

Comparison tables: BBOB 2010 function testbed in 5-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 [15, 11]. The experimental set-up is described in [14].

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 [14] 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: 05-D, running time excess ERT/ERT_{best} on f_1 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

1 Sphere											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	3.1	5.1	11	20	28	35	40	47	60	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	2.2	7.8	12	16	21	27	30	40	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.3	1.4	5.5	10	14	18	22	26	34	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1.3	3.1	8.9	17	22	29	36	42	54	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1.1	1.8	5.3	8.5	12	15	19	23	30	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1.1	1.5	4.7	7.8	11	14	18	21	28	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	1.4	3.9	6.3	8.8	11	14	17	23	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1.9	1.7	4.9	7.6	11	13	17	20	26	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1.1	1.5	4.3	7.2	10	13	16	18	24	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1	1.0	3.7	6.0	8.8	11	14	16	21	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.4	8.5	24	47	67	92	118	144	192	Artif Bee Colony [8]
avg NEWUOA	1	3.3	1	1	1	1	1	1	1	1	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	2.3	27	5.0	12	18	25	33	42	50	66	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1.3	4.1	28	50	79	99	125	153	201	Adap DE (F-AUC) [10]
DE (Uniform)	1	1.3	5.9	32	60	88	117	146	178	236	DE (Uniform) [9]
IPOP-aCMA-ES	1	1.3	2.2	6.8	11	17	20	25	29	38	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1.1	1.7	6.1	11	15	20	24	30	39	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1.1	4.5	25	50	68	91	107	127	163	CMA+DE-MOS [18]
NBC-CMA	1	1.3	3.9	20	31	40	49	56	64	81	NBC-CMA [21]
POEMS	1	263	70	104	248	577	900	1199	1507	2106	POEMS [17]
PM-AdapSS-DE	1	2.1	3.3	30	56	84	109	137	168	220	PM-AdapSS-DE [9, 10]
pPOEMS	1	1.2	67	98	462	2146	4349	6231	9262	13810	pPOEMS [17, 20]
Basic RCGA	1	1.1	6.0	55	117	248	423	626	859	1311	Basic RCGA [24]
SPSA	1	43	7.6	11	14	17	20	24	27	33	SPSA [13]

Table 2: 05-D, running time excess ERT/ERT_{best} on f_2 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

2 Ellipsoid separable											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	39	23	9.0	5.4	5.5	5.4	5.3	5.2	5.1	4.9	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	24	15	5.7	3.5	3.6	3.5	3.5	3.4	3.4	3.3	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	25	14	4.6	3.0	3.0	2.9	2.9	2.8	2.8	2.7	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	30	30	10	6.5	6.9	6.8	6.8	6.7	6.5	6.4	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	11	7.0	3.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	9.2	6.3	2.5	1.7	1.9	1.8	1.8	1.8	1.8	1.8	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	7.3	5.9	2.2	1.4	1.4	1.3	1.3	1.3	1.3	1.3	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	10	7.7	2.8	1.8	1.9	1.8	1.8	1.8	1.8	1.7	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	5.1	3.5	1.8	1.1	1.1	1.1	1.1	1.1	1.1	1.1	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	5.7	3.9	1.6	1	1	1	1	1	1	1	(1+2ms)-CMA-ES [2]
Artif Bee Colony	8.4	4.5	1.7	1.6	2.2	2.5	3.0	3.4	3.7	4.5	Artif Bee Colony [8]
avg NEWUOA	1	1	1	1.8	3.5	4.6	6.0	7.2	8.2	10	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	41	27	11	6.1	5.9	5.8	5.7	5.6	5.5	5.4	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	11	7.1	2.8	1.9	2.2	2.5	2.8	3.0	3.2	3.6	Adap DE (F-AUC) [10]
DE (Uniform)	12	8.1	3.2	2.1	2.5	2.9	3.2	3.5	3.7	4.2	DE (Uniform) [9]
IPOP-aCMA-ES	6.4	4.3	1.6	1.1	1.2	1.2	1.2	1.2	1.2	1.3	IPOP-aCMA-ES [16]
IPOP-CMA-ES	8.0	5.1	2.1	1.4	1.5	1.5	1.5	1.6	1.6	1.6	IPOP-CMA-ES [22]
CMA+DE-MOS	14	10	3.6	2.5	3.0	3.3	3.6	3.9	4.1	4.6	CMA+DE-MOS [18]
NBC-CMA	14	9.0	3.6	2.3	2.5	2.6	2.6	2.6	2.6	2.7	NBC-CMA [21]
POEMS	101	73	31	26	29	31	35	38	41	46	POEMS [17]
PM-AdapSS-DE	12	8.0	3.0	2.1	2.4	2.7	3.0	3.3	3.5	3.9	PM-AdapSS-DE [9, 10]
pPOEMS	118	427	188	116	149	183	202	227	233	283	pPOEMS [17, 20]
Basic RCGA	29	23	12	11	14	17	20	24	26	77	Basic RCGA [24]
SPSA	4707	22213	<i>46e+1/1e5</i>	.	.	.	.	.	.	.	SPSA [13]

