

Comparison Tables: BBOB 2013 Testbed in 40-D (Expensive Setting)

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2013 with a focus on benchmarking black-box algorithms for small function evaluation budgets (“expensive setting”), see <http://coco.gforge.inria.fr/doku.php?id=bbob-2013>. About 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 [6, 4]. The experimental set-up is described in [5].

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 [2]) 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 [5] 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 gives an overview on all algorithms submitted to the noise-free testbed in 2013.

Table 1: Names and references of all algorithms submitted for the noise-free testbed

algorithm name	short	paper	reference
BIPOP-aCMA-STEP los		BI-Population CMA-ES Algorithms with Surrogate Models and Line Searches (Page 1177)	[11]
BIPOP-saACM-k los		BI-Population CMA-ES Algorithms with Surrogate Models and Line Searches (Page 1177)	[11]
CMAES hut		An Evaluation of Sequential Model-Based Optimization for Expensive Blackbox Functions (Page 1209)	[8]
DE pal		Benchmarking a Hybrid Multi Level Single Linkage Algorithm on the BBOB Noiseless Testbed	[12]
HCMA los		BI-Population CMA-ES Algorithms with Surrogate Models and Line Searches (Page 1177)	[11]
HMSL pal		Benchmarking a Hybrid Multi Level Single Linkage Algorithm on the BBOB Noiseless Testbed	[12]
IPOP-10DDr lia		Bounding the Population Size of IPOP-CMA-ES on the Noiseless BBOB Testbed (Page 1161)	[9]
IPOP-500 lia		Bounding the Population Size of IPOP-CMA-ES on the Noiseless BBOB Testbed (Page 1161)	[9]
IPOP-tany lia		Testing the Impact of Parameter Tuning on a Variant of IPOP-CMA-ES with a Bounded Maximum Population Size on the Noiseless BBOB Testbed (Page 1169)	[10]
IPOP-texp lia		Testing the Impact of Parameter Tuning on a Variant of IPOP-CMA-ES with a Bounded Maximum Population Size on the Noiseless BBOB Testbed (Page 1169)	[10]
IPOP lia		Bounding the Population Size of IPOP-CMA-ES on the Noiseless BBOB Testbed (Page 1161)	[9]
		Testing the Impact of Parameter Tuning on a Variant of IPOP-CMA-ES with a Bounded Maximum Population Size on the Noiseless BBOB Testbed (Page 1169)	[10]
MLSL pal		Benchmarking a Hybrid Multi Level Single Linkage Algorithm on the BBOB Noiseless Testbed	[12]
OQNLP pal		Comparison of Multistart Global Optimization Algorithms on the BBOB Noiseless Testbed (Page 1153)	[13]
P-DCN tra		Multiobjectivization with NSGA-II on the Noiseless BBOB Testbed (Page 1217)	[15]
P-zero tra		Multiobjectivization with NSGA-II on the Noiseless BBOB Testbed (Page 1217)	[15]
SMAC hut		An Evaluation of Sequential Model-Based Optimization for Expensive Blackbox Functions (Page 1209)	[8]
U-DCN tra		Multiobjectivization with NSGA-II on the Noiseless BBOB Testbed (Page 1217)	[15]
U-zero tra		Multiobjectivization with NSGA-II on the Noiseless BBOB Testbed (Page 1217)	[15]
fmincon pal		Comparison of Multistart Global Optimization Algorithms on the BBOB Noiseless Testbed (Page 1153)	[13]
fminunc pal		Comparison of Multistart Global Optimization Algorithms on the BBOB Noiseless Testbed (Page 1153)	[13]
ga100 hol		Benchmarking Cellular Genetic Algorithms on the BBOB Noiseless Testbed (Page 1201)	[7]
grid100 hol		Benchmarking Cellular Genetic Algorithms on the BBOB Noiseless Testbed (Page 1201)	[7]
grid16 hol		Benchmarking Cellular Genetic Algorithms on the BBOB Noiseless Testbed (Page 1201)	[7]
hill hol		Benchmarking Cellular Genetic Algorithms on the BBOB Noiseless Testbed (Page 1201)	[7]
ImmCMA aug		Benchmarking the Local Metamodel CMA-ES on the Noiseless BBOB'2013 Test Bed (Page 1225)	[1]
memPSODE vog		Adapt-MEMPSODE: A Memetic Algorithm with Adaptive Selection of Local Searches (Page 1137)	[16]
prcga saw		Benchmarking Projection-Based Real Coded Genetic Algorithm on BBOB-2013 Noiseless Function Testbed (Page 1193)	[14]
ring100 hol		Benchmarking Cellular Genetic Algorithms on the BBOB Noiseless Testbed (Page 1201)	[7]
ring16 hol		Benchmarking Cellular Genetic Algorithms on the BBOB Noiseless Testbed (Page 1201)	[7]
simplex pal		Comparison of Multistart Global Optimization Algorithms on the BBOB Noiseless Testbed (Page 1153)	[13]

Table 2: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_1 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f1	<i>2.5e+2:48</i>	<i>1.6e+2:82</i>	<i>1.0e-8:83</i>	<i>1.0e-8:83</i>	<i>1.0e-8:83</i>	15/15
BIPOP-aCMA	3.4(0.9)	2.6 (0)	19 (0)	19 (0)	19 (0)	15/15
BIPOP-saAC	1.7 (1.0)	1.7 (0.6)	14 (0.8)	14 (0.8)	14 (0.8)	15/15
CMAES hut	1.7 (1)	1.9 (0.5)	∞	∞	∞ <i>4007</i>	0/15
IPOP-10DDr	0.44 (1)	2.4 (0.3)	63(2)	63(2)	63(2)	15/15
IPOP-500 l	0.44 (1)	2.4 (0.3)	63(2)	63(2)	63(2)	15/15
IPOP-tany	0.39 (1)	1.8 (0.5)	67(2)	67(2)	67(2)	15/15
IPOP-texp	0.11 (0.2)	0.69 (0.4) ^{*2}	60(2)	60(2)	60(2)	15/15
IPOP lia	0.44 (1)	2.4 (0.3)	63(2)	63(2)	63(2)	15/15
ga100 hol	7.9(5)	12(4)	∞	∞	∞ <i>2e6</i>	0/15
grid100 ho	43(19)	82(24)	∞	∞	∞ <i>2e6</i>	0/15
grid16 hol	10(6)	14(5)	∞	∞	∞ <i>2e6</i>	0/15
hill hol	3.7(2)	3.3(1)	∞	∞	∞ <i>2e6</i>	0/15
memPSODE v	2.9 (0)	1.8 (0)	1.8 (0) ^{*4}	1.8 (0) ^{*4}	1.8 (0) ^{*4}	15/15
prcga saw	1.8 (3)	5.6(5)	6936(4284)	6936(4284)	6936(4284)	15/15
ring100 ho	14(11)	28(7)	∞	∞	∞ <i>2e6</i>	0/15
ring16 hol	5.0(2)	6.2(2)	∞	∞	∞ <i>2e6</i>	0/15

