

Comparison tables: BBOB 2010 function testbed with BBOB 2009 as reference 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 [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: 20-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											
$\Delta\text{ftarget}$ ERT_{best}/D	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	$\Delta\text{ftarget}$ ERT_{best}/D
(1,2)-CMA-ES	1	63	15	25	34	44	53	63	72	93	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	26	8.9	15	20	25	30	35	41	52	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	25	8.1	13	18	22	27	32	36	47	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	63	17	26	35	44	53	62	72	89	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	18	7.7	13	18	23	27	33	38	49	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	15	6.2	11	15	19	24	28	32	42	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	14	4.7	8.1	11	14	18	21	24	31	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	17	6.3	11	15	19	23	26	31	40	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	11	5.5	10	14	18	21	25	29	37	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	10	4.9	8.5	12	15	19	23	26	33	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	50	36	66	94	136	177	244	292	374	Artif Bee Colony [9]
avg NEWUOA	1	18	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	47	41	13	19	26	33	40	47	54	68	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	79	93	180	265	350	431	515	597	763	Adap DE (F-AUC) [11]
DE (Uniform)	1	89	146	298	442	588	734	882	1027	1319	DE (Uniform) [10]
IPOP-aCMA-ES	1	9.4	7.9	14	20	27	33	39	45	58	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	10	8.0	14	20	26	33	39	46	58	IPOP-CMA-ES [23]
CMA+DE-MOS	1	34	34	58	68	91	123	134	148	200	CMA+DE-MOS [19]
NBC-CMA	1	17	13	21	30	38	46	54	62	79	NBC-CMA [22]
POEMS	1	804	183	411	853	1372	1783	2331	2828	3744	POEMS [18]
PM-AdapSS-DE	1	69	101	196	291	377	465	555	646	827	PM-AdapSS-DE [10, 11]
pPOEMS	1	847	196	468	1052	1852	2567	3510	4501	7123	pPOEMS [18, 21]
Basic RCGA	1	36	55	133	868	2715	3825	4686	5435	6380	Basic RCGA [25]
SPSA	158	59	12	16	20	25	29	34	38	46	SPSA [14]

Table 2: 20-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	19	19	19	19	19	19	19	20	20	20	ERT_{best}/D
(1,2)-CMA-ES	94	133	155	168	172	175	177	179	181	184	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	39	58	71	80	82	83	84	84	85	86	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	33	50	61	67	69	69	70	70	71	72	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	95	147	165	183	188	194	196	198	200	205	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	24	41	54	62	65	67	68	68	69	70	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	21	34	45	51	54	56	56	57	57	58	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	17	26	34	39	41	41	42	42	43	43	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	20	33	43	51	53	54	55	56	57	58	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	12	23	32	38	41	42	43	43	44	45	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	11	21	29	33	35	35	36	36	37	37	(1+2ms)-CMA-ES [2]
Artif Bee Colony	6.3	8.1	12	16	24	30	40	47	56	70	Artif Bee Colony [9]
avg NEWUOA	3.5	10	21	43	63	89	116	141	161	199	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	48	66	73	79	82	83	84	84	85	86	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	27	37	48	58	68	77	86	95	105	123	Adap DE (F-AUC) [11]
DE (Uniform)	45	61	77	92	108	124	140	157	172	203	DE (Uniform) [10]
IPOP-aCMA-ES	10	17	22	27	29	30	31	32	33	34	IPOP-aCMA-ES [17]
IPOP-CMA-ES	16	25	35	41	43	44	45	46	47	48	IPOP-CMA-ES [23]
CMA+DE-MOS	25	35	44	50	57	61	67	70	74	82	CMA+DE-MOS [19]
NBC-CMA	23	39	58	73	83	87	90	93	95	98	NBC-CMA [22]
POEMS	145	191	247	295	345	407	450	507	561	663	POEMS [18]
PM-AdapSS-DE	32	42	52	63	73	83	93	103	112	132	PM-AdapSS-DE [10, 11]
pPOEMS	151	216	305	423	513	661	744	895	1213	1404	pPOEMS [18, 21]
Basic RCGA	41	231	384	930	4447	4531	17394	<i>51e-2/5e4</i>	.	.	Basic RCGA [25]
SPSA	78570	<i>18e+2/1e5</i>	.	.	.	.	.	.	.	.	SPSA [14]