Table 3: 05-D, running time excess ERT/ERT_{best} on f_3 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

3 Rastrigin separable											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	2.7	22	38	<i>80e-1/1e4</i>	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1.2	2.4	3.4	99	247	188	166	139	124	103	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.5	6.0	296	<i>30e-1/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	2.2	14	27	152	<i>60e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1.2	4.2	292	<i>20e-1/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1.5	1.4	4.4	53	241	183	162	136	121	100	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1.3	1.4	2.7	66	<i>20e-1/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1.2	1	5.7	<i>30e-1/1e4</i>	.	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1.7	1.4	7.0	<i>30e-1/1e4</i>	.	.	.	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1.9	1.6	3.3	61	<i>20e-1/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1.3	2.4	1	1	1	1	1	1	1	1.0	Artif Bee Colony [8]
avg NEWUOA	3.3	4.4	2.9	87	<i>40e-1/6e3</i>	.	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	18	7.0	39	1520	2437	1856	1640	<i>20e-1/1e5</i>	.	.	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1.2	2.5	3.3	7.9	32	25	22	18	16	14	Adap DE (F-AUC) [10]
DE (Uniform)	1	1.4	3.4	8.4	68	52	46	39	35	29	DE (Uniform) [9]
IPOP-aCMA-ES	1.4	2.2	1.1	13	739	563	497	417	372	307	IPOP-aCMA-ES [16]
IPOP-CMA-ES	2.3	1.6	2.2	47	1701	1295	1144	960	855	706	IPOP-CMA-ES [22]
CMA+DE-MOS	1.2	3.0	1.5	1.1	1.3	1.2	1.2	1.1	1.0	1	CMA+DE-MOS [18]
NBC-CMA	1.5	1.9	1.8	20	84	64	57	48	42	35	NBC-CMA [21]
POEMS	168	70	3.9	7.4	19	16	15	14	13	12	POEMS [17]
PM-AdapSS-DE	1.5	1.9	4.8	22	90	90	133	145	171	141	PM-AdapSS-DE [9, 10]
pPOEMS	1.3	60	4.6	20	35	38	43	43	44	46	pPOEMS [17, 20]
Basic RCGA	1.1	3.6	3.3	25	48	39	42	36	33	27	Basic RCGA [24]
SPSA	54	7859	<i>21e+0/1e5</i>	.	.	.	.	.	.	.	SPSA [13]

Table 4: 05-D, running time excess ERT/ERT_{best} on f_4 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

4 Skew Rastrigin-Bueche separ											
Δf_{target}	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target}
ERT_{best}/D	0.23	6.5	171	795	991	1200	1551	1709	1842	2271	ERT_{best}/D
(1,2)-CMA-ES	3.1	7.7	71	<i>80e-1/1e4</i>	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1.2	1.8	10	<i>40e-1/1e4</i>	.	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	2.0	8.3	183	<i>30e-1/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	5.8	5.9	45	<i>98e-1/1e4</i>	.	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1.5	1.2	10	<i>40e-1/1e4</i>	.	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1.6	1.1	4.3	185	<i>40e-1/1e4</i>	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1.3	1	2.8	187	<i>30e-1/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	2.8	1.8	11	184	148	122	94	86	79	64	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	2.0	1.1	20	<i>50e-1/1e4</i>	.	.	.	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1.6	1.2	6.8	182	<i>40e-1/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1.3	3.3	1	1	1	1	1	1	1	1	Artif Bee Colony [8]
avg NEWUOA	4.8	6.1	13	<i>50e-1/8e3</i>	.	.	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	25	3.0	292	<i>70e-1/1e5</i>	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1.2	3.4	5.4	257	<i>20e-1/1e5</i>	.	.	.	.	.	Adap DE (F-AUC) [10]
DE (Uniform)	1.4	3.0	4.8	257	661	546	423	384	356	289	DE (Uniform) [9]
IPOP-aCMA-ES	1.8	1.5	1.7	<i>29e-1/2e5</i>	.	.	.	.	.	.	IPOP-aCMA-ES [16]
IPOP-CMA-ES	2.4	1.5	1.9	<i>29e-1/2e5</i>	.	.	.	.	.	.	IPOP-CMA-ES [22]
CMA+DE-MOS	1.4	1.8	1.6	1.5	1.9	1.7	1.4	1.4	1.3	1.2	CMA+DE-MOS [18]
NBC-CMA	1.5	2.7	2.4	91	427	352	273	247	230	186	NBC-CMA [21]
POEMS	211	35	4.6	18	40	34	27	26	24	21	POEMS [17]
PM-AdapSS-DE	2.9	4.0	4.6	1766	<i>30e-1/1e5</i>	.	.	.	.	.	PM-AdapSS-DE [9, 10]
pPOEMS	1.4	39	6.4	15	27	31	28	31	32	33	pPOEMS [17, 20]
Basic RCGA	1.6	3.9	14	<i>30e-1/5e4</i>	.	.	.	.	.	.	Basic RCGA [24]
SPSA	59	1230	4007	<i>36e+0/1e5</i>	.	.	.	.	.	.	SPSA [13]

