

Comparison tables: BBOB 2010 function 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 [16, 12]. The experimental set-up is described in [15].

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 [7]) if an algorithm from BBOB-2009 reached the given target function value. The ERT value is given otherwise (ERT_{best} is noted as infinite). See [15] 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_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	23	13	21	31	40	48	58	67	85	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	13	6.5	12	17	23	28	34	40	52	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	8.3	5.9	11	15	20	25	31	36	45	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	20	10	19	28	35	45	53	62	81	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	11	4.7	10	14	20	25	30	36	46	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	2.7	4.1	8.2	13	17	21	26	30	39	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	5.5	3.6	6.7	10	13	16	20	23	29	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	14	4.3	8.3	13	16	21	25	29	38	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	11	4.1	8.1	12	15	19	23	27	34	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	9.3	3.7	6.8	10	13	17	20	24	31	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	4.9	24	55	86	114	165	203	238	306	Artif Bee Colony [9]
avg NEWUOA	1	27	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	7.7	85	11	19	26	34	42	49	57	72	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	4.5	37	91	137	189	239	290	343	443	Adap DE (F-AUC) [11]
DE (Uniform)	1	4.9	48	121	198	269	344	423	496	649	DE (Uniform) [10]
IPOP-aCMA-ES	1	9.2	6.2	13	19	26	32	39	44	58	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	7.7	5.0	11	18	24	30	37	43	56	IPOP-CMA-ES [23]
CMA+DE-MOS	1	5.9	19	57	71	94	124	140	166	214	CMA+DE-MOS [19]
NBC-CMA	1	5.8	16	25	34	45	54	63	73	93	NBC-CMA [22]
POEMS	1	1684	130	244	608	1045	1469	1958	2403	3321	POEMS [18]
PM-AdapSS-DE	1	4.3	41	95	158	218	275	338	399	518	PM-AdapSS-DE [10, 11]
pPOEMS	1	527	125	252	1035	3154	5744	8009	10514	16455	pPOEMS [18, 21]
Basic RCGA	1	4.0	33	105	207	345	1034	1984	2693	3761	Basic RCGA [25]
SPSA	8.4	104	7.7	11	13	16	19	22	25	31	SPSA [14]

Table 2: 10-D, running time excess $ERT/ERT_{\text{best}}^{2009}$ 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}	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	15	18	19	19	19	19	19	19	19	20	ERT_{best}/D	
(1,2)-CMA-ES	56	75	90	93	99	101	103	104	106	108	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	31	35	46	49	51	51	52	52	53	54	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	27	30	38	42	43	44	44	45	46	47	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	72	83	101	107	112	113	116	118	119	123	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	18	23	31	35	36	36	37	37	38	39	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	11	19	27	30	32	32	33	33	34	35	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	10	15	21	23	23	24	24	25	25	26	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	14	19	26	29	31	31	32	33	33	34	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	8.6	12	17	21	21	22	22	23	23	24	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	7.5	10	13	16	18	18	19	19	20	20	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	6.5	7.2	11	15	22	28	38	48	56	68	Artif Bee Colony [9]	
avg NEWUOA	2.5	6.1	16	39	67	90	124	157	184	250	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	46	52	61	66	67	68	70	70	71	73	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	20	22	29	34	40	46	52	58	64	75	Adap DE (F-AUC) [11]	
DE (Uniform)	26	30	39	47	55	64	74	82	91	109	DE (Uniform) [10]	
IPOP-aCMA-ES	7.9	11	14	16	18	19	20	20	21	23	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	12	15	21	25	26	26	27	28	28	30	IPOP-CMA-ES [23]	
CMA+DE-MOS	20	22	30	37	43	48	53	57	62	71	CMA+DE-MOS [19]	
NBC-CMA	14	21	32	37	41	43	45	46	47	49	NBC-CMA [22]	
POEMS	134	160	214	267	327	369	427	478	533	641	POEMS [18]	
PM-AdapSS-DE	23	25	32	39	46	53	59	67	74	87	PM-AdapSS-DE [10, 11]	
pPOEMS	270	440	612	1018	1277	1785	2032	2336	2621	3285	pPOEMS [18, 21]	
Basic RCGA	37	55	95	147	233	320	394	442	678	1482	Basic RCGA [25]	
SPSA	7996	<i>69e+1/1e5</i>	.	.	.	.	.	.	.	.	SPSA [14]	