Table 3: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_2 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FES/D	0.5	1.2	3	10	50	#succ
f_2	<i>1.0e+7:39</i>	<i>6.3e+6:71</i>	<i>4.0e+5:121</i>	<i>2.5e+4:499</i>	<i>1.0e-8:1188</i>	15/15
BIPOP-aCMA	1.9 (2)	2.6 (0.6)	3.5 (0.4) ^{*4}	1.1 (0.1) ^{*4}	41 (0.8)	15/15
BIPOP-saAC	1.2 (0.9)	1.3 (0.9)	11(5)	4.3 (0.8)	7.5 (0.9)	15/15
CMAES hut	1.2 (0.8)	1.0 (0.7)	15(3)	∞	∞ <i>4007</i>	0/15
IPOP-10DDr	1.8 (2)	2.1 (2)	11(3)	11(2)	68(1)	15/15
IPOP-500 l	1.8 (2)	2.1 (2)	11(3)	11(2)	68(1)	15/15
IPOP-tany	0.90 (0.7)	1.1 (0.9)	11(2)	12(1.0)	66(1)	15/15
IPOP-texp	0.45 (0.5)	0.49 (0.5)	7.2 (2)	10(2)	62(1)	15/15
IPOP lia	1.8 (2)	2.1 (2)	11(3)	11(2)	68(1)	15/15
ga100 hol	3.9(4)	6.9(3)	33(6)	21(3)	∞ <i>2e6</i>	0/15
grid100 ho	9.0(7)	24(20)	142(19)	91(19)	∞ <i>2e6</i>	0/15
grid16 hol	6.1(6)	7.8(4)	24(5)	16(4)	∞ <i>2e6</i>	0/15
hill hol	7.6(4)	5.0(2)	5.9 (2)	4.9 (3)	∞ <i>2e6</i>	0/15
memPSODE v	3.0(2)	2.2 (1)	8.9(4)	6.5(0.5)	16 (0.5)	15/15
prcga saw	1.2 (1)	2.0 (1)	13(2)	8.4(2)	1.1e4(1e4)	4/15
ring100 ho	4.1(7)	11(10)	66(13)	45(6)	∞ <i>2e6</i>	0/15
ring16 hol	4.4(4)	4.5(2)	14(3)	10(1)	∞ <i>2e6</i>	0/15

Table 4: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_3 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
<i>f3</i>	<i>1.6e+3:68</i>	<i>1.0e+3:222</i>	<i>6.3e+2:471</i>	<i>4.0e+2:662</i>	<i>6.3e+1:6332</i>	15/15
BIPOP-aCMA	2.5 (0.7)	0.94 (0)	0.60 (0)	0.55 (0) ^{*4}	0.25 (0.0) ^{*4}	15/15
BIPOP-saAC	1.5 (0.8)	0.93 (0.2)	0.68 (0.1)	1.5 (0.7)	1.5 (0.8)	15/15
CMAES hut	1.2 (0.5)	1.0 (0.3)	1.1 (0.3)	1.7 (0.4)	∞ <i>4007</i>	0/15
IPOP-10DDr	1.2 (1)	1.1 (0.2)	0.99 (0.2)	1.5 (0.3)	3.8(5)	15/15
IPOP-500 l	1.2 (1)	1.1 (0.2)	0.99 (0.2)	1.5 (0.3)	3.8(5)	15/15
IPOP-tany	0.65 (0.8)	0.97 (0.2)	0.84 (0.2)	1.5 (0.3)	2.0 (2)	15/15
IPOP-texp	0.13 (0.1)	0.32 (0.2) ^{*4}	0.50 (0.1)	1.4 (0.5)	3.3(2)	15/15
IPOP lia	1.2 (1)	1.1 (0.2)	0.99 (0.2)	1.5 (0.3)	3.8(5)	15/15
ga100 hol	6.7(5)	5.7(1)	5.2(1)	6.0(0.6)	2.5 (0.3)	15/15
grid100 ho	23(31)	29(17)	25(7)	29(8)	13(3)	15/15
grid16 hol	7.7(6)	6.0(2)	4.7(0.7)	5.1(0.8)	2.3 (0.3)	15/15
hill hol	2.9 (2)	1.3 (0.5)	0.83 (0.2)	0.84 (0.2)	0.44 (0.1)	15/15
memPSODE v	34(2)	11(0.5)	6.7(0.8)	5.6(0.9)	3.8(2)	15/15
prcga saw	1.9 (1)	2.6 (1)	3.3(0.9)	4.9(0.9)	2.4 (0.6)	15/15
ring100 ho	12(7)	13(2)	13(1)	14(1)	5.7(0.4)	15/15
ring16 hol	4.0(2)	2.9 (0.6)	2.5 (0.3)	2.8 (0.3)	1.1 (0.1)	15/15

Table 5: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_4 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
<i>f4</i>	<i>1.0e+3:439</i>	<i>6.3e+2:670</i>	<i>4.0e+2:707</i>	<i>2.5e+2:735</i>	<i>1.0e+2:5369</i>	15/15
BIPOP-aCMA	0.56 (0.1) _{↓4}	0.71 (0.1)	0.89 (0.1)	1.2 (0.2)	0.27 (0.0) ^{*4}	15/15
BIPOP-saAC	1.0 (0.2)	1.2 (0.2)	2.8 (0.6)	3.6 (0.7)	2.9 (0.5)	15/15
CMAES hut	1.1 (0.3)	1.4 (0.3)	3.0(0.8)	4.3(0.7)	5.5(6)	2/15
IPOP-10DDr	1.1 (0.2)	1.4 (0.2)	2.9 (0.8)	4.5(0.5)	3.3(2)	15/15
IPOP-500 l	1.1 (0.2)	1.4 (0.2)	2.9 (0.8)	4.5(0.5)	3.3(2)	15/15
IPOP-tany	0.94 (0.2)	1.4 (0.2)	3.0 (0.6)	4.7(0.6)	3.4(2)	15/15
IPOP-texp	0.27 (0.1) _{↓4} ^{*2}	0.65 (0.2)	2.4 (0.9)	3.8(0.6)	3.4(2)	15/15
IPOP lia	1.1 (0.2)	1.4 (0.2)	2.9 (0.8)	4.5(0.5)	3.3(2)	15/15
ga100 hol	4.7(1)	5.3(0.7)	7.6(0.6)	10(1)	2.7 (0.3)	15/15
grid100 ho	24(6)	26(7)	36(8)	49(7)	14(1)	15/15
grid16 hol	4.3(1.0)	4.5(0.9)	6.3(1.0)	8.8(2)	2.6 (0.3)	15/15
hill hol	0.79 (0.1) _{↓2}	0.69 (0.2)	0.91 (0.2)	1.3 (0.3)	0.43 (0.0)	15/15
memPSODE v	19(10)	13(7)	13(6)	13(6)	3.6(1)	15/15
prcga saw	1.8 (1)	3.7(0.6)	7.0(1)	11(3)	3.1(0.9)	15/15
ring100 ho	11(2)	13(2)	18(2)	25(2)	6.2(0.3)	15/15
ring16 hol	2.4 (0.4)	2.4 (0.3)	3.4(0.4)	4.6(0.5)	1.2 (0.2)	15/15