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

6 Attractive sector											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	2.1	5.5	5.5	4.5	4.3	4.5	4.8	5.1	5.6	5.8	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1.3	2.7	2.5	2.2	2.1	2.0	2.0	2.1	2.0	2.1	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1.3	1.8	2.0	1.7	1.8	1.8	1.8	1.7	1.7	1.6	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	4.0	4.6	6.0	5.9	6.6	6.9	7.5	7.9	8.3	8.6	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1.8	1.0	1.5	1.6	1.5	1.6	1.6	1.7	1.8	1.8	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1.9	2.0	1.6	1.5	1.4	1.5	1.4	1.4	1.4	1.4	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1.6	1.2	1	1	1	1	1	1	1	1	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1.7	2.2	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1.5	1.5	1.7	1.4	1.7	1.6	1.5	1.6	1.6	2.0	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1	1.0	1.0	1.4	1.3	1.5	1.9	2.3	3.2	(1+2ms)-CMA-ES [2]
Artif Bee Colony	6.4	3.6	4.5	14	315	385	684	633	715	734	Artif Bee Colony [8]
avg NEWUOA	1.0	1.1	1.2	1.5	2.3	2.5	2.9	3.2	3.4	3.7	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	4.2	23	222	588	446	489	411	364	316	333	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	4.0	3.0	6.0	6.8	7.3	7.6	7.7	7.8	7.6	7.8	Adap DE (F-AUC) [10]
DE (Uniform)	3.9	3.1	8.3	8.2	8.6	8.7	8.7	8.9	8.7	8.9	DE (Uniform) [9]
IPOP-aCMA-ES	2.2	2.3	2.3	1.9	1.9	1.9	1.8	1.8	1.8	1.7	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1.6	1.4	2.3	1.9	1.9	1.9	1.9	1.8	1.8	1.8	IPOP-CMA-ES [22]
CMA+DE-MOS	9.1	4.8	7.4	7.7	7.6	7.2	7.0	6.9	6.8	6.7	CMA+DE-MOS [18]
NBC-CMA	7.6	3.7	7.6	17	13	11	9.3	8.3	7.4	6.3	NBC-CMA [21]
POEMS	85	35	24	41	47	48	50	52	52	54	POEMS [17]
PM-AdapSS-DE	5.0	3.2	7.5	7.3	7.8	7.9	8.1	8.2	8.2	8.2	PM-AdapSS-DE [9, 10]
pPOEMS	76	33	29	181	270	305	338	363	382	408	pPOEMS [17, 20]
Basic RCGA	24	12	24	64	220	409	660	<i>47e-4/5e4</i>	.	.	Basic RCGA [24]
SPSA	434	5852	26289	29313	21694	<i>44e+0/1e5</i>	.	.	.	.	SPSA [13]

Table 8: 05-D, running time excess ERT/ERT_{best} on f_8 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