Table 3: 10-D, running time excess ERT/ERT_{best} 2009 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}	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	0.10	6.9	174	360	361	364	364	364	365	365	ERT_{best}/D	
(1,2)-CMA-ES	4.4	61	<i>30e+0/1e4</i>	.	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1.6	5.3	274	<i>14e+0/1e4</i>	.	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1.3	6.2	390	<i>17e+0/1e4</i>	.	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	4.0	83	398	<i>38e+0/1e4</i>	.	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	7.9	7.2	<i>15e+0/1e4</i>	.	.	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	2.2	3.5	91	<i>11e+0/1e4</i>	.	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	3.3	3.5	76	<i>99e-1/1e4</i>	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	3.1	6.0	376	<i>18e+0/1e4</i>	.	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	4.1	14	838	<i>18e+0/1e4</i>	.	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	7.3	2.4	835	<i>20e+0/1e4</i>	.	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	2.3	6.0	1.6	2.2	2.5	2.8	3.1	3.4	3.8	4.5	Artif Bee Colony [9]	
avg NEWUOA	11	16	<i>21e+0/7e3</i>	.	.	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	51	5.0	78	3903	3893	3864	3859	3859	3857	<i>50e-1/1e5</i>	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	2.1	15	200	1212	3965	3936	3930	3929	3926	3921	Adap DE (F-AUC) [11]	
DE (Uniform)	1.7	20	211	4009	<i>30e-1/1e5</i>	.	.	.	.	.	DE (Uniform) [10]
IPOP-aCMA-ES	3.5	2.9	5.6	643	2678	2659	2656	2655	2653	2651	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	2.6	3.2	2.7	1658	5796	5752	5744	5742	5737	5729	IPOP-CMA-ES [23]	
CMA+DE-MOS	2.0	8.1	2.1	3.0	3.7	4.0	4.4	4.7	4.9	5.6	CMA+DE-MOS [19]	
NBC-CMA	1.7	6.0	8.2	1213	<i>40e-1/3e4</i>	.	.	.	.	.	NBC-CMA [22]
POEMS	678	43	6.8	28	54	56	58	62	64	70	POEMS [18]	
PM-AdapSS-DE	2.2	18	93	508	646	1876	3944	<i>10e-1/1e5</i>	.	.	PM-AdapSS-DE [10, 11]	
pPOEMS	2.4	45	8.2	54	134	140	154	165	186	227	pPOEMS [18, 21]	
Basic RCGA	2.4	12	8.2	133	255	330	333	335	336	339	Basic RCGA [25]	
SPSA	6.67e5	12992	<i>87e+0/1e5</i>	.	.	.	.	.	.	.	SPSA [14]

Table 4: 10-D, running time excess ERT/ERT_{best} 2009 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	0.10	10	223	363	366	370	371	374	374	2877	ERT_{best}/D
(1,2)-CMA-ES	3.4	67	<i>41e+0/1e4</i>	.	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	6.4	6.2	306	<i>18e+0/1e4</i>	.	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	7.8	8.7	209	<i>18e+0/1e4</i>	.	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	13	145	<i>51e+0/1e4</i>	.	.	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	5.6	6.2	<i>22e+0/1e4</i>	.	.	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	5.7	5.4	<i>17e+0/1e4</i>	.	.	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	8.1	5.4	311	<i>15e+0/1e4</i>	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	3.0	23	<i>20e+0/1e4</i>	.	.	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	5.7	19	317	<i>27e+0/1e4</i>	.	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	4.1	21	<i>26e+0/1e4</i>	.	.	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	3.1	5.4	1.3	3.2	4.4	5.1	5.7	6.3	6.7	0.99	Artif Bee Colony [9]
avg NEWUOA	13	42	<i>27e+0/1e4</i>	.	.	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	93	5.5	362	<i>90e-1/1e5</i>	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	4.1	20	92	<i>60e-1/1e5</i>	.	.	.	.	.	.	Adap DE (F-AUC) [11]
DE (Uniform)	3.1	26	111	<i>50e-1/1e5</i>	.	.	.	.	.	.	DE (Uniform) [10]
IPOP-aCMA-ES	6.3	3.1	7.6	<i>60e-1/1e5</i>	.	.	.	.	.	.	IPOP-aCMA-ES [17]
IPOP-CMA-ES	2.9	3.4	7.5	<i>60e-1/2e5</i>	.	.	.	.	.	.	IPOP-CMA-ES [23]
CMA+DE-MOS	2.2	8.5	1.9	6.8	8.2	8.6	9.1	9.4	10	1.4	CMA+DE-MOS [19]
NBC-CMA	2.6	6.0	8.1	<i>60e-1/3e4</i>	.	.	.	.	.	.	NBC-CMA [22]
POEMS	1209	34	6.6	40	114	116	120	120	123	17	POEMS [18]
PM-AdapSS-DE	3.9	22	92	<i>60e-1/1e5</i>	.	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	2.3	37	10	68	285	298	316	332	348	51	pPOEMS [18, 21]
Basic RCGA	2.3	19	107	<i>79e-1/5e4</i>	.	.	.	.	.	.	Basic RCGA [25]
SPSA	185	8979	<i>99e+0/1e5</i>	.	.	.	.	.	.	.	SPSA [14]

Table 5: 10-D, running time excess $ERT/ERT_{\text{best}} 2009$ on f_5 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