Table 6: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_5 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FES/D	0.5	1.2	3	10	50	#succ
f5	<i>4.0e+2:51</i>	<i>2.5e+2:81</i>	<i>1.0e-1:120</i>	<i>1.0e-8:121</i>	<i>1.0e-8:121</i>	15/15
BIPOP-aCMA	1.6 (0)	1.0 (0) ^{*4}	0.68 (0) ^{*4}	0.68 (0) ^{*4}	0.68 (0) ^{*4}	15/15
BIPOP-saAC	1.8 (0.3)	1.8 (0.3)	2.9 (0.2)	2.9 (0.2)	2.9 (0.2)	15/15
CMAES hut	2.3 (0.7)	2.2 (0.4)	4.7 (0.6)	4.7 (0.6)	4.7 (0.6)	15/15
IPOP-10DDr	1.9 (0.9)	3.9(1)	298(415)	657(535)	657(535)	15/15
IPOP-500 l	1.9 (0.9)	3.9(1)	298(415)	657(535)	657(535)	15/15
IPOP-tany	1.9 (0.4)	3.3(1)	261(270)	435(305)	435(305)	15/15
IPOP-texp	3.3(0.5)	3.6(1.0)	1.5e4(5e4)	3.3e4(1e5)	3.3e4(1e5)	15/15
IPOP lia	1.9 (0.9)	3.9(1)	298(415)	657(535)	657(535)	15/15
ga100 hol	19(4)	25(5)	88(8)	91(8)	91(8)	15/15
grid100 ho	83(30)	128(26)	371(62)	376(66)	376(66)	15/15
grid16 hol	23(6)	26(4)	67(8)	67(8)	67(8)	15/15
hill hol	4.2(1)	4.3(0.9)	12(2)	11(2)	11(2)	15/15
memPSODE v	3.8(0.4)	3.3(0.5)	6.0(0.9)	6.1(0.8)	6.1(0.8)	15/15
prcga saw	15(6)	24(14)	∞	∞	∞ 2e6	0/15
ring100 ho	45(10)	61(11)	190(13)	190(13)	190(13)	15/15
ring16 hol	9.4(2)	11(2)	35(3)	35(5)	35(5)	15/15

Table 7: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best } 2009}$ on f_6 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best } 2009}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f6	<i>6.3e+5:50</i>	<i>4.0e+5:82</i>	<i>4.0e+4:127</i>	<i>4.0e+2:734</i>	<i>6.3e+1:2121</i>	15/15
BIPOP-aCMA	2.9 (1)	2.7 (1)	3.6(1)	3.0 (0.5)	1.8 (0.3)	15/15
BIPOP-saAC	1.3 (0.9)	1.2 (0.5)	1.7 (0.4)	1.9 (0.5)	1.4 (0.2)	15/15
CMAES hut	1.4 (0.8)	1.2 (0.6)	2.1 (0.6)	2.8 (0.5)	2.4 (1)	11/15
IPOP-10DDr	1.2 (1)	1.8 (0.9)	2.9 (0.9)	1.3 (0.3)	1.2 (0.2)	15/15
IPOP-500 l	1.2 (1)	1.8 (0.9)	2.9 (0.9)	1.3 (0.3)	1.2 (0.2)	15/15
IPOP-tany	0.89 (0.8)	1.1 (0.6)	2.4 (0.7)	1.2 (0.3)	1.3 (0.1)	15/15
IPOP-texp	0.53 (0.5)	0.78 (0.5)	2.0 (0.9)	1.1 (0.6)	1.2 (0.2)	15/15
IPOP lia	1.2 (1)	1.8 (0.9)	2.9 (0.9)	1.3 (0.3)	1.2 (0.2)	15/15
ga100 hol	5.9(5)	7.7(4)	16(6)	9.4(6)	19(9)	15/15
grid100 ho	16(20)	31(30)	88(41)	105(60)	769(561)	11/15
grid16 hol	4.5(4)	7.1(5)	17(6)	27(18)	193(181)	14/15
hill hol	2.4 (2)	2.1 (1)	3.0(1)	6.4(8)	269(480)	12/15
memPSODE v	2.6 (1)	2.1 (0.7)	1.9 (1)	4.1(7)	8.1(4)	15/15
prcga saw	2.8 (3)	5.7(4)	15(6)	5.4(2)	190(228)	14/15
ring100 ho	12(12)	17(11)	39(16)	27(14)	57(10)	15/15
ring16 hol	4.4(4)	5.3(4)	10(5)	8.5(5)	17(17)	15/15

Table 8: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_7 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FES/D	0.5	1.2	3	10	50	#succ
f_7	<i>1.6e+3:35</i>	<i>1.0e+3:106</i>	<i>6.3e+2:165</i>	<i>2.5e+2:489</i>	<i>2.5e+1:2987</i>	15/15
BIPOP-aCMA	4.6(1)	3.1(0.7)	3.5(0.7)	2.1 (0.3)	1.1 (0.3)	15/15
BIPOP-saAC	2.6 (0.8)	1.5 (0.8)	1.9 (0.4)	1.1 (0.2)	2.2 (2)	15/15
CMAES hut	1.8 (1)	1.4 (0.7)	2.1 (0.7)	1.6 (0.4)	0.75 (0.2)	15/15
IPOP-10DDr	3.1(3)	2.0 (0.6)	2.1 (0.4)	1.4 (0.2)	2.8 (5)	15/15
IPOP-500 l	3.1(3)	2.0 (0.6)	2.1 (0.4)	1.4 (0.2)	2.8 (5)	15/15
IPOP-tany	1.5 (1)	1.5 (0.8)	1.7 (0.6)	1.2 (0.2)	0.72 (0.1)	15/15
IPOP-texp	0.63 (0.6)	0.57 (0.4) ^{*2}	0.68 (0.4) ^{*3}	0.76 (0.2) ^{*3}	3.4(6)	15/15
IPOP lia	3.1(3)	2.0 (0.6)	2.1 (0.4)	1.4 (0.2)	2.8 (5)	15/15
ga100 hol	7.1(7)	7.0(2)	9.0(1.0)	8.2(2)	∞ <i>2e6</i>	0/15
grid100 ho	19(27)	37(24)	57(27)	90(58)	∞ <i>2e6</i>	0/15
grid16 hol	7.0(5)	6.8(4)	10(4)	16(20)	∞ <i>2e6</i>	0/15
hill hol	4.5(2)	2.4 (1)	2.4 (1)	3.6(2)	∞ <i>2e6</i>	0/15
memPSODE v	24(14)	11(12)	18(16)	16(3)	41(25)	15/15
prcga saw	2.0 (2)	3.0(2)	4.1(2)	3.9(1)	3423(4069)	3/15
ring100 ho	12(10)	15(5)	20(4)	23(5)	1968(2343)	4/15
ring16 hol	5.6(4)	4.6(2)	5.3(1)	5.8(2)	9455(1e4)	1/15