8 Rosenbrock original												
	Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
	(1,2)-CMA-ES	4.9	7.9	8.3	8.7	12	13	13	13	13	14	(1,2)-CMA-ES [5, 3]
	(1,2m)-CMA-ES	3.1	3.6	4.8	4.8	6.3	7.0	7.3	7.4	7.6	7.7	(1,2m)-CMA-ES [5]
	(1,2ms)-CMA-ES	3.9	2.9	3.6	4.9	6.0	6.5	6.7	6.8	6.8	6.9	(1,2ms)-CMA-ES [5]
	(1,2s)-CMA-ES	5.9	10	10	12	16	17	18	18	18	19	(1,2s)-CMA-ES [3]
	(1,4)-CMA-ES	2.0	1.8	2.2	4.1	5.0	5.2	5.4	5.4	5.5	5.7	(1,4)-CMA-ES [6, 4]
	(1,4m)-CMA-ES	1.5	2.1	2.5	3.0	3.7	4.2	4.3	4.5	4.5	4.7	(1,4m)-CMA-ES [6]
	(1,4ms)-CMA-ES	1.1	1.7	1.9	2.4	3.0	3.2	3.3	3.4	3.4	3.6	(1,4ms)-CMA-ES [1, 6]
	(1,4s)-CMA-ES	1.1	1.5	2.1	3.4	4.3	4.7	4.8	4.9	4.9	5.0	(1,4s)-CMA-ES [4]
	(1+1)-CMA-ES	1.9	1.6	1.9	2.9	3.3	3.4	3.5	3.5	3.6	3.7	(1+1)-CMA-ES [7]
	(1+2ms)-CMA-ES	1.3	1.3	1.6	2.5	2.8	2.9	2.9	3.0	3.1	3.1	(1+2ms)-CMA-ES [2]
	Artif Bee Colony	3.3	3.2	5.1	10	46	403	2257	<i>10e-4/1e5</i>	.	.	Artif Bee Colony [8]
	avg NEWUOA	1	1	1	1	1	1	1	1	1	1	avg NEWUOA [23]
	CMA-EGS (IPOP,r1)	8.5	5.8	7.0	6.3	7.2	7.6	8.0	8.3	8.7	9.5	CMA-EGS (IPOP,r1) [12]
	Adap DE (F-AUC)	4.9	6.8	11	7.5	9.4	10	10	11	12	13	Adap DE (F-AUC) [10]
	DE (Uniform)	5.5	8.0	13	8.6	12	14	15	15	16	17	DE (Uniform) [9]
	IPOP-aCMA-ES	1.6	1.6	2.4	2.5	3.2	3.4	3.6	3.7	3.8	4.0	IPOP-aCMA-ES [16]
	IPOP-CMA-ES	2.0	2.4	3.0	4.0	4.6	4.9	5.0	5.1	5.2	5.4	IPOP-CMA-ES [22]
	CMA+DE-MOS	4.7	4.4	9.3	8.8	11	11	12	12	12	13	CMA+DE-MOS [18]
	NBC-CMA	3.3	4.8	6.1	5.9	7.1	7.6	7.7	7.9	8.0	8.4	NBC-CMA [21]
	POEMS	50	26	50	44	102	341	620	1016	1332	1994	POEMS [17]
	PM-AdapSS-DE	4.1	6.8	11	7.9	13	16	17	17	18	19	PM-AdapSS-DE [9, 10]
	pPOEMS	42	23	72	219	319	433	524	618	713	941	pPOEMS [17, 20]
	Basic RCGA	4.3	7.5	27	466	1268	2685	2684	8341	<i>54e-2/5e4</i>	.	Basic RCGA [24]
	SPSA	270	948	3216	10287	<i>50e-1/1e5</i>	.	.	.	.	.	SPSA [13]

Table 9: 05-D, running time excess ERT/ERT_{best} on f_9 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

9 Rosenbrock rotated											
Δf_{target}	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target}
ERT_{best}/D											ERT_{best}/D
(1,2)-CMA-ES	6.7	5.1	5.0	8.8	11	13	13	13	13	13	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	3.2	2.9	3.1	4.6	6.0	6.6	6.7	6.8	6.9	7.2	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	2.9	4.9	5.7	3.8	5.1	5.5	5.7	5.8	5.9	6.0	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	5.0	6.8	6.6	16	19	20	20	21	21	21	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1.6	3.9	3.8	4.4	5.3	5.6	5.6	5.7	5.7	5.9	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1.5	2.0	2.2	3.1	3.9	4.2	4.3	4.4	4.4	4.6	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1.3	2.1	2.3	3.3	3.7	3.7	3.8	3.8	3.9	4.0	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1.4	2.3	2.4	3.7	4.4	4.6	4.6	4.6	4.7	4.8	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1.1	1.2	1.4	4.1	4.3	4.3	4.3	4.3	4.3	4.4	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1.3	1.8	1.9	2.0	2.4	2.4	2.5	2.5	2.6	2.7	(1+2ms)-CMA-ES [2]
Artif Bee Colony	4.4	4.6	5.9	22	334	2189	<i>13e-3/1e5</i>	.	.	.	Artif Bee Colony [8]
avg NEWUOA	1	1	1	1	1	1	1	1	1	1	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	14	12	20	26	27	28	27	29	29	31	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	4.9	7.0	10	5.8	7.8	8.8	9.3	10	10	12	Adap DE (F-AUC) [10]
DE (Uniform)	7.3	7.9	13	7.3	10	12	13	13	14	15	DE (Uniform) [9]
IPOP-aCMA-ES	1.4	1.7	2.3	2.0	2.7	2.9	3.0	3.1	3.2	3.4	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1.5	1.6	2.5	3.5	4.2	4.3	4.5	4.5	4.7	4.9	IPOP-CMA-ES [22]
CMA+DE-MOS	5.0	6.5	5.4	3.2	8.0	10	10	10	11	11	CMA+DE-MOS [18]
NBC-CMA	4.3	5.0	6.3	3.5	5.0	5.6	5.8	6.0	6.1	6.5	NBC-CMA [21]
POEMS	59	29	46	38	84	338	618	923	1184	1924	POEMS [17]
PM-AdapSS-DE	4.6	6.7	11	7.0	10	12	13	13	13	15	PM-AdapSS-DE [9, 10]
pPOEMS	57	35	120	182	285	346	430	533	634	822	pPOEMS [17, 20]
Basic RCGA	6.0	5.7	17	2894	<i>17e-1/5e4</i>	.	.	.	.	.	Basic RCGA [24]
SPSA	427	3168	5513	18416	<i>54e-1/1e5</i>	.	.	.	.	.	SPSA [13]

Table 14: 05-D, running time excess ERT/ERT_{best} on f_{14} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