5 Linear slope											
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	2.1	5.7	6.9	7.1	7.1	7.1	7.1	7.1	7.1	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1.0	2.9	3.4	3.7	3.8	3.8	3.8	3.8	3.8	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	0.97	3.5	4.0	4.1	4.1	4.1	4.1	4.1	4.1	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1.5	6.3	8.2	8.3	8.3	8.3	8.3	8.3	8.3	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1.3	4.3	5.4	5.6	5.6	5.6	5.6	5.6	5.6	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1.3	4.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.0	3.4	4.1	4.1	4.2	4.2	4.2	4.2	4.2	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1.3	3.0	4.1	4.1	4.2	4.2	4.2	4.2	4.2	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	0.75	2.8	3.2	3.3	3.3	3.4	3.4	3.4	3.4	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	0.80	2.1	2.7	3.0	3.0	3.0	3.0	3.0	3.0	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	8.8	51	71	75	75	75	75	75	75	Artif Bee Colony [9]
avg NEWUOA	1	1.9	2.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	1	3.2	5.4	6.1	6.1	6.1	6.1	6.1	6.1	6.1	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	4.7	31	39	44	44	44	44	44	44	Adap DE (F-AUC) [11]
DE (Uniform)	1	6.7	43	53	56	58	58	58	58	58	DE (Uniform) [10]
IPOP-aCMA-ES	1	2.0	5.2	6.7	6.8	6.8	6.8	6.8	6.8	6.8	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	2.0	4.9	5.9	6.2	6.2	6.2	6.2	6.2	6.2	IPOP-CMA-ES [23]
CMA+DE-MOS	1	6.2	34	54	54	54	54	54	54	54	CMA+DE-MOS [19]
NBC-CMA	1	8.2	36	43	43	43	43	43	43	43	NBC-CMA [22]
POEMS	1	135	198	235	263	274	277	277	277	277	POEMS [18]
PM-AdapSS-DE	1	4.8	39	52	54	54	54	54	54	54	PM-AdapSS-DE [10, 11]
pPOEMS	1	127	196	232	253	272	275	276	276	276	pPOEMS [18, 21]
Basic RCGA	1	28	391	791	1242	1958	3124	4360	5138	73940	Basic RCGA [25]
SPSA	1	2.3	6.2	8.2	8.6	8.7	8.7	8.7	8.7	8.7	SPSA [14]

Table 6: 10-D, running time excess ERT/ERT_{best} 2009 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}	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	2.8	10	41	62	83	104	129	157	184	237	ERT_{best}/D
(1,2)-CMA-ES	4.0	8.8	7.1	9.2	12	19	21	25	35	90	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	3.1	4.4	2.4	2.2	2.3	2.4	2.3	2.4	2.4	2.4	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	4.1	3.9	1.9	1.9	2.1	2.1	2.1	2.1	2.2	2.5	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	8.4	13	10	17	35	44	55	77	77	597	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	2.7	3.1	2.1	2.3	2.4	2.5	2.6	2.6	2.7	2.8	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	2.1	2.9	1.6	1.6	1.7	1.7	1.8	1.8	1.8	1.7	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1.4	1.7	1.1	1.3	1.3	1.4	1.4	1.4	1.4	1.5	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1.7	3.0	1.7	2.2	2.6	2.8	2.9	3.7	4.2	4.6	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1.9	2.3	1.4	5.9	26	78	246	938	<i>26e-4/1e4</i>	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1.5	1.6	1.1	2.6	14	75	155	937	<i>21e-4/1e4</i>	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	10	4.7	12	232	598	2036	2247	2797	7830	6289	Artif Bee Colony [9]
avg NEWUOA	1.5	1.6	0.97	0.99	1.0	1.0	1.1	1.1	1.1	1.1	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	11	14	35	73	188	269	239	212	198	209	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	12	15	11	12	13	13	13	13	12	12	Adap DE (F-AUC) [11]
DE (Uniform)	12	23	15	16	17	17	17	16	16	16	DE (Uniform) [10]
IPOP-aCMA-ES	2.1	3.8	1.8	1.9	1.8	1.8	1.7	1.7	1.6	1.6	IPOP-aCMA-ES [17]
IPOP-CMA-ES	2.5	3.2	1.9	1.9	1.9	1.9	1.8	1.8	1.7	1.7	IPOP-CMA-ES [23]
CMA+DE-MOS	14	10	7.8	7.1	6.7	6.4	6.2	5.8	5.5	5.2	CMA+DE-MOS [19]
NBC-CMA	10	4.9	31	21	17	14	11	10	8.4	7.0	NBC-CMA [22]
POEMS	95	35	31	39	43	45	45	45	44	44	POEMS [18]
PM-AdapSS-DE	11	20	14	14	15	15	14	14	13	13	PM-AdapSS-DE [10, 11]
pPOEMS	99	35	40	71	128	138	149	151	156	168	pPOEMS [18, 21]
Basic RCGA	38	14	39	83	136	313	407	941	<i>56e-5/5e4</i>	.	Basic RCGA [25]
SPSA	1269	67510	35633	<i>22e+1/1e5</i>	.	.	.	.	.	.	SPSA [14]