Table 9: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_8 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f_8	<i>1.0e+5:85</i>	<i>6.3e+4:111</i>	<i>4.0e+4:125</i>	<i>2.5e+3:430</i>	<i>6.3e+1:2106</i>	15/15
BIPOP-aCMA	3.1(0.9)	3.2(1)	4.2(2)	2.5 (0.2)	1.4 (0.8)	15/15
BIPOP-saAC	2.2 (0.4)	2.0 (0.2)	1.9 (0.2)	0.86 (0.2)	0.65 (0.2)	15/15
CMAES hut	2.5 (0.5)	2.5 (0.5)	2.9 (0.6)	1.8 (0.2)	2.2 (2)	9/15
IPOP-10DDr	2.8 (0.5)	2.7 (0.4)	2.8 (0.4)	1.7 (0.1)	2.1 (0.2)	15/15
IPOP-500 l	2.8 (0.5)	2.7 (0.4)	2.8 (0.4)	1.7 (0.1)	2.1 (0.2)	15/15
IPOP-tany	2.4 (0.5)	2.4 (0.5)	2.7 (0.4)	1.7 (0.2)	3.5(9)	15/15
IPOP-texp	0.51 (0.4) ^{*2}	0.76 (0.4) ^{*3}	1.0 (0.3)	1.3 (0.2)	2.4 (1)	15/15
IPOP lia	2.8 (0.5)	2.7 (0.4)	2.8 (0.4)	1.7 (0.1)	2.1 (0.2)	15/15
ga100 hol	16(4)	17(2)	19(4)	16(2)	1632(2001)	6/15
grid100 ho	97(40)	90(36)	102(35)	75(10)	6722(7457)	2/15
grid16 hol	15(4)	15(5)	17(5)	12(2)	1.3e4(2e4)	1/15
hill hol	4.2(2)	3.6(1)	3.6(0.6)	2.3 (0.5)	578(736)	10/15
memPSODE v	1.4 (0.2)	1.3 (0.2)	1.2 (0.2)	0.58 (0.1) ^{*3}	1.5 (2)	15/15
prcga saw	3.7(2)	6.6(6)	9.4(5)	10(2)	1458(2009)	9/15
ring100 ho	39(6)	40(5)	46(7)	37(3)	36(3)	15/15
ring16 hol	8.8(2)	8.6(2)	9.3(1)	7.0(0.9)	1734(2158)	6/15

Table 10: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_9 for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f9	<i>2.5e+2:676</i>	<i>1.6e+2:865</i>	<i>1.0e+2:1397</i>	<i>6.3e+1:1896</i>	<i>4.0e+1:2180</i>	15/15
BIPOP-aCMA	2.3 (0.3)	2.0 (0.2)	1.4 (0.3)	1.2 (0.2)	1.3 (0.2)	15/15
BIPOP-saAC	0.90 (0.3)	0.79 (0.3)	0.55 (0.2)	0.61 (0.3)	0.60 (0.3)	15/15
CMAES hut	1.9 (0.2)	1.7 (0.2)	1.2 (0.1)	0.98 (0.1)	1.2 (0.1)	15/15
IPOP-10DDr	2.4 (0.3)	2.3 (0.7)	1.8 (1)	2.7 (0.9)	2.6 (0.7)	15/15
IPOP-500 l	2.4 (0.3)	2.3 (0.7)	1.8 (1)	2.7 (0.9)	2.6 (0.7)	15/15
IPOP-tany	2.1 (0.3)	1.9 (0.4)	1.7 (1)	3.8(10)	3.6(9)	15/15
IPOP-texp	1.1 (0.2)	1.0 (0.1)	0.76 (0.1)	0.69 (0.1)	0.87 (0.1)	15/15
IPOP lia	2.4 (0.3)	2.3 (0.7)	1.8 (1)	2.7 (0.9)	2.6 (0.7)	15/15
ga100 hol	37(26)	77(35)	104(197)	192(315)	193(284)	14/15
grid100 ho	192(98)	423(425)	480(717)	986(1165)	1052(993)	9/15
grid16 hol	139(58)	221(165)	274(671)	426(544)	392(469)	12/15
hill hol	11(12)	14(11)	169(393)	146(329)	136(290)	14/15
memPSODE v	0.79 (0.3)	0.83 (0.6)	1.2 (1)	1.2 (1.0)	1.1 (0.9)	15/15
prcga saw	2.6 (0.7)	29(10)	49(70)	1187(1795)	1049(1091)	11/15
ring100 ho	70(8)	72(10)	61(10)	59(13)	91(25)	15/15
ring16 hol	26(8)	56(39)	262(717)	302(530)	271(463)	12/15

Table 11: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{10} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f10	<i>1.0e+7:44</i>	<i>6.3e+6:80</i>	<i>2.5e+6:126</i>	<i>2.5e+5:408</i>	<i>6.3e+3:2376</i>	15/15
BIPOP-aCMA	1.9 (2)	2.1 (2)	4.3(2)	6.1(2)	3.8 (0.7)	15/15
BIPOP-saAC	1.2 (0.6)	1.1 (0.8)	3.2(3)	4.4(1)	1.3 (0.2) ^{*4}	15/15
CMAES hut	0.92 (0.5)	1.0 (0.6)	2.8 (1)	5.0(1)	∞ <i>4007</i>	0/15
IPOP-10DDr	1.4 (2)	1.7 (1.0)	3.2(1)	4.4(0.7)	3.9(0.9)	15/15
IPOP-500 l	1.4 (2)	1.7 (1.0)	3.2(1)	4.4(0.7)	3.9(0.9)	15/15
IPOP-tany	0.73 (0.9)	1.2 (0.9)	2.5 (0.9)	4.3 (0.7)	4.0(0.8)	15/15
IPOP-texp	0.42 (0.6)	0.50 (0.4)	0.85 (0.5) ^{*2}	3.4 (1.0)	3.3 (0.5)	15/15
IPOP lia	1.4 (2)	1.7 (1.0)	3.2(1)	4.4(0.7)	3.9(0.9)	15/15
ga100 hol	2.2 (2)	4.6(2)	10(3)	25(11)	∞ <i>2e6</i>	0/15
grid100 ho	2.0 (2)	7.7(6)	38(27)	307(267)	∞ <i>2e6</i>	0/15
grid16 hol	1.9 (3)	3.3(3)	8.1(4)	94(83)	∞ <i>2e6</i>	0/15
hill hol	3.0 (2)	2.1 (1)	2.4 (1.0)	16(11)	6137(6734)	2/15
memPSODE v	3.9(4)	2.8 (3)	3.3(2)	3.4 (0.9)	31(14)	15/15
prcga saw	0.96 (1)	2.5 (2)	5.9(3)	14(5)	625(307)	15/15
ring100 ho	2.5 (3)	7.0(6)	19(7)	92(44)	∞ <i>2e6</i>	0/15
ring16 hol	1.8 (2)	2.3 (2)	4.8(1)	27(19)	6191(7103)	2/15

Table 12: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{11} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f11	<i>1.0e+4:22</i>	<i>2.5e+3:52</i>	<i>2.5e+2:432</i>	<i>1.6e+2:887</i>	<i>1.6e+1:2204</i>	15/15
BIPOP-aCMA	2.8 (3)	1.9 (2)	23(2)	1.2 (1)	5.3 (0.3)	15/15
BIPOP-saAC	1.5 (1)	1.0 (0.7)	15 (8)	7.3 (4)	3.0 (2)	15/15
CMAES hut	1.5 (1)	1.4 (0.8)	∞	∞	∞ <i>4007</i>	0/15
IPOP-10DDr	2.8 (4)	1.6 (1)	39(5)	22(2)	13(0.6)	15/15
IPOP-500 l	2.8 (4)	1.6 (1)	39(5)	22(2)	13(0.6)	15/15
IPOP-tany	2.4 (2)	1.2 (1)	40(5)	22(2)	12(0.5)	15/15
IPOP-texp	1.3 (0.9)	0.92 (0.7)	33(5)	20(2)	11(0.4)	15/15
IPOP lia	2.8 (4)	1.6 (1)	39(5)	22(2)	13(0.6)	15/15
ga100 hol	2.1 (3)	1.5 (2)	43(44)	52(33)	376(222)	15/15
grid100 ho	3.6(4)	3.2(3)	1693(892)	3337(3384)	∞ <i>2e6</i>	0/15
grid16 hol	2.0 (2)	1.7 (1)	523(322)	472(228)	∞ <i>2e6</i>	0/15
hill hol	2.7 (3)	1.3 (1)	156(94)	157(87)	592(182)	14/15
memPSODE v	3.6(6)	2.8 (3)	1.9 (0.6)	0.97 (0.3) ^{*3}	0.75 (0.1) ^{*4}	15/15
prcga saw	2.6 (3)	2.0 (2)	6.5 (8)	76(85)	1601(1144)	11/15
ring100 ho	2.5 (3)	2.0 (3)	174(142)	232(91)	804(469)	13/15
ring16 hol	1.9 (2)	1.4 (1)	96(66)	90(45)	432(219)	15/15