Table 4: 20-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} 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	467	<i>17e+1/1e4</i>	.	.	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	219	119	<i>79e+0/1e4</i>	.	.	.	.	.	.	.	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	200	151	<i>79e+0/1e4</i>	.	.	.	.	.	.	.	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	447	<i>15e+1/1e4</i>	.	.	.	.	.	.	.	.	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	151	171	<i>88e+0/1e4</i>	.	.	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	100	53	<i>66e+0/1e4</i>	.	.	.	.	.	.	.	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	109	66	<i>69e+0/1e4</i>	.	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	149	453	<i>10e+1/1e4</i>	.	.	.	.	.	.	.	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	51	3814	<i>14e+1/1e4</i>	.	.	.	.	.	.	.	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	61	3765	<i>13e+1/1e4</i>	.	.	.	.	.	.	.	(1+2ms)-CMA-ES [2]
Artif Bee Colony	220	2.9	2.0	4.2	5.6	6.0	6.3	6.9	7.3	0.45	Artif Bee Colony [9]
avg NEWUOA	112	1442	<i>12e+1/2e4</i>	.	.	.	.	.	.	.	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	298	2.5	<i>26e+0/1e5</i>	.	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	93	237	<i>19e+0/1e5</i>	.	.	.	.	.	.	.	Adap DE (F-AUC) [11]
DE (Uniform)	109	250	<i>21e+0/1e5</i>	.	.	.	.	.	.	.	DE (Uniform) [10]
IPOP-aCMA-ES	54	2.4	<i>14e+0/1e5</i>	.	.	.	.	.	.	.	IPOP-aCMA-ES [17]
IPOP-CMA-ES	59	2.3	<i>13e+0/1e5</i>	.	.	.	.	.	.	.	IPOP-CMA-ES [23]
CMA+DE-MOS	88	4.7	10	12	14	14	15	15	16	0.93	CMA+DE-MOS [19]
NBC-CMA	50	4.5	<i>25e+0/1e4</i>	.	.	.	.	.	.	.	NBC-CMA [22]
POEMS	4010	18	14	109	307	308	310	311	313	18	POEMS [18]
PM-AdapSS-DE	137	128	<i>20e+0/1e5</i>	.	.	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	4614	21	31	254	1043	1054	1056	1056	1054	59	pPOEMS [18, 21]
Basic RCGA	86	67	<i>22e+0/5e4</i>	.	.	.	.	.	.	.	Basic RCGA [25]
SPSA	1638	<i>24e+1/1e5</i>	.	.	.	.	.	.	.	.	SPSA [14]

Table 5: 20-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	2.6	6.1	7.0	7.2	7.2	7.2	7.2	7.2	7.2	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1.6	3.5	4.4	4.4	4.4	4.4	4.4	4.4	4.4	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1.5	3.3	3.9	4.1	4.1	4.1	4.1	4.1	4.1	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	3.1	6.5	7.7	7.9	8.3	8.3	8.3	8.3	8.3	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	2.2	5.1	6.1	6.4	6.5	6.5	6.5	6.5	6.5	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1.9	3.7	4.4	4.5	4.6	4.6	4.6	4.6	4.6	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1.1	2.7	3.2	3.3	3.3	3.3	3.3	3.3	3.3	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1.7	4.1	5.0	5.4	5.4	5.4	5.4	5.4	5.4	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1.6	3.1	3.6	3.8	3.8	3.8	3.8	3.8	3.8	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1.1	2.5	3.1	3.2	3.2	3.2	3.2	3.2	3.2	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	37	69	90	93	93	93	93	93	93	Artif Bee Colony [9]
avg NEWUOA	1	2.7	2.7	3.2	3.3	3.3	3.3	3.3	3.3	3.3	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	1	3.6	5.3	5.8	6.0	6.0	6.0	6.0	6.0	6.0	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	15	42	52	53	54	54	54	54	54	Adap DE (F-AUC) [11]
DE (Uniform)	1	27	69	83	85	86	86	86	86	86	DE (Uniform) [10]
IPOP-aCMA-ES	1	2.7	5.1	6.2	6.2	6.2	6.2	6.2	6.2	6.2	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	3.2	5.8	6.5	6.7	6.7	6.7	6.7	6.7	6.7	IPOP-CMA-ES [23]
CMA+DE-MOS	1	23	51	53	53	53	53	53	53	53	CMA+DE-MOS [19]
NBC-CMA	1	12	6573	13412	13412	13412	13412	13412	13412	13412	NBC-CMA [22]
POEMS	1	180	255	310	330	343	348	350	352	352	POEMS [18]
PM-AdapSS-DE	1	35	82	92	96	96	96	96	96	96	PM-AdapSS-DE [10, 11]
pPOEMS	1	175	253	308	338	349	355	360	360	360	pPOEMS [18, 21]
Basic RCGA	1	138	557	3186	5233	6485	7260	7764	9890	<i>64e-7/5e4</i>	Basic RCGA [25]
SPSA	1	3.1	6.4	7.9	8.1	8.2	8.2	8.2	8.2	8.2	SPSA [14]