Table 8: 10-D, running time excess $ERT/ERT_{\text{best}}^{2009}$ 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}	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	13	14	10	20	19	19	19	19	19	19	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	4.8	3.0	2.3	7.6	7.7	7.7	7.7	7.7	7.7	7.8	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	3.9	4.8	2.9	6.8	6.7	6.6	6.6	6.7	6.7	6.8	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	8.9	12	8.4	24	23	22	22	22	22	22	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	4.4	4.8	3.0	7.0	6.8	6.7	6.6	6.7	6.7	6.8	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	3.1	2.3	1.6	6.1	5.9	5.8	5.8	5.8	5.8	5.9	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	2.9	1.7	1.2	5.3	5.1	4.9	4.9	4.9	4.9	4.9	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	3.3	3.1	3.3	5.0	5.0	4.9	5.0	5.0	5.0	5.1	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	2.3	2.8	2.2	3.5	3.5	3.5	3.5	3.6	3.6	3.8	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	2.5	2.1	1.9	3.5	3.4	3.3	3.3	3.4	3.4	3.6	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	11	8.6	7.2	7.4	19	77	549	<i>40e-5/1e5</i>	.	.	Artif Bee Colony [9]	
avg NEWUOA	1.2	1.2	0.99	0.87	0.84	0.83	0.82	0.82	0.82	0.82	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	8.9	7.2	5.2	8.4	8.3	8.3	8.4	8.7	9.1	10	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	23	16	14	14	15	15	15	16	16	18	Adap DE (F-AUC) [11]	
DE (Uniform)	33	24	20	20	21	21	22	23	23	26	DE (Uniform) [10]	
IPOP-aCMA-ES	3.9	3.2	2.6	4.4	4.4	4.3	4.3	4.4	4.4	4.6	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	4.0	3.1	2.3	3.7	3.9	3.9	4.0	4.1	4.2	4.3	IPOP-CMA-ES [23]	
CMA+DE-MOS	16	10	6.7	12	12	12	12	12	13	13	CMA+DE-MOS [19]	
NBC-CMA	9.4	4.3	3.1	6.4	7.1	7.5	7.6	7.8	7.9	8.1	NBC-CMA [22]	
POEMS	74	57	64	706	1065	1469	2026	2936	<i>40e-6/3e5</i>	.	POEMS [18]	
PM-AdapSS-DE	25	19	16	20	21	22	22	23	23	25	PM-AdapSS-DE [10, 11]	
pPOEMS	75	53	162	200	199	198	207	233	270	378	pPOEMS [18, 21]	
Basic RCGA	17	22	102	1998	6723	<i>56e-1/5e4</i>	.	.	.	.	Basic RCGA [25]	
SPSA	457	1339	8736	<i>13e+0/1e5</i>	.	.	.	.	.	.	SPSA [14]	

Table 14: 10-D, running time excess ERT/ERT_{best} 2009 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	3.8	9.1	6.7	6.9	7.6	7.9	10	12	4.3	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	4.0	4.2	3.7	3.9	4.2	4.4	6.3	7.7	2.5	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	2.9	3.4	2.8	3.0	3.3	3.6	5.3	6.7	2.1	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	23	10	6.6	7.1	7.7	7.6	11	13	4.0	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	7.5	2.8	2.8	3.2	3.7	3.6	5.3	6.1	1.8	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	3.3	2.3	2.4	2.7	3.0	3.1	4.4	5.5	1.6	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.9	2.1	1.9	2.2	2.5	2.6	3.6	4.4	1.3	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	7.3	2.8	2.5	2.9	3.1	3.1	4.1	4.8	1.4	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	3.4	2.0	1.9	2.3	2.4	2.4	3.8	4.9	1.1	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	3.1	1.8	1.6	2.0	2.1	2.1	3.0	3.7	1.0	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.9	6.4	17	22	35	703	<i>64e-5/1e5</i>	.	.	Artif Bee Colony [9]
avg NEWUOA	1	9.2	1.7	1.3	1.3	1.2	1.1	2.2	7.1	64	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	8.9	71	9.2	5.7	6.1	6.2	8.4	19	26	64	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	2.1	10	18	26	24	16	15	13	2.8	Adap DE (F-AUC) [11]
DE (Uniform)	1	2.0	9.5	25	34	33	22	22	19	4.1	DE (Uniform) [10]
IPOP-aCMA-ES	1	3.7	2.1	2.8	3.7	3.8	3.1	3.6	3.5	0.84	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	5.4	2.2	2.9	3.8	4.2	3.8	4.8	5.0	1.3	IPOP-CMA-ES [23]
CMA+DE-MOS	1	3.0	7.5	13	14	14	13	15	14	3.2	CMA+DE-MOS [19]
NBC-CMA	1	2.3	5.2	5.7	6.5	6.3	5.1	6.6	7.1	1.9	NBC-CMA [22]
POEMS	1	847	73	53	105	142	116	186	1491	<i>33e-7/3e5</i>	POEMS [18]
PM-AdapSS-DE	1	1.9	13	21	29	27	19	18	15	3.2	PM-AdapSS-DE [10, 11]
pPOEMS	1	103	73	61	193	496	570	818	987	<i>61e-8/3e5</i>	pPOEMS [18, 21]
Basic RCGA	1	2.1	5.5	30	44	91	1052	13979	<i>76e-5/5e4</i>	.	Basic RCGA [25]
SPSA	21	348	97	74	61	49	53	293	1046	<i>43e-7/1e5</i>	SPSA [14]