Table 13: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_{12} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f12	<i>2.5e+8:54</i>	<i>1.6e+8:218</i>	<i>1.0e+8:284</i>	<i>1.0e+7:424</i>	<i>4.0e+1:2479</i>	15/15
BIPOP-aCMA	7.6(2)	2.5 (0.5)	2.3 (0.4)	2.7 (0.2)	1.9 (0.1)	15/15
BIPOP-saAC	3.7(1)	1.3 (0.4)	1.2 (0.4)	1.2 (0.2)	0.43 (0.0)	15/15
CMAES hut	4.2(1)	1.5 (0.3)	1.5 (0.4)	2.1 (0.3)	1.6 (0.1)	14/15
IPOP-10DDr	4.0(1)	1.4 (0.2)	1.4 (0.2)	2.0 (0.2)	1.5 (0.1)	15/15
IPOP-500 l	4.0(1)	1.4 (0.2)	1.4 (0.2)	2.0 (0.2)	1.5 (0.1)	15/15
IPOP-tany	3.1 (1)	1.3 (0.2)	1.3 (0.2)	2.1 (0.2)	1.6 (0.1)	15/15
IPOP-texp	0.85 (0.7) ^{*2}	0.51 (0.2) ^{*2}	0.58 (0.2)	1.6 (0.2)	1.4 (0.1)	15/15
IPOP lia	4.0(1)	1.4 (0.2)	1.4 (0.2)	2.0 (0.2)	1.5 (0.1)	15/15
ga100 hol	17(6)	7.5(2)	8.9(1)	17(3)	405(409)	13/15
grid100 ho	108(53)	46(17)	52(15)	86(11)	∞ 2e6	0/15
grid16 hol	20(16)	7.4(4)	8.1(3)	13(3)	1083(844)	9/15
hill hol	4.8(3)	1.6 (0.5)	1.7 (0.4)	2.5 (0.5)	595(808)	10/15
memPSODE v	3.6 (2)	0.97 (0.5)	0.86 (0.4)	0.77 (0.3) ^{*2}	0.24 (0.1) ^{*4}	15/15
prcga saw	6.4(5)	3.7(2)	4.9(1)	10(2)	40(30)	15/15
ring100 ho	42(10)	20(4)	23(2)	44(3)	345(75)	15/15
ring16 hol	10(4)	4.4(1)	4.5(0.8)	7.9(0.7)	212(87)	15/15

Table 14: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{13} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f13	<i>2.5e+3:85</i>	<i>1.6e+3:121</i>	<i>1.6e+3:121</i>	<i>6.3e+1:429</i>	<i>1.0e+1:2029</i>	15/15
BIPOP-aCMA	3.3(2)	5.1(0.9)	5.1(0.9)	5.4(0.3)	1.6 (0.1)	15/15
BIPOP-saAC	1.8 (0.5)	1.9 (0.2)	1.9 (0.2)	1.6 (0.1)	0.76 (0.8)	15/15
CMAES hut	1.5 (0.8)	3.2(0.9)	3.2(0.9)	5.1(0.4)	2.1 (1)	12/15
IPOP-10DDr	2.4 (0.3)	3.3(0.4)	3.3(0.4)	5.0(0.6)	3.1(4)	15/15
IPOP-500 l	2.4 (0.3)	3.3(0.4)	3.3(0.4)	5.0(0.6)	3.1(4)	15/15
IPOP-tany	1.5 (0.5)	2.8 (0.5)	2.8 (0.5)	5.1(0.5)	2.6 (4)	15/15
IPOP-texp	0.53 (0.5) ^{*2}	1.5 (0.5)	1.5 (0.5)	4.4 (0.4)	1.5 (0.1)	15/15
IPOP lia	2.4 (0.3)	3.3(0.4)	3.3(0.4)	5.0(0.6)	3.1(4)	15/15
ga100 hol	10(4)	19(3)	19(3)	141(32)	505(553)	11/15
grid100 ho	46(36)	105(26)	105(26)	916(561)	1.5e4(1e4)	1/15
grid16 hol	10(4)	18(5)	18(5)	135(24)	463(546)	12/15
hill hol	2.6 (1)	3.9(1)	3.9(1)	76(56)	585(985)	10/15
memPSODE v	1.5 (0.5)	1.8 (0.7)	1.8 (0.7)	1.8 (0.2)	1.4 (2)	15/15
prcga saw	4.4(3)	13(4)	13(4)	70(14)	769(1001)	11/15
ring100 ho	24(7)	52(4)	52(4)	293(47)	212(76)	15/15
ring16 hol	5.4(2)	10(1)	10(1)	66(12)	1195(1485)	7/15

Table 15: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_{14} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f14	<i>6.3e+1:34</i>	<i>4.0e+1:137</i>	<i>2.5e+1:176</i>	<i>4.0e+0:438</i>	<i>1.0e-3:2207</i>	15/15
BIPOP-aCMA	8.1(6)	3.8(1)	3.9(1.0)	3.1(0.5)	3.6 (0.3)	15/15
BIPOP-saAC	4.0(2)	1.9 (0.7)	2.4 (0.7)	1.8 (0.4)	1.4 (0.1) ^{*4}	15/15
CMAES hut	3.2 (1)	1.5 (0.8)	2.4 (0.5)	2.5 (0.4)	∞ <i>4007</i>	0/15
IPOP-10DDr	4.6(3)	2.0 (0.3)	2.2 (0.3)	2.1 (0.3)	4.5(0.3)	15/15
IPOP-500 l	4.6(3)	2.0 (0.3)	2.2 (0.3)	2.1 (0.3)	4.5(0.3)	15/15
IPOP-tany	2.5 (2)	1.5 (0.5)	1.8 (0.5)	2.2 (0.3)	4.7(0.2)	15/15
IPOP-texp	0.59 (0.6) [*]	0.42 (0.2) ^{*3}	0.74 (0.3) ^{*3}	1.8 (0.3)	4.2 (0.4)	15/15
IPOP lia	4.6(3)	2.0 (0.3)	2.2 (0.3)	2.1 (0.3)	4.5(0.3)	15/15
ga100 hol	13(4)	7.1(3)	12(4)	20(4)	∞ <i>2e6</i>	0/15
grid100 ho	43(34)	43(27)	64(20)	96(19)	∞ <i>2e6</i>	0/15
grid16 hol	15(16)	9.1(5)	12(5)	17(3)	∞ <i>2e6</i>	0/15
hill hol	5.9(2)	2.2 (0.5)	2.5 (0.6)	3.0 (0.7)	∞ <i>2e6</i>	0/15
memPSODE v	6.6(2)	1.9 (0.7)	1.6 (0.6)	1.2 (0.3) ^{*3}	8.2(4)	15/15
prcga saw	4.6(4)	3.4(2)	5.3(2)	10(2)	2279(2073)	9/15
ring100 ho	24(24)	19(7)	31(10)	52(6)	∞ <i>2e6</i>	0/15
ring16 hol	8.2(5)	4.8(1)	6.9(2)	10(2)	∞ <i>2e6</i>	0/15