Table 6: 20-D, running time excess $ERT/ERT_{\text{best}} 2009$ 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	4.0	26	65	117	171	213	261	298	336	420	ERT_{best}/D	
(1,2)-CMA-ES	21	11	8.9	12	26	78	567	<i>11e-3/1e4</i>	.	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	7.1	3.1	2.2	1.8	1.8	2.1	2.5	3.0	3.5	6.7	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	6.9	2.7	1.9	1.6	1.5	1.5	1.7	1.8	2.1	3.1	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	19	11	15	41	133	670	<i>15e-2/1e4</i>	.	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	3.8	2.6	2.1	1.9	2.0	2.2	2.5	3.1	3.6	7.4	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	4.6	2.7	2.0	1.6	1.6	1.6	1.5	1.7	1.8	2.2	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	3.2	1.6	1.3	1.1	1.0	1.1	1.2	1.5	1.7	2.5	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	3.3	2.3	2.0	2.0	2.4	3.1	4.8	10	22	342	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	2.1	1.7	13	92	831	<i>69e-2/1e4</i>	.	.	.	.	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	1.7	1.8	12	107	846	<i>74e-2/1e4</i>	.	.	.	.	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	11	8.3	46	453	2587	<i>54e-2/1e5</i>	.	.	.	.	Artif Bee Colony [9]	
avg NEWUOA	2.3	1.1	1.00	0.74	0.72	0.71	0.70	0.74	0.74	0.73	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	13	5.3	3.7	3.2	3.7	7.5	45	177	874	1036	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	22	25	19	15	14	14	14	14	14	14	Adap DE (F-AUC) [11]	
DE (Uniform)	27	40	29	23	20	20	20	20	20	20	DE (Uniform) [10]	
IPOP-aCMA-ES	3.6	2.3	1.6	1.3	1.1	1.1	1.1	1.1	1.1	1.1	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	3.0	2.3	1.7	1.3	1.2	1.2	1.2	1.2	1.2	1.2	IPOP-CMA-ES [23]	
CMA+DE-MOS	20	8.9	5.5	3.9	3.4	3.2	3.0	3.0	3.0	2.8	CMA+DE-MOS [19]	
NBC-CMA	53	108	50	28	19	16	13	12	10	8.6	NBC-CMA [22]	
POEMS	91	30	32	28	26	26	26	27	27	27	POEMS [18]	
PM-AdapSS-DE	22	28	20	16	15	14	14	14	14	14	PM-AdapSS-DE [10, 11]	
pPOEMS	94	32	36	32	32	34	34	35	35	38	pPOEMS [18, 21]	
Basic RCGA	41	15	52	60	56	54	51	196	2128	<i>63e-6/5e4</i>	Basic RCGA [25]	
SPSA	2263	<i>40e+1/1e5</i>	.	.	.	.	.	.	.	.	SPSA [14]	

Table 7: 20-D, running time excess $ERT/ERT_{\text{best}}^{2009}$ on f_7 , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

		7 Step-ellipsoid										
	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	42	<i>23e+0/1e4</i>	.	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]
	(1,2m)-CMA-ES	14	4.4	71	<i>67e-1/1e4</i>	.	.	.	.	.	.	(1,2m)-CMA-ES [5]
	(1,2ms)-CMA-ES	11	4.8	71	<i>72e-1/1e4</i>	.	.	.	.	.	.	(1,2ms)-CMA-ES [5]
	(1,2s)-CMA-ES	25	27	<i>29e+0/1e4</i>	.	.	.	.	.	.	.	(1,2s)-CMA-ES [3]
	(1,4)-CMA-ES	4.1	3.7	118	<i>78e-1/1e4</i>	.	.	.	.	.	.	(1,4)-CMA-ES [6, 4]
	(1,4m)-CMA-ES	3.1	3.2	23	<i>48e-1/1e4</i>	.	.	.	.	.	.	(1,4m)-CMA-ES [6]
	(1,4ms)-CMA-ES	3.0	4.6	37	<i>62e-1/1e4</i>	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]
	(1,4s)-CMA-ES	3.8	4.5	275	<i>12e+0/1e4</i>	.	.	.	.	.	.	(1,4s)-CMA-ES [4]
	(1+1)-CMA-ES	3.0	11	24	41	37	177	177	177	177	172	(1+1)-CMA-ES [8]
	(1+2ms)-CMA-ES	1.8	1.9	24	54	96	181	181	181	181	176	(1+2ms)-CMA-ES [2]
	Artif Bee Colony	5.5	19	251	<i>60e-1/1e5</i>	.	.	.	.	.	.	Artif Bee Colony [9]
	avg NEWUOA	7.1	1.4	101	<i>51e-1/2e4</i>	.	.	.	.	.	.	avg NEWUOA [24]
	CMA-EGS (IPOP,r1)	21	5.3	21	<i>53e-1/1e5</i>	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]
	Adap DE (F-AUC)	3.0	18	5.2	3.1	1.9	1.6	1.6	1.6	1.6	1.6	Adap DE (F-AUC) [11]
	DE (Uniform)	3.3	30	8.4	5.2	3.3	2.6	2.7	2.7	2.7	2.7	DE (Uniform) [10]
	IPOP-aCMA-ES	2.7	2.5	1.6	2.7	1.6	0.99	0.99	0.99	0.99	1.0	IPOP-aCMA-ES [17]
	IPOP-CMA-ES	3.1	3.0	1.9	4.8	2.7	1.7	1.7	1.7	1.7	1.6	IPOP-CMA-ES [23]
	CMA+DE-MOS	2.7	12	2.7	6.0	3.9	2.4	2.4	2.4	2.4	2.3	CMA+DE-MOS [19]
	NBC-CMA	3.2	3.6	1.3	31	225	<i>55e-2/1e4</i>	.	.	.	.	NBC-CMA [22]
	POEMS	429	57	23	1968	<i>11e-1/3e5</i>	.	.	.	.	.	POEMS [18]
	PM-AdapSS-DE	3.0	21	5.9	3.4	2.1	1.6	1.6	1.6	1.6	1.7	PM-AdapSS-DE [10, 11]
	pPOEMS	307	55	22	280	1778	2412	2412	2412	2412	2349	pPOEMS [18, 21]
	Basic RCGA	4.7	12	13	1111	<i>13e-1/5e4</i>	Basic RCGA [25]
	SPSA	104	995	<i>58e+0/1e5</i>	SPSA [14]