Table 16: 10-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}}$ 2009 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}	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target}	
$\text{ERT}_{\text{best}}/D$	0.10	0.10	43	703	1578	4567	5115	6511	6580	7157	$\text{ERT}_{\text{best}}/D$	
(1,2)-CMA-ES	1	1.7	553	<i>11e+0/1e4</i>	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	1	1.4	26	96	<i>25e-1/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	1	1.3	32	96	<i>32e-1/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	1	1.3	779	<i>15e+0/1e4</i>	.	.	.	.	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	1	1.5	22	45	<i>20e-1/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	1	1.4	11	14	91	<i>64e-2/1e4</i>	.	.	.	.	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	1	1.4	12	24	<i>13e-1/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	1	1.5	27	97	<i>28e-1/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	1	1.7	5.2	46	<i>16e-1/1e4</i>	.	.	.	.	.	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	1	1.2	4.2	97	<i>13e-1/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	1	1.3	3.3	149	<i>92e-2/1e5</i>	.	.	.	.	.	Artif Bee Colony [9]	
avg NEWUOA	1	1.5	3.3	41	<i>13e-1/1e4</i>	.	.	.	.	.	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	1	53	14	20	89	308	<i>10e-2/1e5</i>	.	.	.	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	1	1.7	70	<i>51e-1/1e5</i>	.	.	.	.	.	.	Adap DE (F-AUC) [11]	
DE (Uniform)	1	1.7	104	<i>45e-1/1e5</i>	.	.	.	.	.	.	DE (Uniform) [10]	
IPOP-aCMA-ES	1	1.3	1.6	0.95	1.2	0.84	1.1	0.91	0.92	0.87	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	1	1.3	3.5	1.2	1.2	0.87	0.90	0.72	0.75	0.71	IPOP-CMA-ES [23]	
CMA+DE-MOS	1	1.3	2.6	0.55	0.99	1.2	1.4	1.1	1.2	1.2	CMA+DE-MOS [19]	
NBC-CMA	1	1.5	9.4	0.71	1.3	1.8	2.9	3.5	11	19	NBC-CMA [22]	
POEMS	1	1	11	3.8	130	428	382	301	298	274	POEMS [18]	
PM-AdapSS-DE	1	1.5	70	<i>34e-1/1e5</i>	.	.	.	.	.	.	PM-AdapSS-DE [10, 11]	
pPOEMS	1	1.3	16	18	89	189	243	192	192	178	pPOEMS [18, 21]	
Basic RCGA	1	1.3	7.9	13	38	50	142	112	<i>87e-3/5e4</i>	.	Basic RCGA [25]	
SPSA	1	1551	1239	2107	<i>56e-1/1e5</i>	.	.	.	.	.	SPSA [14]	

Table 17: 10-D, running time excess ERT/ERT_{best} 2009 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										
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	2.5	119	3362	<i>25e-1/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	2.7	5.5	55	196	229	<i>18e-2/1e4</i>	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.1	31	52	327	<i>34e-2/1e4</i>	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1.2	204	3343	<i>24e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	9.3	82	<i>38e-2/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	3.1	22	324	<i>24e-2/1e4</i>	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.1	2.6	51	214	<i>15e-2/1e4</i>	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1.7	3.4	121	<i>69e-2/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1.3	17	443	<i>13e-1/1e4</i>	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	6.2	717	<i>13e-1/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.2	11	954	<i>65e-2/1e5</i>	.	.	.	.	.	Artif Bee Colony [9]
avg NEWUOA	1	1.1	2.2	987	<i>10e-1/3e4</i>	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	24	59	6.2	1.4	0.77	0.74	2.0	4.4	70	530	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1.1	7.4	8.0	3.2	1.8	1.6	1.4	1.5	1.5	Adap DE (F-AUC) [11]
DE (Uniform)	1	1.1	5.4	11	4.6	2.7	2.4	2.1	2.0	2.0	DE (Uniform) [10]
IPOP-aCMA-ES	1	1.1	2.4	1.2	1.8	1.2	1.3	1.0	1.0	1.0	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1.6	2.7	2.6	1.5	0.83	1.0	0.90	0.88	1.0	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1.4	3.3	30	10	4.1	3.3	4.8	3.8	3.3	CMA+DE-MOS [19]
NBC-CMA	1	1.1	2.9	1.8	0.72	0.87	1.6	7.7	31	<i>16e-6/3e4</i>	NBC-CMA [22]
POEMS	1	274	86	24	111	42	84	104	178	1591	POEMS [18]
PM-AdapSS-DE	1	1.2	4.6	8.5	3.6	2.0	1.8	1.5	1.5	1.5	PM-AdapSS-DE [10, 11]
pPOEMS	1	1.2	91	32	72	54	52	45	44	146	pPOEMS [18, 21]
Basic RCGA	1	1.1	5.8	16	48	36	40	50	111	<i>16e-5/5e4</i>	Basic RCGA [25]
SPSA	6.67e5	8.76e5	34195	32685	<i>86e-1/1e5</i>	.	.	.	.	.	SPSA [14]