Table 16: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{15} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f15	<i>1.0e+3</i> :192	<i>6.3e+2</i> :458	<i>4.0e+2</i> :1170	<i>2.5e+2</i> :3875	<i>2.5e+2</i> :3875	15/15
BIPOP-aCMA	2.2 (0.9)	1.6 (0.3)	1.3 (0.3)	1.1 (0.3)	1.1 (0.3)	15/15
BIPOP-saAC	1.1 (0.4)	0.68 (0.1)	1.00 (0.3)	0.91 (0.3)	0.91 (0.3)	15/15
CMAES hut	0.99 (0.3)	1.0 (0.3)	1.1 (0.3)	1.8 (1)	1.8 (1)	8/15
IPOP-10DDr	1.3 (0.4)	0.93 (0.1)	0.83 (0.2)	1.1 (0.3)	1.1 (0.3)	15/15
IPOP-500 l	1.3 (0.4)	0.93 (0.1)	0.83 (0.2)	1.1 (0.3)	1.1 (0.3)	15/15
IPOP-tany	1.0 (0.2)	0.85 (0.1)	0.81 (0.2)	1.1 (0.3)	1.1 (0.3)	15/15
IPOP-texp	0.56 (0.3) _{↓2} *	0.61 (0.2)	0.77 (0.2)	0.90 (0.3)	0.90 (0.3)	15/15
IPOP lia	1.3 (0.4)	0.93 (0.1)	0.83 (0.2)	1.1 (0.3)	1.1 (0.3)	15/15
ga100 hol	6.2(2)	5.6(0.9)	5.6(1)	6.5(2)	6.5(2)	15/15
grid100 ho	62(25)	1069(1180)	7226(8506)	∞	∞ <i>2e6</i>	0/15
grid16 hol	13(5)	975(2187)	4926(5982)	∞	∞ <i>2e6</i>	0/15
hill hol	4.7(4)	5030(6576)	∞	∞	∞ <i>2e6</i>	0/15
memPSODE v	55(30)	55(12)	37(19)	24(8)	24(8)	15/15
prcga saw	2.9 (2)	3.4(0.5)	3.7(0.6)	3.2(1)	3.2(1)	15/15
ring100 ho	16(4)	19(3)	34(19)	116(224)	116(224)	14/15
ring16 hol	4.0(1)	6.6(6)	438(856)	605(780)	605(777)	7/15

Table 17: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{16} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f16	<i>4.0e+1:117</i>	<i>2.5e+1:297</i>	<i>1.6e+1:4010</i>	<i>1.6e+1:4010</i>	<i>1.0e+1:5244</i>	15/15
BIPOP-aCMA	21(17)	14(3)	1.1 (0.3)	1.1 (0.3)	1.0 (0.3)	15/15
BIPOP-saAC	22(10)	12(5)	1.0 (0.4)	1.0 (0.4)	0.94 (0.4)	15/15
CMAES hut	23(17)	14(9)	1.7 (1)	1.7 (2)	3.7(4)	3/15
IPOP-10DDr	8.9(6)	7.0 (1)	0.61 (0.1)	0.61 (0.1)	0.55 (0.1)	15/15
IPOP-500 l	8.9(6)	7.0 (1)	0.61 (0.1)	0.61 (0.1)	0.55 (0.1)	15/15
IPOP-tany	9.3(6)	7.6(2)	0.67 (0.1)	0.67 (0.1)	0.58 (0.1)	15/15
IPOP-texp	5.8(5)	5.3 (2)	0.49 (0.2)	0.49 (0.2)	0.45 (0.1)*	15/15
IPOP lia	8.9(6)	7.0 (1)	0.61 (0.1)	0.61 (0.1)	0.55 (0.1)	15/15
ga100 hol	13(15)	24(11)	42(13)	42(13)	339(480)	8/15
grid100 ho	9.0(7)	96(67)	515(608)	515(748)	∞ 2e6	0/15
grid16 hol	3.1 (2)	416(300)	622(770)	622(756)	5566(6102)	1/15
hill hol	1.3 (1)	19(6)	1077(1496)	1077(1291)	5611(6102)	1/15
memPSODE v	22(4)	26(17)	3.8(3)	3.8(3)	7.5(6)	15/15
prcga saw	11(14)	22(14)	2.3 (0.7)	2.3 (0.7)	120(382)	13/15
ring100 ho	5.8(6)	27(12)	8.3(2)	8.3(2)	37(30)	15/15
ring16 hol	2.9 (2)	8.0(4)	253(499)	253(499)	1058(1158)	4/15

Table 18: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{17} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f17	<i>1.6e+1:54</i>	<i>1.0e+1:399</i>	<i>6.3e+0:688</i>	<i>4.0e+0:1115</i>	<i>1.0e+0:4220</i>	15/15
BIPOP-aCMA	6.7(4)	1.7 (0.6)	1.4 (0.3)	1.1 (0.2)	0.54 (0.1)	15/15
BIPOP-saAC	3.8(2)	0.99 (0.4)	1.00 (0.2)	0.88 (0.1)	2.4 (0.4)	15/15
CMAES hut	2.8 (3)	1.0 (0.4)	1.1 (0.3)	1.00 (0.3)	0.59 (0.2)	15/15
IPOP-10DDr	2.2 (2)	0.81 (0.2)	0.84 (0.2)	0.77 (0.2)	0.49 (0.1)	15/15
IPOP-500 l	2.2 (2)	0.81 (0.2)	0.84 (0.2)	0.77 (0.2)	0.49 (0.1)	15/15
IPOP-tany	1.4 (1)	0.59 (0.2)	0.71 (0.2)	0.72 (0.1)	0.43 (0.1)	15/15
IPOP-texp	0.37 (0.3)	0.31 (0.1) ^{*2}	0.53 (0.2)	0.61 (0.2)	0.46 (0.1)	15/15
IPOP lia	2.2 (2)	0.81 (0.2)	0.84 (0.2)	0.77 (0.2)	0.49 (0.1)	15/15
ga100 hol	6.3(3)	3.3(0.8)	4.9(0.9)	5.9(2)	717(948)	6/15
grid100 ho	38(13)	1549(2583)	∞	∞	∞ <i>2e6</i>	0/15
grid16 hol	48(27)	975(2505)	4.3e4(5e4)	∞	∞ <i>2e6</i>	0/15
hill hol	1.5e4(2e4)	∞	∞	∞	∞ <i>2e6</i>	0/15
memPSODE v67	67(102)	27(18)	56(57)	188(209)	279(156)	15/15
prcga saw	2.1 (3)	1.5 (0.9)	3.0 (1)	3.3(0.8)	1400(1895)	6/15
ring100 ho	10(8)	11(6)	37(23)	1340(1814)	∞ <i>2e6</i>	0/15
ring16 hol	5.1(4)	3.8(3)	1162(1525)	2.5e4(3e4)	∞ <i>2e6</i>	0/15