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Table 8: 20-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} 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	4.9	10	19	20	20	20	20	20	20	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	5.4	7.2	5.3	7.8	8.2	8.3	8.3	8.3	8.2	8.1	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	4.5	2.2	3.6	4.5	4.8	5.0	5.0	5.0	5.0	5.0	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	11	13	12	17	18	18	19	19	19	18	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	4.1	2.3	4.9	7.7	8.0	8.0	8.1	8.0	8.0	8.0	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	3.8	2.6	3.6	5.8	6.0	6.1	6.1	6.1	6.1	6.1	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	2.8	2.0	3.3	5.8	5.9	5.9	5.9	5.9	5.8	5.8	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	4.8	3.2	3.8	5.9	6.2	6.2	6.2	6.2	6.2	6.2	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	2.6	1.5	3.2	4.8	5.1	5.2	5.3	5.3	5.3	5.3	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	2.4	1.7	3.0	5.4	5.6	5.6	5.7	5.7	5.7	5.7	(1+2ms)-CMA-ES [2]
Artif Bee Colony	14	6.4	3.9	5.9	10	37	353	1171	<i>24e-5/1e5</i>	.	Artif Bee Colony [9]
avg NEWUOA	2.0	1.6	0.96	0.97	1.0	1.0	1.0	1.0	1.0	0.99	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	6.3	3.2	5.3	6.5	6.9	7.1	7.2	7.2	7.3	7.4	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	43	21	23	21	23	24	24	25	25	26	Adap DE (F-AUC) [11]
DE (Uniform)	73	37	34	31	33	34	35	36	37	39	DE (Uniform) [10]
IPOP-aCMA-ES	4.1	2.6	3.5	3.5	3.7	3.8	3.9	3.9	3.9	4.0	IPOP-aCMA-ES [17]
IPOP-CMA-ES	3.9	3.2	3.7	3.9	4.2	4.3	4.4	4.4	4.4	4.5	IPOP-CMA-ES [23]
CMA+DE-MOS	19	6.7	11	12	13	13	13	13	13	13	CMA+DE-MOS [19]
NBC-CMA	5.7	3.5	6.3	6.8	7.7	8.3	8.6	8.7	8.7	8.8	NBC-CMA [22]
POEMS	96	79	500	902	1629	21544	<i>15e-3/3e5</i>	.	.	.	POEMS [18]
PM-AdapSS-DE	48	24	35	35	38	39	39	40	40	41	PM-AdapSS-DE [10, 11]
pPOEMS	96	75	103	97	109	117	121	135	147	188	pPOEMS [18, 21]
Basic RCGA	24	25	<i>17e+0/5e4</i>	.	.	.	.	.	.	.	Basic RCGA [25]
SPSA	256	3988	<i>98e+0/1e5</i>	.	.	.	.	.	.	.	SPSA [14]

Table 13: 20-D, running time excess ERT/ERT_{best} 2009 on f_{13} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