Table 18: 10-D, running time excess ERT/ERT_{best} 2009 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}	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	0.10	0.19	24	84	701	1593	2754	3161	3723	4271	ERT_{best}/D	
(1,2)-CMA-ES	2.6	18	139	<i>78e-1/1e4</i>	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	1	4.2	1.8	171	<i>11e-1/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	1.1	8.8	7.6	224	<i>13e-1/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	1.9	19	297	<i>74e-1/1e4</i>	.	.	.	.	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	1	10	61	384	<i>18e-1/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	1	5.7	13	82	205	<i>58e-2/1e4</i>	.	.	.	.	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	1	1.8	6.4	137	<i>83e-2/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	1	6.6	39	811	<i>23e-1/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	1.4	6.6	93	<i>48e-1/1e4</i>	.	.	.	.	.	.	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	1	2.5	63	<i>39e-1/1e4</i>	.	.	.	.	.	.	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	1	4.7	63	7923	<i>18e-1/1e5</i>	.	.	.	.	.	Artif Bee Colony [9]	
avg NEWUOA	1	10	73	<i>32e-1/9e4</i>	.	.	.	.	.	.	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	40	46	1.8	4.7	3.7	4.3	23	135	<i>54e-5/1e5</i>	.	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	1	2.9	7.6	6.5	1.4	0.96	0.76	0.81	0.90	0.99	Adap DE (F-AUC) [11]	
DE (Uniform)	1.3	3.4	9.5	9.0	2.0	1.3	1.0	1.1	1.2	1.4	DE (Uniform) [10]	
IPOP-aCMA-ES	1	7.7	1.2	1.6	0.82	0.97	0.78	0.88	0.80	0.88	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	1	2.1	1.1	1.7	0.95	0.95	0.84	1.0	0.97	0.91	IPOP-CMA-ES [23]	
CMA+DE-MOS	1.1	2.8	5.4	3.5	0.85	1.2	0.87	1.0	1.1	1.3	CMA+DE-MOS [19]	
NBC-CMA	1	3.0	2.0	1.5	0.54	2.4	9.1	139	118	<i>31e-5/3e4</i>	NBC-CMA [22]	
POEMS	1	613	20	285	162	287	439	1332	<i>25e-3/3e5</i>	.	POEMS [18]	
PM-AdapSS-DE	1.1	1.8	8.4	7.4	1.6	1.1	0.81	0.89	0.95	1.0	PM-AdapSS-DE [10, 11]	
pPOEMS	1	74	20	116	42	46	54	93	123	230	pPOEMS [18, 21]	
Basic RCGA	1	1.6	8.3	114	36	48	58	229	<i>14e-3/5e4</i>	.	Basic RCGA [25]	
SPSA	8.78e5	1.04e6	<i>66e+1/1e5</i>	.	.	.	.	.	.	.	SPSA [14]	

Table 19: 10-D, running time excess ERT/ERT_{best} 2009 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	514	7.33e5	<i>24e-1/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	128	1.55e5	<i>90e-2/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	164	2.24e5	<i>11e-1/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	239	1.46e6	<i>32e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	82	1.99e5	<i>13e-1/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	68	45284	<i>58e-2/1e4</i>	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	57	43406	<i>68e-2/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	79	75584	<i>77e-2/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	63	65610	<i>85e-2/1e4</i>	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	54	22281	<i>55e-2/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1.1	410	4.22e6	<i>12e-1/1e5</i>	.	.	.	.	.	Artif Bee Colony [9]
avg NEWUOA	1	1	48	7.08e5	<i>83e-2/1e5</i>	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	23	64	223	28056	422	<i>20e-2/1e5</i>	.	.	.	.	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1.2	303	4.04e5	<i>59e-2/1e5</i>	.	.	.	.	.	Adap DE (F-AUC) [11]
DE (Uniform)	1	1.2	390	8.37e5	<i>52e-2/1e5</i>	.	.	.	.	.	DE (Uniform) [10]
IPOP-aCMA-ES	1	1	68	9042	10	0.61	0.53	0.53	0.53	0.54	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1	56	12509	8.9	0.55	0.53	0.53	0.53	0.53	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1.1	212	5852	6.5	1.2	1.1	1.1	1.1	1.1	CMA+DE-MOS [19]
NBC-CMA	1	1.2	117	2.11e6	<i>15e-1/3e4</i>	.	.	.	.	.	NBC-CMA [22]
POEMS	1	253	2538	5.19e5	4011	<i>55e-2/3e5</i>	.	.	.	.	POEMS [18]
PM-AdapSS-DE	1	1.7	256	5.48e5	<i>81e-2/1e5</i>	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	1	1.2	2624	3.58e5	4022	<i>23e-2/3e5</i>	.	.	.	.	pPOEMS [18, 21]
Basic RCGA	1	1.2	167	70727	157	<i>17e-2/5e4</i>	.	.	.	.	Basic RCGA [25]
SPSA	44	126	658	6.65e6	<i>18e-1/1e5</i>	.	.	.	.	.	SPSA [14]