	14 Sum of different powers										
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	1.8	2.8	4.8	5.7	6.2	6.8	5.9	4.0	4.7	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	5.2	3.4	3.8	4.3	4.8	4.5	3.3	3.5	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.8	3.8	3.1	3.2	3.6	4.0	3.8	2.8	3.1	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1.2	4.3	6.2	6.2	6.3	9.3	7.7	5.3	6.0	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1.6	2.0	1.8	3.0	3.2	3.4	2.8	2.1	2.0	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1.6	2.8	2.1	2.8	3.3	3.2	2.5	1.9	2.0	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.5	2.1	1.7	2.3	2.3	2.4	2.0	1.4	1.5	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	2.5	2.4	2.0	2.4	3.0	3.1	2.3	1.6	1.7	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1.6	1.5	1.8	2.3	2.5	2.2	1.7	1.3	1.3	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1.6	1	1.4	1.7	2.0	2.2	1.6	1	1	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.9	4.2	11	19	29	557	18595	<i>27e-5/1e5</i>	.	Artif Bee Colony [8]
avg NEWUOA	1	1.7	2.5	1	1	1	1	1	1.5	387	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	4.1	25	17	7.1	7.3	8.8	14	12	8.3	76	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1.3	2.7	9.2	14	15	11	6.0	3.5	3.1	Adap DE (F-AUC) [10]
DE (Uniform)	1	1.2	2.8	10	16	18	13	7.1	4.1	3.5	DE (Uniform) [9]
IPOP-aCMA-ES	1	2.3	1.8	2.1	3.1	3.6	3.0	1.9	1.2	1.1	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1.3	2.6	2.9	3.7	4.3	3.8	2.6	1.7	1.7	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1.2	3.5	13	14	15	11	7.2	4.5	4.0	CMA+DE-MOS [18]
NBC-CMA	1	1.3	1.7	6.9	8.4	8.0	6.1	3.6	2.4	2.4	NBC-CMA [21]
POEMS	1	280	135	42	77	123	111	71	155	<i>46e-8/3e5</i>	POEMS [17]
PM-AdapSS-DE	1	1.5	1.2	9.2	17	17	12	6.7	3.8	3.3	PM-AdapSS-DE [9, 10]
pPOEMS	1	69	74	46	136	594	654	478	326	803	pPOEMS [17, 20]
Basic RCGA	1	1.1	1.9	23	39	59	224	800	4593	<i>90e-6/5e4</i>	Basic RCGA [24]
SPSA	24	120	203	104	84	69	81	331	660	<i>60e-7/1e5</i>	SPSA [13]

Table 16: 05-D, running time excess ERT/ERT_{best} on f_{16} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

16 Weierstrass											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	1.4	25	111	<i>14e-1/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	10	12	35	129	83	75	74	<i>18e-2/1e4</i>	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.2	9.4	19	29	65	<i>17e-2/1e4</i>	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1.3	35	253	<i>28e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1.1	4.4	12	23	63	<i>22e-2/1e4</i>	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1.3	1.7	2.5	9.4	11	13	35	<i>98e-4/1e4</i>	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.5	3.4	7.0	14	27	40	<i>39e-3/1e4</i>	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1.8	5.0	8.4	25	132	<i>14e-2/1e4</i>	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1.2	1.2	8.9	14	61	<i>71e-3/1e4</i>	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1.2	1.0	3.3	12	<i>62e-3/1e4</i>	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.7	1.4	4.5	72	<i>48e-3/1e5</i>	.	.	.	.	Artif Bee Colony [8]
avg NEWUOA	1	1.2	1.6	5.3	36	<i>35e-2/8e3</i>	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	1.3	20	4.7	77	312	594	817	<i>15e-2/1e5</i>	.	.	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1.2	3.9	17	23	15	15	13	13	13	Adap DE (F-AUC) [10]
DE (Uniform)	1	1.2	2.6	19	15	24	21	19	19	18	DE (Uniform) [9]
IPOP-aCMA-ES	1	1.1	2.4	1.0	1.3	1.0	1	1.0	1.0	1.0	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1.3	1.5	1	1.3	1	1.2	1.1	1.1	1.1	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1.6	1	1.2	2.0	2.2	1.5	1.5	9.3	9.4	CMA+DE-MOS [18]
NBC-CMA	1	1.3	1.9	1.7	1	1.5	1.0	1	1	1	NBC-CMA [21]
POEMS	1	57	6.5	6.0	71	102	90	82	81	80	POEMS [17]
PM-AdapSS-DE	1	1.3	2.4	53	42	29	24	22	34	33	PM-AdapSS-DE [9, 10]
pPOEMS	1	1.5	5.9	22	31	96	141	132	136	140	pPOEMS [17, 20]
Basic RCGA	1	1.4	1.5	26	37	147	427	385	<i>16e-3/5e4</i>	.	Basic RCGA [24]
SPSA	4.3	280	334	587	454	640	846	<i>12e-1/1e5</i>	.	.	SPSA [13]