Table 19: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_{18} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f18	<i>6.3e+1:55</i>	<i>4.0e+1:329</i>	<i>4.0e+1:329</i>	<i>2.5e+1:579</i>	<i>6.3e+0:2006</i>	15/15
BIPOP-aCMA	5.1(2)	1.6 (0.5)	1.6 (0.5)	1.4 (0.4)	0.97 (0.2)	15/15
BIPOP-saAC	2.5 (1)	1.1 (0.5)	1.1 (0.5)	1.1 (0.3)	0.82 (0.3)	15/15
CMAES hut	2.5 (1)	0.97 (0.4)	0.97 (0.4)	1.1 (0.3)	0.96 (0.3)	15/15
IPOP-10DDr	1.9 (2)	0.83 (0.2)	0.83 (0.2)	0.84 (0.2)	0.80 (0.2)	15/15
IPOP-500 l	1.9 (2)	0.83 (0.2)	0.83 (0.2)	0.84 (0.2)	0.80 (0.2)	15/15
IPOP-tany	1.0 (0.9)	0.67 (0.2)	0.67 (0.2)	0.79 (0.2)	0.77 (0.1)	15/15
IPOP-texp	0.45 (0.5)	0.38 (0.2) ^{*3}	0.38 (0.2) ^{*3}	0.59 (0.1)	0.73 (0.1)	15/15
IPOP lia	1.9 (2)	0.83 (0.2)	0.83 (0.2)	0.84 (0.2)	0.80 (0.2)	15/15
ga100 hol	6.2(4)	3.9(1)	3.9(1)	4.8(1)	1153(1498)	7/15
grid100 ho	12(10)	218(191)	218(191)	1.5e4(2e4)	∞ 2e6	0/15
grid16 hol	5.0(5)	638(839)	638(839)	1.5e4(2e4)	∞ 2e6	0/15
hill hol	6026(2e4)	1.3e4(2e4)	1.3e4(2e4)	∞	∞ 2e6	0/15
memPSODE v	78(94)	34(13)	34(13)	41(20)	283(222)	15/15
prcga saw	2.0 (3)	1.7 (0.7)	1.7 (0.7)	3.0 (0.8)	337(997)	13/15
ring100 ho	10(9)	11(5)	11(5)	31(18)	∞ 2e6	0/15
ring16 hol	3.5(3)	4.3(1)	4.3(1)	541(1169)	∞ 2e6	0/15

Table 20: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{19} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f19	<i>1.6e-1</i> :8.6e5	<i>1.0e-1</i> :1.4e6	<i>6.3e-2</i> :3.1e6	<i>4.0e-2</i> :5.2e6	<i>2.5e-2</i> :8.7e6	15/15
BIPOP-aCMA	1.1 (0.9)	1.0 (1)	0.73 (0.6)	0.77 (0.4)	0.73 (0.3)	15/15
BIPOP-saAC	0.75 (0.8)	0.75 (0.9)	0.75 (0.7)	0.89 (0.6)	1.0 (0.4)	15/15
CMAES hut	∞	∞	∞	∞	∞ <i>4007</i>	0/15
IPOP-10DDr	4.4(5)	2.8 (3)	1.5 (1)	1.1 (1)	0.94 (0.7)	15/15
IPOP-500 l	4.4(5)	2.8 (3)	1.5 (1)	1.2 (1.0)	1.4 (1)	15/15
IPOP-tany	5.2(8)	3.4(5)	1.7 (2)	1.3 (1)	1.0 (0.9)	15/15
IPOP-texp	2.4 (4)	1.6 (3)	0.94 (1)	0.97 (0.9)	0.80 (0.5)	15/15
IPOP lia	4.4(5)	2.8 (3)	1.5 (1)	1.1 (1)	0.94 (0.7)	15/15
ga100 hol	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
grid100 ho	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
grid16 hol	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
hill hol	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
memPSODE v	∞	∞	∞	∞	∞ <i>2e7</i>	0/15
prcga saw	0.43 (0.2)	0.77 (0.7)	0.43 (0.4)	0.31 (0.2)	0.23 (0.1)	14/15
ring100 ho	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
ring16 hol	∞	∞	∞	∞	∞ <i>2e6</i>	0/15

Table 21: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{20} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f20	<i>2.5e+4</i> :83	<i>1.6e+4</i> :86	<i>1.0e+3</i> :125	<i>2.5e+0</i> :515	<i>1.6e+0</i> :5582	15/15
BIPOP-aCMA	5.8(2)	6.4(2)	7.1(0.8)	5.6(0.6)	71(58)	15/15
BIPOP-saAC	2.9 (0.3)	3.0 (0.5)	2.9 (0.5)	3.3 (1)	52(50)	15/15
CMAES hut	3.4(0.8)	4.0(0.8)	5.0(0.9)	5.1(1.0)	11(11)	1/15
IPOP-10DDr	4.4(0.4)	4.9(0.7)	5.8(0.5)	5.6(1.0)	141(64)	15/15
IPOP-500 l	4.4(0.4)	4.9(0.7)	5.8(0.5)	5.6(1.0)	132(56)	15/15
IPOP-tany	3.2(0.8)	3.8(0.7)	5.1(0.5)	5.8(0.9)	145(112)	15/15
IPOP-texp	0.44 (0.2) ^{*4} _{↓6}	0.67 (0.4) ^{*4}	2.1 (1)	4.7(0.8)	309(136)	15/15
IPOP lia	4.4(0.4)	4.9(0.7)	5.8(0.5)	5.6(1.0)	141(64)	15/15
ga100 hol	20(4)	24(4)	33(8)	22(3)	3.3(0.4)	15/15
grid100 ho	100(37)	121(39)	174(30)	92(17)	16(5)	15/15
grid16 hol	17(6)	20(6)	27(5)	15(1)	2.7 (0.6)	15/15
hill hol	4.4(2)	4.7(2)	6.0(2)	2.9 (0.7)	0.60 (0.1) [*]	15/15
memPSODE v	2.7 (0.5)	2.6 (0.5)	2.3 (0.7)	4.0 (2)	1.6 (1)	15/15
prcga saw	2.9 (0.5)	4.6(2)	11(2)	13(3)	4.4(2)	15/15
ring100 ho	51(7)	59(9)	83(8)	48(4)	7.2(0.5)	15/15
ring16 hol	10(2)	12(3)	16(2)	9.0(1)	1.4 (0.1)	15/15