Table 20: 10-D, running time excess ERT/ERT_{best} 2009 on f_{20} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

	20 Schwefel $x*\sin(x)$										
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	11	12	12	10	<i>99e-2/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	6.2	6.6	6.7	5.6	<i>91e-2/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	5.7	5.8	5.9	2.3	<i>87e-2/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	11	11	12	9.5	<i>10e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	4.9	5.1	5.3	2.6	<i>89e-2/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	3.9	4.5	4.5	2.3	<i>79e-2/1e4</i>	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	3.2	3.6	3.9	2.6	<i>69e-2/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	3.8	4.0	4.4	3.1	<i>87e-2/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	3.4	3.4	3.8	3.9	<i>87e-2/1e4</i>	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	2.5	2.7	2.9	3.3	<i>83e-2/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	8.6	9.5	10	0.18	1.3	1.3	1.3	1.4	2.1	6.0	Artif Bee Colony [9]
avg NEWUOA	1.5	1.3	1.2	37	<i>12e-1/8e3</i>	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	10	11	11	<i>18e-1/1e5</i>	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	19	27	28	18	26	25	25	25	25	24	Adap DE (F-AUC) [11]
DE (Uniform)	30	35	38	15	5.4	5.3	5.2	5.2	5.1	5.1	DE (Uniform) [10]
IPOP-aCMA-ES	3.4	4.3	4.3	2.3	0.84	0.86	0.87	0.87	0.88	0.89	IPOP-aCMA-ES [17]
IPOP-CMA-ES	3.5	4.3	4.6	2.8	0.78	0.79	0.79	0.80	0.80	0.81	IPOP-CMA-ES [23]
CMA+DE-MOS	15	20	21	0.76	0.14	0.19	0.26	0.29	0.30	0.42	CMA+DE-MOS [19]
NBC-CMA	6.2	11	12	5.9	<i>77e-2/3e4</i>	.	.	.	.	.	NBC-CMA [22]
POEMS	99	100	104	1.1	15	15	15	15	14	14	POEMS [18]
PM-AdapSS-DE	24	30	31	23	<i>36e-2/1e5</i>	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	104	105	104	3.4	15	15	15	15	15	15	pPOEMS [18, 21]
Basic RCGA	10	13	14	484	<i>17e-1/5e4</i>	.	.	.	.	.	Basic RCGA [25]
SPSA	12	15	19	<i>19e-1/1e5</i>	.	.	.	.	.	.	SPSA [14]

Table 21: 10-D, running time excess ERT/ERT_{best} 2009 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	18	14	22	21	21	20	19	8.4	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	8.4	11	14	14	13	13	12	5.5	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	4.3	5.4	7.3	7.1	7.0	6.6	6.4	2.9	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	39	20	18	18	17	17	16	7.2	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	6.2	6.4	11	11	10	10	10	4.3	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	4.2	6.7	4.7	4.6	4.5	4.3	4.1	1.9	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	4.8	4.3	3.6	3.5	3.4	3.3	3.1	1.4	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	7.0	6.4	6.9	6.8	6.6	6.3	6.0	2.7	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	4.2	6.3	4.4	4.3	4.2	4.0	3.8	1.7	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	4.1	6.5	6.0	5.8	5.7	5.4	5.2	2.3	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	8.0	2.9	8.5	10	12	24	39	82	Artif Bee Colony [9]
avg NEWUOA	1	1	3.2	8.2	4.7	4.7	4.5	4.3	4.1	1.9	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	1	62	13	101	60	59	58	56	55	25	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1	23	114	84	83	81	77	74	33	Adap DE (F-AUC) [11]
DE (Uniform)	1	1	25	115	116	113	110	105	101	45	DE (Uniform) [10]
IPOP-aCMA-ES	1	1	2.6	31	58	57	55	53	50	23	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1	5.9	14	52	51	50	47	45	21	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1	25	347	512	503	489	466	447	201	CMA+DE-MOS [19]
NBC-CMA	1	1	12	275	188	184	179	170	163	73	NBC-CMA [22]
POEMS	1	1	3498	2668	1648	1615	1570	1494	1431	642	POEMS [18]
PM-AdapSS-DE	1	1	18	226	262	256	249	237	227	102	PM-AdapSS-DE [10, 11]
pPOEMS	1	1	38	746	980	1122	1317	1259	1211	547	pPOEMS [18, 21]
Basic RCGA	1	1	121	120	86	86	86	84	82	38	Basic RCGA [25]
SPSA	1	102	94	1309	1543	1515	1488	2894	2780	1272	SPSA [14]