	13 Sharp ridge											
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	3.2	8.5	33	101	138	175	937	1086	1223	1510	ERT_{best}/D	
(1,2)-CMA-ES	11	10	20	25	41	87	47	63	<i>13e-3/1e4</i>	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	4.8	5.2	13	12	24	36	33	62	55	93	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	4.5	4.7	4.6	6.9	23	37	49	130	116	94	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	10	9.5	13	29	41	115	36	<i>27e-3/1e4</i>	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	4.2	5.0	8.3	15	25	42	21	65	121	<i>46e-4/1e4</i>	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	3.4	4.0	6.4	10	16	28	8.0	18	36	<i>32e-5/1e4</i>	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	2.6	3.2	4.5	6.6	11	26	21	30	56	<i>18e-4/1e4</i>	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	3.5	4.0	7.6	4.9	14	23	17	30	57	<i>10e-4/1e4</i>	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	2.5	3.3	6.5	4.8	10	16	4.1	5.4	7.6	13	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	2.3	3.0	4.9	6.0	7.7	13	3.3	3.6	5.2	18	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	25	41	25	73	627	3931	1555	<i>60e-3/1e5</i>	.	.	Artif Bee Colony [9]	
avg NEWUOA	2.1	1.8	1.5	5.3	14	30	14	57	172	<i>67e-5/2e4</i>	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	6.4	6.5	6.8	7.6	37	125	108	256	556	<i>90e-5/1e5</i>	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	35	55	25	12	11	11	2.4	2.4	2.5	2.5	Adap DE (F-AUC) [11]	
DE (Uniform)	57	90	43	20	19	19	4.1	4.1	4.2	4.2	DE (Uniform) [10]	
IPOP-aCMA-ES	3.9	5.3	3.6	3.4	3.7	3.4	0.80	0.98	1.3	1.3	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	3.5	5.3	6.5	4.8	6.2	5.1	1.4	1.6	1.7	2.3	IPOP-CMA-ES [23]	
CMA+DE-MOS	16	18	10	9.1	12	12	2.8	2.9	3.2	3.0	CMA+DE-MOS [19]	
NBC-CMA	6.0	7.6	4.7	15	29	24	5.7	7.4	9.3	45	NBC-CMA [22]	
POEMS	98	201	6277	41616	<i>90e-1/3e5</i>	.	.	.	.	.	POEMS [18]	
PM-AdapSS-DE	41	63	28	13	12	12	2.6	2.6	2.6	2.6	PM-AdapSS-DE [10, 11]	
pPOEMS	104	223	938	2244	6207	24363	4562	<i>57e-2/3e5</i>	.	.	pPOEMS [18, 21]	
Basic RCGA	19	112	232	296	825	1228	<i>28e-2/5e4</i>	.	.	.	Basic RCGA [25]	
SPSA	76	2892	<i>29e+0/1e5</i>	.	.	.	.	.	.	.	SPSA [14]	

Table 14: 20-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	156	16	8.2	8.2	8.2	7.8	10	14	4.8	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	62	7.7	3.8	4.1	4.2	4.2	5.6	8.1	2.0	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	41	6.0	3.1	3.3	3.5	3.6	4.9	6.6	1.6	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	143	14	6.9	7.4	7.4	6.9	9.3	13	5.7	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	16	5.7	3.1	3.6	4.0	3.9	5.2	7.3	1.6	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	19	5.0	2.8	3.1	3.3	3.2	4.5	6.4	1.4	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	16	3.8	2.1	2.3	2.6	2.6	3.5	5.0	1.1	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	17	4.7	2.6	2.9	3.4	3.2	4.2	5.4	1.3	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	12	2.9	1.9	2.3	2.5	2.2	3.3	5.4	1.2	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	13	2.3	1.6	1.9	2.1	1.9	2.7	4.5	0.97	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1.1	4.0	18	18	28	53	3378	<i>10e-4/1e5</i>	.	.	Artif Bee Colony [9]
avg NEWUOA	1	38	2.7	1.5	1.6	1.6	1.3	2.7	9.3	26	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	26	159	10	4.6	5.2	5.7	6.2	11	22	4.8	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	4.5	33	30	38	36	23	20	19	2.8	Adap DE (F-AUC) [11]
DE (Uniform)	1	5.5	53	50	64	60	38	32	31	4.2	DE (Uniform) [10]
IPOP-aCMA-ES	1	10	3.6	2.7	3.5	4.0	3.2	3.4	3.9	0.67	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	13	3.7	2.8	3.6	4.2	3.9	4.7	6.0	1.2	IPOP-CMA-ES [23]
CMA+DE-MOS	1	5.1	20	10	11	13	12	13	14	2.3	CMA+DE-MOS [19]
NBC-CMA	1.1	3.5	5.5	3.7	4.6	5.3	5.1	6.9	9.0	1.7	NBC-CMA [22]
POEMS	1	3152	98	65	123	165	131	1158	<i>27e-6/3e5</i>	.	POEMS [18]
PM-AdapSS-DE	1	5.1	43	34	43	40	25	21	20	2.8	PM-AdapSS-DE [10, 11]
pPOEMS	1	743	102	72	143	423	353	443	4529	<i>78e-7/3e5</i>	pPOEMS [18, 21]
Basic RCGA	1	4.9	16	26	57	298	1502	<i>11e-4/5e4</i>	.	.	Basic RCGA [25]
SPSA	59	853	98	51	45	39	56	234	1207	<i>85e-7/1e5</i>	SPSA [14]