Table 17: 05-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}}$ on f_{17} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

	17 Schaffer F7, condition 10										
Δ_{target} $\text{ERT}_{\text{best}}/D$	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δ_{target} $\text{ERT}_{\text{best}}/D$
(1,2)-CMA-ES	1	1.1	19	76	764	<i>14e-2/1e4</i>	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1.3	2.4	7.5	12	22	95	<i>51e-4/1e4</i>	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.3	1.9	7.1	24	37	<i>87e-4/1e4</i>	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1.3	19	122	751	<i>36e-2/1e4</i>	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	42	28	34	53	<i>27e-3/1e4</i>	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	7.3	3.2	7.7	12	132	<i>34e-4/1e4</i>	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.1	1.8	1	8.5	46	<i>12e-3/1e4</i>	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	1.5	5.0	35	91	<i>23e-3/1e4</i>	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	5.5	35	178	<i>14e-2/1e4</i>	.	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1.2	5.5	24	46	<i>38e-3/1e4</i>	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.1	2.3	22	121	2119	<i>31e-3/1e5</i>	.	.	.	Artif Bee Colony [8]
avg NEWUOA	1	1.2	1.1	59	767	<i>24e-2/1e4</i>	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	17	37	6.1	4.7	4.7	68	91	175	1356	<i>36e-5/1e5</i>	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1.2	2.0	5.4	4.3	2.1	2.0	1.9	1.6	1.3	Adap DE (F-AUC) [10]
DE (Uniform)	1	1	1.4	6.1	5.1	2.4	2.3	2.3	1.8	1.6	DE (Uniform) [9]
IPOP-aCMA-ES	1	1.3	1.5	1.2	1	1	1.1	1.1	1.2	1.1	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1.1	1.7	1.5	1.8	1.0	1.1	1.2	1	1	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1.1	1	8.2	10	6.6	7.9	6.9	4.7	3.9	CMA+DE-MOS [18]
NBC-CMA	1	1.2	2.0	3.1	3.6	1.2	1	1	2.0	3.2	NBC-CMA [21]
POEMS	1	78	79	23	29	14	21	90	121	136	POEMS [17]
PM-AdapSS-DE	1	1.3	1.5	5.7	4.4	2.1	2.1	2.1	1.6	1.4	PM-AdapSS-DE [9, 10]
pPOEMS	1	1.3	61	32	167	95	105	109	89	81	pPOEMS [17, 20]
Basic RCGA	1	1.1	1.0	79	92	58	83	181	212	<i>30e-5/5e4</i>	Basic RCGA [24]
SPSA	35977	77306	17476	2945	4218	4121	<i>85e-2/1e5</i>	.	.	.	SPSA [13]

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

	18 Schaffer F7, condition 1000										
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1.1	1.5	31	123	<i>11e-1/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	3.0	3.1	17	56	<i>16e-2/1e4</i>	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	3.5	6.9	17	51	173	<i>13e-2/1e4</i>	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	4.9	24	369	<i>19e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	2.2	2.5	19	52	176	<i>14e-2/1e4</i>	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1.4	1.6	3.6	22	40	<i>67e-3/1e4</i>	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.7	2.6	11	15	174	<i>39e-3/1e4</i>	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	3.5	7.4	22	48	<i>13e-2/1e4</i>	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	2.6	7.3	32	212	<i>42e-2/1e4</i>	.	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1.1	2.3	13	30	80	177	<i>14e-2/1e4</i>	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1.1	1	4.3	16	727	<i>14e-2/1e5</i>	.	.	.	.	Artif Bee Colony [8]
avg NEWUOA	1	3.5	8.7	167	<i>57e-2/3e4</i>	.	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	28	34	1.9	4.4	60	255	<i>22e-3/1e5</i>	.	.	.	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1.5	3.6	2.3	1.8	1.1	1.0	1.0	1.1	1.2	Adap DE (F-AUC) [10]
DE (Uniform)	1	1.7	3.3	2.6	2.0	1.2	1.1	1.1	1.2	1.3	DE (Uniform) [9]
IPOP-aCMA-ES	1	3.8	2.9	1	1.7	1.4	1.2	1	1	1	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1.6	4.8	1	1.7	2.1	2.2	1.6	1.4	1.3	1.2	IPOP-CMA-ES [22]
CMA+DE-MOS	1.1	1.1	4.1	4.1	7.2	3.6	2.5	2.2	2.0	2.4	CMA+DE-MOS [18]
NBC-CMA	1	1.5	2.6	1.9	1	1	1.8	4.7	7.7	18	NBC-CMA [21]
POEMS	2.5	167	16	14	80	431	675	2792	<i>15e-3/3e5</i>	.	POEMS [17]
PM-AdapSS-DE	1.1	2.8	3.7	2.5	1.8	1.1	1	1.0	1.1	1.2	PM-AdapSS-DE [9, 10]
pPOEMS	1.1	49	15	58	84	63	59	64	69	83	pPOEMS [17, 20]
Basic RCGA	1	2.2	6.7	54	55	73	281	477	<i>53e-4/5e4</i>	.	Basic RCGA [24]
SPSA	3.33e5	4.02e5	16464	11378	<i>31e+1/1e5</i>	.	.	.	.	.	SPSA [13]