Table 22: 10-D, running time excess ERT/ERT_{best} 2009 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	19	9.2	30	29	28	28	23	19	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	18	9.3	18	17	16	16	14	11	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	20	11	25	24	24	23	19	16	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	62	12	40	39	38	37	31	25	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	15	7.0	10	9.3	9.1	9.0	7.5	6.1	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	12	6.6	12	11	11	11	8.9	7.2	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	8.2	4.1	14	14	14	13	11	8.9	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	16	8.4	13	13	12	12	10	8.2	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	9.3	4.5	4.0	3.8	3.8	3.7	3.1	2.5	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	22	4.5	5.0	4.8	4.7	4.6	3.9	3.1	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	17	4.3	34	364	<i>13e-3/1e5</i>	.	.	.	Artif Bee Colony [9]
avg NEWUOA	1	1	3.6	2.6	2.1	2.1	2.0	2.0	1.7	1.4	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	1	53	22	417	1024	982	957	939	784	628	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1	32	706	<i>20e-1/1e5</i>	.	.	.	.	.	Adap DE (F-AUC) [11]
DE (Uniform)	1	1	31	405	2206	2117	2061	2024	1689	1354	DE (Uniform) [10]
IPOP-aCMA-ES	1	1	44	203	663	636	620	608	508	407	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1	42	90	666	640	623	612	510	409	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1	171	538	1268	1218	1187	1166	974	781	CMA+DE-MOS [19]
NBC-CMA	1	1	792	221	<i>51e-1/3e4</i>	.	.	.	.	.	NBC-CMA [22]
POEMS	1	1	4774	4231	3072	2950	2873	2822	2356	1892	POEMS [18]
PM-AdapSS-DE	1	1	28	706	<i>20e-1/1e5</i>	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	1	1	2258	363	424	412	404	401	338	276	pPOEMS [18, 21]
Basic RCGA	1	1	711	205	343	520	<i>69e-2/5e4</i>	.	.	.	Basic RCGA [25]
SPSA	3.3	69	2954	831	<i>51e-1/1e5</i>	.	.	.	.	.	SPSA [14]

Table 23: 10-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}}^{2009}$ 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											
$\Delta\text{ftarget}$ $\text{ERT}_{\text{best}}/D$	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	$\Delta\text{ftarget}$ $\text{ERT}_{\text{best}}/D$
(1,2)-CMA-ES	1	1	38	1557	<i>14e-1/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	4.7	68	<i>35e-2/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	8.6	70	<i>39e-2/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	44	797	<i>14e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	7.5	33	<i>35e-2/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	5.7	33	<i>34e-2/1e4</i>	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	5.0	15	91	<i>23e-2/1e4</i>	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	5.7	58	<i>60e-2/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	6.5	4.5	<i>28e-2/1e4</i>	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	5.1	4.5	<i>26e-2/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	2.5	33	<i>49e-2/1e5</i>	.	.	.	.	.	Artif Bee Colony [9]
avg NEWUOA	1	1	11	2.6	<i>21e-2/1e4</i>	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	1	35	34	397	<i>84e-2/1e5</i>	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1	2.3	85	160	<i>15e-2/1e5</i>	.	.	.	.	Adap DE (F-AUC) [11]
DE (Uniform)	1	1	1.5	97	278	80	72	71	70	69	DE (Uniform) [10]
IPOP-aCMA-ES	1	1	1.8	458	<i>71e-2/2e5</i>	.	.	.	.	.	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1	2.4	376	308	65	59	58	57	56	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1	1.7	24	15	4.0	3.6	3.6	3.6	3.5	CMA+DE-MOS [19]
NBC-CMA	1	1	1.4	692	<i>11e-1/3e4</i>	.	.	.	.	.	NBC-CMA [22]
POEMS	1	1	9.1	26	50	107	<i>36e-3/3e5</i>	.	.	.	POEMS [18]
PM-AdapSS-DE	1	1	1.6	81	<i>28e-2/1e5</i>	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	1	1	5.7	161	77	111	211	<i>25e-3/3e5</i>	.	.	pPOEMS [18, 21]
Basic RCGA	1	1	2.5	162	436	<i>44e-2/5e4</i>	Basic RCGA [25]
SPSA	1	173	1046	3799	<i>11e-1/1e5</i>	SPSA [14]

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