Table 17: 20-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}	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	0.05	0.05	3.1	52	200	612	1534	2231	2814	4024	ERT_{best}/D	
(1,2)-CMA-ES	1	1	403	<i>53e-1/1e4</i>	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	1	13	8.6	2765	<i>19e-1/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	1	10	6.7	2880	<i>20e-1/1e4</i>	.	.	.	.	.	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	1	15	462	<i>64e-1/1e4</i>	.	.	.	.	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	1	1	73	2771	<i>26e-1/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	1	1.1	5.1	641	<i>22e-1/1e4</i>	.	.	.	.	.	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	1	7.1	6.1	1374	<i>16e-1/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	1	3.3	59	<i>30e-1/1e4</i>	.	.	.	.	.	.	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	1	1.3	53	<i>48e-1/1e4</i>	.	.	.	.	.	.	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	1	1.2	42	<i>46e-1/1e4</i>	.	.	.	.	.	.	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	1	1.1	34	<i>40e-1/1e5</i>	.	.	.	.	.	.	Artif Bee Colony [9]	
avg NEWUOA	1	2.1	2.4	<i>29e-1/4e4</i>	.	.	.	.	.	.	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	72	141	7.2	1.2	1.1	1.2	1.1	2.1	3.8	12	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	1	1.4	23	13	6.6	3.4	1.9	1.7	1.9	5.5	Adap DE (F-AUC) [11]	
DE (Uniform)	1	1.3	38	19	10	5.4	3.0	2.8	3.2	2.8	DE (Uniform) [10]	
IPOP-aCMA-ES	1	1.3	2.3	0.89	0.50	1.3	0.82	0.71	0.83	0.87	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	1	1	2.1	0.94	1.2	1.0	0.76	0.91	0.99	1.0	IPOP-CMA-ES [23]	
CMA+DE-MOS	1	1.1	11	8.2	2.8	1.5	1.1	1.0	1.2	1.0	CMA+DE-MOS [19]	
NBC-CMA	1	1.1	3.4	1.2	1.1	1.3	15	<i>10e-4/2e4</i>	.	.	NBC-CMA [22]	
POEMS	1	691	98	27	126	188	299	1887	<i>21e-4/3e5</i>	.	POEMS [18]	
PM-AdapSS-DE	1	1.4	23	13	6.6	3.4	1.9	1.7	1.8	18	PM-AdapSS-DE [10, 11]	
pPOEMS	1	1.3	98	31	54	115	313	1911	<i>11e-4/3e5</i>	.	pPOEMS [18, 21]	
Basic RCGA	1.1	1.5	6.1	13	31	23	17	32	<i>12e-5/5e4</i>	.	Basic RCGA [25]	
SPSA	3.00e6	3.00e6	87351	<i>23e+2/1e5</i>	.	.	.	.	.	.	SPSA [14]	

Table 18: 20-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} 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	103	<i>18e+0/1e4</i>	.	.	.	.	.	.	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	1	45	143	<i>64e-1/1e4</i>	.	.	.	.	.	.	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	1.1	31	131	<i>73e-1/1e4</i>	.	.	.	.	.	.	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	6.4	115	<i>19e+0/1e4</i>	.	.	.	.	.	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	1	16	257	<i>82e-1/1e4</i>	.	.	.	.	.	.	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	1.1	10	67	<i>40e-1/1e4</i>	.	.	.	.	.	.	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	1	11	34	<i>54e-1/1e4</i>	.	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	1	20	302	<i>91e-1/1e4</i>	.	.	.	.	.	.	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	1	10	<i>15e+0/1e4</i>	.	.	.	.	.	.	.	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	1	3.7	4700	<i>14e+0/1e4</i>	.	.	.	.	.	.	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	1.1	21	45792	<i>13e+0/1e5</i>	.	.	.	.	.	.	Artif Bee Colony [9]	
avg NEWUOA	1.3	19	3217	<i>10e+0/6e4</i>	.	.	.	.	.	.	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	74	64	1.4	0.97	1.1	2.0	2.2	10	31	201	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	1.1	5.7	11	4.6	1.7	1.8	3.2	6.0	11	28	Adap DE (F-AUC) [11]	
DE (Uniform)	1	6.4	18	7.8	2.8	2.9	1.7	1.5	1.5	1.6	DE (Uniform) [10]	
IPOP-aCMA-ES	1.3	7.5	1.2	1.5	0.75	1.1	0.91	0.86	0.78	0.83	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	1	7.2	1.1	1.8	1.1	1.5	0.97	1.2	1.0	1.1	IPOP-CMA-ES [23]	
CMA+DE-MOS	1.1	4.9	4.0	1.6	1.1	1.8	1.3	1.3	1.3	1.2	CMA+DE-MOS [19]	
NBC-CMA	1.1	3.1	1.5	0.76	1.1	35	<i>16e-3/2e4</i>	.	.	.	NBC-CMA [22]	
POEMS	2.4	915	21	125	275	2948	<i>92e-3/3e5</i>	.	.	.	POEMS [18]	
PM-AdapSS-DE	1	4.4	13	5.4	1.9	1.9	8.4	5.9	6.5	7.8	PM-AdapSS-DE [10, 11]	
pPOEMS	1.1	487	21	51	106	1394	<i>33e-3/3e5</i>	.	.	.	pPOEMS [18, 21]	
Basic RCGA	1	6.7	7.5	20	23	62	<i>16e-3/5e4</i>	.	.	.	Basic RCGA [25]	
SPSA	5.50e6	2.86e6	<i>46e+2/1e5</i>	.	.	.	.	.	.	.	SPSA [14]	