Table 19: 05-D, running time excess ERT/ERT_{best} on f_{19} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

19 Griewank-Rosenbrock F8F2											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	1	2.4	25	<i>56e-2/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	4.8	6.9	8.7	<i>27e-2/1e4</i>	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.4	1.7	13	13	<i>39e-2/1e4</i>	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	4.3	39	<i>59e-2/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	1.6	10	<i>39e-2/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	1.6	14	6.1	<i>19e-2/1e4</i>	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	1.3	4.7	4.4	8.3	6.4	6.3	6.3	6.2	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	1.9	15	<i>34e-2/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	1	7.8	14	<i>20e-2/1e4</i>	.	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1	1.3	9.1	2.2	<i>98e-3/1e4</i>	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.2	2.7	4.4	35	82	<i>12e-2/1e5</i>	.	.	.	Artif Bee Colony [8]
avg NEWUOA	1	1	1.8	24	9.2	<i>55e-3/1e5</i>	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	17	37	7.5	8.7	19	40	<i>73e-3/1e5</i>	.	.	.	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1.1	2.3	3.9	16	12	11	11	11	11	Adap DE (F-AUC) [10]
DE (Uniform)	1	1.2	2.7	5.2	15	18	14	14	14	14	DE (Uniform) [9]
IPOP-aCMA-ES	1	1	1.1	1.8	1.1	1	1	1	1	1	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1	1.6	2.6	1.2	1.5	1.2	1.2	1.2	1.2	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1.2	2.1	1	1	4.7	5.1	5.0	5.0	5.0	CMA+DE-MOS [18]
NBC-CMA	1	1.1	3.1	4.5	20	48	37	37	36	36	NBC-CMA [21]
POEMS	1	202	81	46	97	118	91	90	90	90	POEMS [17]
PM-AdapSS-DE	1	1.7	2.8	3.0	19	26	20	20	20	31	PM-AdapSS-DE [9, 10]
pPOEMS	1	1.1	76	28	15	14	28	28	28	28	pPOEMS [17, 20]
Basic RCGA	1	1.1	2.6	1.5	4.3	<i>63e-3/5e4</i>	.	.	.	.	Basic RCGA [24]
SPSA	36	97	33	319	269	<i>59e-2/1e5</i>	.	.	.	.	SPSA [13]

Table 21: 05-D, running time excess ERT/ERT_{best} on f_{21} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

21 Gallagher 101 peaks											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	1	5.6	5.2	4.1	4.1	4.1	4.1	4.1	4.1	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	4.5	3.5	2.9	2.9	2.9	2.9	2.9	2.9	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	1.9	3.0	3.1	3.1	3.0	3.0	3.0	3.0	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	19	8.7	7.5	7.4	7.4	7.4	7.4	7.3	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	4.6	1.8	2.2	2.2	2.2	2.2	2.2	2.2	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	2.8	2.1	2.0	2.0	2.0	2.0	2.0	2.0	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	1	1.1	1	1	1	1	1	1	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	4.1	2.6	1.7	1.7	1.7	1.7	1.7	1.7	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	2.2	2.1	1.8	1.8	1.8	1.8	1.8	1.8	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1	6.1	2.3	2.4	2.4	2.4	2.4	2.4	2.4	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	2.6	1.1	2.1	3.2	4.3	7.7	27	87	Artif Bee Colony [8]
avg NEWUOA	1	1	1.4	1.5	1.1	1.1	1.1	1.1	1.1	1.1	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	1	21	2.7	69	70	87	93	106	122	150	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1	4.1	1	36	35	35	35	35	35	Adap DE (F-AUC) [10]
DE (Uniform)	1	1	3.6	20	25	25	24	24	24	24	DE (Uniform) [9]
IPOP-aCMA-ES	1	1	2.8	4.4	10	11	11	11	11	11	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1	5.0	3.4	10	10	10	10	10	10	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1	3.7	42	90	155	158	157	157	172	CMA+DE-MOS [18]
NBC-CMA	1	1	2.0	58	38	38	38	38	38	37	NBC-CMA [21]
POEMS	1	1	20	450	461	459	456	454	451	449	POEMS [17]
PM-AdapSS-DE	1	1	3.2	20	65	65	64	64	63	63	PM-AdapSS-DE [9, 10]
pPOEMS	1	1	22	6.9	69	77	79	83	86	93	pPOEMS [17, 20]
Basic RCGA	1	1	2.0	51	34	42	42	44	44	46	Basic RCGA [24]
SPSA	1	34	27	181	640	637	636	649	1318	1308	SPSA [13]

