.2**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1.7**	**1.1**	**1**	**1**	**1**	**1**	**1**	**1.3**	*28e-7/1e6*	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.1**	11	*68e-1/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	53	27	*10e+0/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.4**	**1.1**	*48e-1/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	1.76e6	2.41e6	*20e+1/1e5*	.	.	.	.	.	.	.	SPSA [8]

Table 24: 20-D, running time excess ERT/ERT$_{\text{best}}$ 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$_{\text{best}}$/D	0.05	0.05	10	97	926	3166	5746	9469	14794	24797	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1.3**	377	*86e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	6.7	3.4	*33e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	4.6	3.2	1544	*36e-1/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	33	654	*84e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1.2**	133	*46e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	7.0	**2.3**	*23e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	47	*40e-1/1e4*	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1.5**	21	*50e-1/1e4*	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	3.3	88	*59e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
IPOP-aCMA-ES	**1**	3.4	**1**	**4.0**	**2.3**	**1.0**	**1**	**1.1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1.0**	**1**	**1.7**	**1**	**1.1**	**1**	**1.1**	**1.3**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1.1**	4.0	**2.6**	**1**	**1.4**	**2.3**	**2.4**	**2.1**	**3.0**	CMA+DE-MOS [12]
NEWUOA	**1**	10	84	*66e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1.2**	**2.1**	8.2	8.0	6.1	6.8	23	*39e-5/5e4*	.	Basic RCGA [16]
SPSA	1.00e6	1.00e6	29207	*13e+0/1e5*	.	.	.	.	.	.	SPSA [8]

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	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	16	1.17e5	2.96e5	9.83e5	1.75e6	6.98e6	6.99e6	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	2812	*12e-1/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	453	*94e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	379	*96e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	*13e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	501	*95e-2/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	253	*88e-2/1e4*	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	254	*95e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	733	*10e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	**1**	**1.5**	*45e-2/9e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	283	321	364	**2.3**	4.0	*23e-2/1e5*	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**2.6**	**1.6**	**1**	**1.3**	**1.4**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	**3.0**	3.0	**1.5**	**1**	**1**	**1.0**	**1.0**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	**1.1**	4.7	**2.9**	*18e-2/1e5*	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	**1**	**1.3**	*49e-2/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1.1**	**1**	**1**	*33e-2/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	1.00e6	1.00e6	1.00e6	3109	**1.5**	*12e-2/1e5*	.	.	.	.	SPSA [8]

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	17	2.09e5	∞	∞	∞	∞	∞	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	*15e-1/1e4*	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	*15e-1/1e4*	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	*15e-1/1e4*	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	*14e-1/1e4*	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	*14e-1/1e4*	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	*13e-1/1e4*	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	8707	*13e-1/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	8532	*13e-1/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	122	7763	*16e-1/9e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	2514	3109	3338	39	*33e-2/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	19	*30e-2/2e5*	.	.	.	.	.	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	**17**	*28e-2/2e5*	.	.	.	.	.	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	**1.1**	**4.6**	*39e-2/1e5*	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	4.2	392	*12e-1/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1.1**	**1**	**1**	*32e-2/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	2.80e7	2.80e7	2.80e7	83636	*45e+3/1e5*	.	.	.	.	.	SPSA [8]

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	10	11182	59822	1.80e5	3.02e5	3.07e5	3.16e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**1**	39	*70e-2/1e4*	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1**	3.1	*52e-2/1e4*	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1**	4.4	*48e-2/1e4*	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**1**	38	*67e-2/1e4*	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1**	5.9	*44e-2/1e4*	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**1**	3.9	13	*39e-2/1e4*	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	3.4	*23e-2/1e4*	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1**	6.0	*53e-2/1e4*	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	7.7	**1.1**	*43e-2/9e3*	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	292	335	353	3.9	*28e-2/1e5*	.	.	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**1**	**1.3**	**1**	**1.3**	**1.3**	**1.3**	**1.3**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1**	**1.4**	**4.3**	**1.4**	**1**	**1**	**1**	**1**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	**1.1**	7.9	**1**	*44e-3/1e5*	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	3.7	**1.3**	*45e-2/4e3*	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**1**	**1.6**	4.8	*59e-3/5e4*	.	.	.	.	Basic RCGA [16]
SPSA	226	276	960	11890	36	*10e-1/1e5*	.	.	.	.	SPSA [8]