Table 20: 20-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}	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	3.5	4.1	2307	1.55e5	2.76e5	2.77e5	2.78e5	2.80e5	2.82e5	ERT_{best}/D	
(1,2)-CMA-ES	15	13	13	30	<i>12e-1/1e4</i>	.	.	.	.	.	(1,2)-CMA-ES [5, 3]	
(1,2m)-CMA-ES	7.5	6.9	6.5	30	<i>11e-1/1e4</i>	.	.	.	.	.	(1,2m)-CMA-ES [5]	
(1,2ms)-CMA-ES	6.0	5.6	5.3	<i>11e-1/1e4</i>	.	.	.	.	.	.	(1,2ms)-CMA-ES [5]	
(1,2s)-CMA-ES	14	12	11	15	<i>12e-1/1e4</i>	.	.	.	.	.	(1,2s)-CMA-ES [3]	
(1,4)-CMA-ES	5.9	5.6	5.1	61	<i>12e-1/1e4</i>	.	.	.	.	.	(1,4)-CMA-ES [6, 4]	
(1,4m)-CMA-ES	5.0	4.6	4.6	31	<i>11e-1/1e4</i>	.	.	.	.	.	(1,4m)-CMA-ES [6]	
(1,4ms)-CMA-ES	3.8	3.6	3.5	11	<i>11e-1/1e4</i>	.	.	.	.	.	(1,4ms)-CMA-ES [1, 6]	
(1,4s)-CMA-ES	4.7	4.4	4.4	7.3	<i>10e-1/1e4</i>	.	.	.	.	.	(1,4s)-CMA-ES [4]	
(1+1)-CMA-ES	3.5	3.5	3.3	20	<i>12e-1/1e4</i>	.	.	.	.	.	(1+1)-CMA-ES [8]	
(1+2ms)-CMA-ES	3.2	3.1	2.9	18	<i>11e-1/1e4</i>	.	.	.	.	.	(1+2ms)-CMA-ES [2]	
Artif Bee Colony	20	18	16	0.12	<i>23e-2/1e5</i>	.	.	.	.	.	Artif Bee Colony [9]	
avg NEWUOA	1.8	1.4	1.3	107	<i>12e-1/2e4</i>	.	.	.	.	.	avg NEWUOA [24]	
CMA-EGS (IPOP,r1)	10	8.7	7.9	<i>20e-1/1e5</i>	.	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]	
Adap DE (F-AUC)	43	42	40	643	<i>15e-1/1e5</i>	.	.	.	.	.	Adap DE (F-AUC) [11]	
DE (Uniform)	76	77	76	<i>17e-1/1e5</i>	.	.	.	.	.	.	DE (Uniform) [10]	
IPOP-aCMA-ES	4.5	4.7	4.7	3.2	0.83	0.58	0.58	0.59	0.59	0.60	IPOP-aCMA-ES [17]	
IPOP-CMA-ES	4.9	4.8	4.6	6.4	0.65	0.57	0.57	0.58	0.58	0.58	IPOP-CMA-ES [23]	
CMA+DE-MOS	23	23	21	0.97	0.08	0.05	0.06	0.06	0.06	0.07	CMA+DE-MOS [19]	
NBC-CMA	8.2	8.0	7.3	91	<i>12e-1/1e4</i>	.	.	.	.	.	NBC-CMA [22]	
POEMS	129	124	118	2.4	8.6	<i>30e-2/3e5</i>	.	.	.	.	POEMS [18]	
PM-AdapSS-DE	51	51	46	<i>22e-1/1e5</i>	.	.	.	.	.	.	PM-AdapSS-DE [10, 11]	
pPOEMS	128	128	134	1.8	<i>24e-2/3e5</i>	.	.	.	.	.	pPOEMS [18, 21]	
Basic RCGA	10	10	10	<i>22e-1/5e4</i>	.	.	.	.	.	.	Basic RCGA [25]	
SPSA	14	15	16	<i>22e-1/1e5</i>	.	.	.	.	.	.	SPSA [14]	