Table 22: 05-D, running time excess ERT/ERT_{best} on f_{22} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

22 Gallagher 21 peaks											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	1	6.0	12	13	13	13	13	12	12	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	3.4	4.2	8.5	8.3	8.2	7.9	7.8	7.4	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	4.9	7.9	22	22	21	20	20	19	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	7.7	12	21	21	20	20	19	18	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	2.3	4.9	7.0	6.9	6.7	6.5	6.4	6.1	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	4.0	3.9	5.3	5.2	5.1	5.0	4.9	4.6	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	3.4	4.8	6.5	6.4	6.2	6.0	5.9	5.6	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	5.5	6.9	4.9	4.9	4.7	4.6	4.6	4.3	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	1.2	3.1	3.7	3.6	3.5	3.4	3.4	3.2	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1	1.0	2.5	2.1	2.1	2.0	2.0	1.9	1.8	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	1.7	2.9	15	104	163	496	1407	2821	Artif Bee Colony [8]
avg NEWUOA	1	1	1.1	1	1	1	1	1	1	1	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	1	27	19	130	636	620	602	583	821	771	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1	1.6	78	344	335	325	314	308	289	Adap DE (F-AUC) [10]
DE (Uniform)	1	1	2.2	78	201	196	190	184	180	169	DE (Uniform) [9]
IPOP-aCMA-ES	1	1	2.9	8.1	28	121	117	114	112	105	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1	4.1	18	71	72	70	68	67	63	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1	1.2	9.1	128	211	243	236	233	221	CMA+DE-MOS [18]
NBC-CMA	1	1	1	101	124	157	152	147	144	135	NBC-CMA [21]
POEMS	1	1	378	903	1112	1085	1052	1016	997	937	POEMS [17]
PM-AdapSS-DE	1	1	1.4	1.8	201	196	190	184	180	169	PM-AdapSS-DE [9, 10]
pPOEMS	1	1	10	9.4	115	120	124	131	139	148	pPOEMS [17, 20]
Basic RCGA	1	1	2.1	59	157	374	739	734	725	1394	Basic RCGA [24]
SPSA	1	42	225	507	3356	<i>69e-2/1e5</i>	.	.	.	.	SPSA [13]

Table 23: 05-D, running time excess ERT/ERT_{best} on f_{23} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

23 Katsuuras											
Δf_{target} ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} ERT_{best}/D
(1,2)-CMA-ES	1	1	2.0	80	<i>97e-2/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	11	29	6.9	4.9	6.8	6.1	5.6	5.5	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	4.5	18	4.1	10	<i>18e-2/1e4</i>	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	2.2	83	<i>98e-2/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	4.0	22	3.0	4.8	3.2	5.9	5.5	5.4	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	2.7	10	1.8	<i>87e-3/1e4</i>	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	1.5	7.0	11	10	<i>20e-2/1e4</i>	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	2.1	18	22	<i>23e-2/1e4</i>	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	3.5	4.3	2.4	4.9	<i>10e-2/1e4</i>	.	.	.	(1+1)-CMA-ES [7]
(1+2ms)-CMA-ES	1	1	3.3	1	4.0	<i>12e-2/1e4</i>	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	1.5	15	<i>37e-2/1e5</i>	.	.	.	.	.	Artif Bee Colony [8]
avg NEWUOA	1	1	4.2	2.0	6.1	<i>15e-2/9e3</i>	.	.	.	.	avg NEWUOA [23]
CMA-EGS (IPOP,r1)	1	8.1	10	26	<i>55e-2/1e5</i>	.	.	.	.	.	CMA-EGS (IPOP,r1) [12]
Adap DE (F-AUC)	1	1	1.7	7.3	1	1	1	1.2	1.3	1.8	Adap DE (F-AUC) [10]
DE (Uniform)	1	1	1.4	9.0	1.1	1.1	1.0	1.2	1.4	1.8	DE (Uniform) [9]
IPOP-aCMA-ES	1	1	1.1	16	33	15	10	8.9	8.2	8.1	IPOP-aCMA-ES [16]
IPOP-CMA-ES	1	1	1.5	21	14	6.7	4.4	3.9	3.6	3.6	IPOP-CMA-ES [22]
CMA+DE-MOS	1	1	1.6	13	1.8	1.4	1.1	1	1	1	CMA+DE-MOS [18]
NBC-CMA	1	1	1	33	129	60	39	35	32	32	NBC-CMA [21]
POEMS	1	1	8.5	17	18	25	17	15	14	14	POEMS [17]
PM-AdapSS-DE	1	1	1.2	7.1	5.0	5.9	4.2	4.1	5.4	6.8	PM-AdapSS-DE [9, 10]
pPOEMS	1	1	2.4	56	12	17	12	12	12	14	pPOEMS [17, 20]
Basic RCGA	1	1	1.5	29	52	<i>53e-2/5e4</i>	Basic RCGA [24]
SPSA	1	105	217	1410	<i>11e-1/1e5</i>	SPSA [13]

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