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	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	3560	66915	85265	86235	87391	1.14e5	1.15e5	1.18e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	*71e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	*65e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	*66e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	*70e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	*66e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	*64e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	*65e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	*68e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	*69e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	284	367	**3.5**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.3**	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1**	**7.2**	**10**	**10**	**10**	**7.7**	**7.6**	**7.5**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	23	10	14	14	14	11	10	10	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	189	*50e+0/1e5*	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	*70e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	**9.3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	Basic RCGA [16]
SPSA	309	350	*73e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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

∆ftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	∆ftarget
ERT$_{\text{best}}$/D	0.05	0.05	60763	5.48e5	7.28e5	9.61e5	9.64e5	9.68e5	9.71e5	9.78e5	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	*73e+0/1e4*	.	.	.	.	.	.	.	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	*74e+0/1e4*	.	.	.	.	.	.	.	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	*73e+0/1e4*	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	*72e+0/1e4*	.	.	.	.	.	.	.	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	*70e+0/1e4*	.	.	.	.	.	.	.	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	*72e+0/1e4*	.	.	.	.	.	.	.	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	*72e+0/1e4*	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	*72e+0/1e4*	.	.	.	.	.	.	.	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	*74e+0/9e3*	.	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	3132	3641	**2.7**	**1.3**	**1**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	1	**1**	**1**	**1.3**	**1**	**1**	**1**	**1**	**1**	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	**1.9**	**1.1**	**2.2**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	*59e+0/1e5*	.	.	.	.	.	.	.	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	*73e+0/4e3*	.	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	12	*34e+0/5e4*	.	.	.	.	.	.	Basic RCGA [16]
SPSA	2290	9084	*69e+0/1e5*	.	.	.	.	.	.	.	SPSA [8]

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

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Δftarget	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δftarget
ERT$_{\text{best}}$/D	0.05	0.05	204	1745	3886	3897	3908	3921	3931	3955	ERT$_{\text{best}}$/D
(1,2)-CMA-ES	**1**	**1**	**2.6**	4.8	3.1	3.1	3.1	3.1	3.2	3.2	(1,2)-CMA-ES [4, 2]
(1,2m)-CMA-ES	**1**	**1**	**1.2**	**1.6**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	(1,2m)-CMA-ES [4]
(1,2ms)-CMA-ES	**1**	**1**	**1.1**	**1.7**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	(1,2ms)-CMA-ES [4]
(1,2s)-CMA-ES	**1**	**1**	**2.3**	8.6	11	11	11	11	11	11	(1,2s)-CMA-ES [2]
(1,4)-CMA-ES	**1**	**1**	**1.2**	**2.6**	**2.0**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	(1,4)-CMA-ES [5, 3]
(1,4m)-CMA-ES	**1**	**1**	**2.1**	**2.2**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	(1,4m)-CMA-ES [5]
(1,4ms)-CMA-ES	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	(1,4ms)-CMA-ES [1, 5]
(1,4s)-CMA-ES	**1**	**1**	**1.4**	**2.5**	3.1	3.1	3.1	3.1	3.1	3.0	(1,4s)-CMA-ES [3]
avg NEWUOA	**1**	**1**	8.0	*45e-1/9e3*	.	.	.	.	.	.	avg NEWUOA [15]
CMA-EGS (IPOP,r1)	295	351	36	39	39	52	*76e-2/1e5*	.	.	.	CMA-EGS (IPOP,r1) [7]
IPOP-aCMA-ES	**1**	**1**	**1.8**	175	176	176	175	175	174	173	IPOP-aCMA-ES [11]
IPOP-CMA-ES	**1**	**1**	5.9	203	122	121	121	121	121	120	IPOP-CMA-ES [14]
CMA+DE-MOS	**1**	**1**	124	158	168	167	167	166	166	165	CMA+DE-MOS [12]
NEWUOA	**1**	**1**	11	*77e-1/4e3*	.	.	.	.	.	.	NEWUOA [15]
Basic RCGA	**1**	**1**	19	23	16	17	21	23	23	29	Basic RCGA [16]
SPSA	292	365	6871	*73e+0/1e5*	.	.	.	.	.	.	SPSA [8]

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