Table 21: 20-D, running time excess $ERT/ERT_{\text{best}}^{2009}$ 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	13	8.3	10	10	11	11	10	9.1	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	5.9	3.3	3.6	3.5	3.4	3.4	3.3	2.9	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	7.2	4.9	4.0	4.0	3.9	3.8	3.7	3.3	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	6.8	9.3	9.1	9.0	8.9	8.6	8.4	7.4	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	2.1	3.6	4.7	4.6	4.5	4.4	4.3	3.8	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	3.9	4.7	4.8	4.7	4.7	4.5	4.4	3.9	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	2.4	1.7	1.8	1.8	1.7	1.7	1.6	1.5	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	3.8	2.3	2.6	2.6	2.5	2.4	2.4	2.1	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	3.5	5.5	5.4	5.3	5.2	5.1	4.9	4.4	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	3.3	4.6	3.9	3.8	3.8	3.7	3.6	3.2	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	5.0	22	25	26	27	30	35	85	Artif Bee Colony [9]
avg NEWUOA	1	1	3.2	5.7	3.5	3.5	3.4	3.3	3.3	2.9	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	2.7	106	1.9	211	217	214	210	204	197	175	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1	12	613	568	560	547	531	515	456	Adap DE (F-AUC) [11]
DE (Uniform)	1	1	21	461	568	560	548	532	516	457	DE (Uniform) [10]
IPOP-aCMA-ES	1	1	1.9	81	66	65	64	62	60	54	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1	3.7	139	110	108	106	103	100	88	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1	11	262	285	281	275	268	260	231	CMA+DE-MOS [19]
NBC-CMA	1	1	84	69	59	58	56	55	53	47	NBC-CMA [22]
POEMS	1	1	11053	5970	<i>47e-1/3e5</i>	.	.	.	.	.	POEMS [18]
PM-AdapSS-DE	1	1	12	351	568	560	547	531	515	456	PM-AdapSS-DE [10, 11]
pPOEMS	1	1	137	1172	956	1186	1160	1127	1093	974	pPOEMS [18, 21]
Basic RCGA	1	1	119	103	85	85	86	97	96	87	Basic RCGA [25]
SPSA	3.5	251	597	1240	<i>18e-1/1e5</i>	.	.	.	.	.	SPSA [14]

Table 22: 20-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}}$ 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} $\text{ERT}_{\text{best}}/D$	1e+03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05	1e-07	Δf_{target} $\text{ERT}_{\text{best}}/D$
(1,2)-CMA-ES	1	1	10	27	124	120	116	111	108	22	(1,2)-CMA-ES [5, 3]
(1,2m)-CMA-ES	1	1	8.8	13	21	20	20	19	18	3.7	(1,2m)-CMA-ES [5]
(1,2ms)-CMA-ES	1	1	8.2	13	17	16	16	15	15	3.0	(1,2ms)-CMA-ES [5]
(1,2s)-CMA-ES	1	1	35	22	37	36	35	34	33	6.6	(1,2s)-CMA-ES [3]
(1,4)-CMA-ES	1	1	18	6.6	11	11	11	10	10	2.0	(1,4)-CMA-ES [6, 4]
(1,4m)-CMA-ES	1	1	5.6	7.7	16	16	15	15	14	2.9	(1,4m)-CMA-ES [6]
(1,4ms)-CMA-ES	1	1	9.0	5.0	28	27	26	25	24	4.9	(1,4ms)-CMA-ES [1, 6]
(1,4s)-CMA-ES	1	1	4.7	13	27	26	25	24	24	4.7	(1,4s)-CMA-ES [4]
(1+1)-CMA-ES	1	1	17	9.4	15	14	14	13	13	2.6	(1+1)-CMA-ES [8]
(1+2ms)-CMA-ES	1	1	10	4.4	10	10	9.2	8.8	8.6	1.7	(1+2ms)-CMA-ES [2]
Artif Bee Colony	1	1	10	47	77	578	<i>44e-3/1e5</i>	.	.	.	Artif Bee Colony [9]
avg NEWUOA	1	1	2.0	5.6	14	13	12	12	12	2.4	avg NEWUOA [24]
CMA-EGS (IPOP,r1)	1.9	104	676	546	<i>20e-1/1e5</i>	.	.	.	.	.	CMA-EGS (IPOP,r1) [13]
Adap DE (F-AUC)	1	1	675	1436	<i>26e-1/1e5</i>	.	.	.	.	.	Adap DE (F-AUC) [11]
DE (Uniform)	1	1	1580	989	<i>20e-1/1e5</i>	.	.	.	.	.	DE (Uniform) [10]
IPOP-aCMA-ES	1	1	462	264	<i>20e-1/6e4</i>	.	.	.	.	.	IPOP-aCMA-ES [17]
IPOP-CMA-ES	1	1	445	287	<i>20e-1/6e4</i>	.	.	.	.	.	IPOP-CMA-ES [23]
CMA+DE-MOS	1	1	536	797	677	659	638	610	594	118	CMA+DE-MOS [19]
NBC-CMA	1	1	323	350	<i>73e-1/1e4</i>	.	.	.	.	.	NBC-CMA [22]
POEMS	1	1	6453	6994	<i>73e-1/3e5</i>	.	.	.	.	.	POEMS [18]
PM-AdapSS-DE	1	1	1572	2332	<i>51e-1/1e5</i>	.	.	.	.	.	PM-AdapSS-DE [10, 11]
pPOEMS	1	1	2022	1439	1680	1634	1584	1513	1474	294	pPOEMS [18, 21]
Basic RCGA	1	1	1186	1200	<i>73e-1/5e4</i>	Basic RCGA [25]
SPSA	7.6	240	1073	1439	<i>26e-1/1e5</i>	SPSA [14]

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