Table 22: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ on f_{21} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best 2009}}$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f21	<i>6.3e+1</i> :160	<i>4.0e+1</i> :305	<i>2.5e+1</i> :380	<i>1.6e+1</i> :784	<i>6.3e+0</i> :2510	30/30
BIPOP-aCMA	3.8(0.8)	2.6 (0.5)	4.0(0.4)	2.2 (0.4)	3.3(5)	15/15
BIPOP-saAC	2.4 (0.9)	3.5(5)	3.5(4)	1.7 (2)	0.98 (0.7)	15/15
CMAES hut	2.5 (1)	2.7 (0.8)	2.6 (1)	2.2 (3)	1.8 (2)	8/15
IPOP-10DDr	2.1 (0.5)	1.5 (0.3)	1.4 (0.4)	2.7 (0.2)	189(5)	15/15
IPOP-500 l	2.1 (0.5)	1.5 (0.3)	1.4 (0.4)	2.7 (0.2)	15(5)	15/15
IPOP-tany	1.8 (0.4)	1.3 (0.1)	1.3 (0.3)	0.79 (0.1)	2.5 (8)	15/15
IPOP-texp	1.0 (0.3) ^{*3}	0.96 (0.3) [*]	1.1 (0.2)	0.69 (0.2)	6.2(5)	15/15
IPOP lia	2.1 (0.5)	1.5 (0.3)	1.4 (0.4)	2.7 (0.2)	299(5)	15/15
ga100 hol	14(5)	11(2)	12(5)	189(5)	293(400)	11/15
grid100 ho	63(15)	48(13)	51(16)	217(17)	928(1202)	7/15
grid16 hol	11(4)	8.0(2)	9.2(6)	642(1276)	202(399)	12/15
hill hol	2.6 (1)	470(1)	1917(2635)	1277(1276)	698(798)	8/15
memPSODE v	2.7 (1)	2.1 (0.9)	2.5 (3)	2.8 (3)	1.1 (1.0)	15/15
prcga saw	10(3)	7.3(2)	7.2(2)	4.7(1)	411(797)	11/15
ring100 ho	31(10)	25(8)	26(6)	16(4)	8.6(3)	15/15
ring16 hol	7.5(1)	5.9(1)	6.2(1)	3.7(0.8)	125(398)	13/15

Table 23: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{22} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
<i>f22</i>	<i>6.3e+1:160</i>	<i>4.0e+1:231</i>	<i>2.5e+1:687</i>	<i>1.6e+1:1392</i>	<i>1.0e+1:3090</i>	15/15
BIPOP-aCMA	4.0(1)	3.7 (1)	6.4(7)	10(16)	7.8(16)	15/15
BIPOP-saAC	2.5 (0.7)	4.8(7)	2.6 (3)	2.9 (5)	7.2(4)	15/15
CMAES hut	2.4 (0.6)	2.2 (0.7)	1.4 (0.4)	1.0 (1)	0.62 (0.7)	12/15
IPOP-10DDr	2.3 (0.8)	37(91)	13(31)	9.0(15)	388(848)	15/15
IPOP-500 l	2.3 (0.8)	37(91)	13(31)	9.0(15)	3262(6474)	12/15
IPOP-tany	2.0 (0.5)	4.2(0.7)	3.6(6)	135(13)	87(186)	15/15
IPOP-texp	1.3 (0.9)*	21(15)	17(5)	99(62)	158(294)	15/15
IPOP lia	2.3 (0.8)	37(91)	13(31)	9.0(15)	1110(924)	14/15
ga100 hol	14(5)	631(5)	214(2)	107(2)	49(2)	14/15
grid100 ho	69(21)	80(47)	755(1458)	543(749)	574(649)	8/15
grid16 hol	908(5)	632(11)	1064(1458)	1261(2155)	742(971)	7/15
hill hol	2.7 (1.0)	620(1)	729(1455)	719(1437)	740(971)	7/15
memPSODE v	2.9 (2)	2.9 (3)	1.6 (1)	0.89 (0.7)	0.77 (0.9)	15/15
prcga saw	11(3)	11(3)	292(2)	340(994)	274(647)	12/15
ring100 ho	37(6)	36(8)	15(3)	10(2)	5.4 (2)	15/15
ring16 hol	7.8(3)	8.3(4)	451(1455)	361(719)	163(324)	12/15

Table 24: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{23} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
<i>f23</i>	<i>6.3e+0:68</i>	<i>4.0e+0:292</i>	<i>2.5e+0:603</i>	<i>2.5e+0:603</i>	<i>1.6e+0:2487</i>	15/15
BIPOP-aCMA	5.1(7)	110(112)	185(143)	185(143)	45 (35)	15/15
BIPOP-saAC	13(15)	86(63)	175(183)	175(183)	43 (44)	15/15
CMAES hut	15(12)	96(108)	∞	∞	∞ <i>4007</i>	0/15
IPOP-10DDr	3.5(3)	49(60)	396(378)	396(378)	96(92)	15/15
IPOP-500 l	3.5(3)	49(60)	396(378)	396(378)	96(92)	15/15
IPOP-tany	2.4 (3)	65(106)	220(185)	220(185)	53(45)	15/15
IPOP-texp	4.6(5)	54(53)	389(379)	389(379)	102(150)	15/15
IPOP lia	3.5(3)	49(60)	396(378)	396(378)	96(92)	15/15
ga100 hol	4.4(4)	56(44)	1216(1129)	1216(1129)	1531(1656)	6/15
grid100 ho	2.9 (3)	54(41)	447(177)	447(177)	1094(1050)	8/15
grid16 hol	2.8 (4)	35 (33)	572(606)	572(606)	510(651)	11/15
hill hol	2.4 (2)	10 (7)	300(110)	300(110)	576(811)	9/15
memPSODE v	89(63)	42(10)	51 (36)	51 (36)	29 (16)	15/15
prcga saw	4.6(3)	82(93)	1563(1523)	1563(1464)	1.4e4(2e4)	1/15
ring100 ho	3.6(5)	40(33)	118 (41)	118 (41)	98(46)	15/15
ring16 hol	1.8 (2)	20 (15)	95 (76)	95 (76)	839(1091)	8/15

Table 25: 40-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ on f_{24} for given run-length based budgets (0.5D, 1.2D, 3D, 10D, and 50D function evaluations). The ERT and in braces, as dispersion measure, the half difference between 90 and 10%-tile of bootstrapped run lengths appear for each algorithm and run-length based target, the corresponding $\text{ERT}_{\text{best}} 2009$ (preceded by the target Δf -value in *italics*) in the first row. #succ is the number of trials that reached the target value of the last column. The median number of conducted function evaluations is additionally given in *italics*, if the target in the last column was never reached. Entries with succeeding star are statistically significantly better (according to the rank-sum test) compared to all other algorithms in the table, with $p = 0.05$ or $p = 10^{-k}$ when the number k following the star is larger than 1, with Bonferroni correction by the number of instances.

#FEs/D	0.5	1.2	3	10	50	#succ
f24	<i>4.0e+2:1404</i>	<i>2.5e+2:17825</i>	<i>1.6e+2:18980</i>	<i>1.0e+2:38677</i>	<i>6.3e+1:1.6e5</i>	15/15
BIPOP-aCMA	1.2 (0.8)	7.4(7)	24(32)	13(16)	3.7(4)	15/15
BIPOP-saAC	0.95 (0.3)	4.9(5)	11(16)	7.9(12)	2.0 (3)	15/15
CMAES hut	1.1 (0.7)	∞	∞	∞	∞ <i>4007</i>	0/15
IPOP-10DDr	1.2 (0.5)	1.4 (0.8)	1.4 (0.9)	1.8 (1.0)	1.3 (0.4)	15/15
IPOP-500 l	1.2 (0.5)	1.4 (0.8)	1.4 (0.9)	1.8 (1.0)	1.3 (0.4)	15/15
IPOP-tany	0.88 (0.4)	1.5 (1.0)	1.5 (0.9)	1.2 (1.0)	0.84 (0.6)	15/15
IPOP-texp	0.61 (0.4)	1.5 (1)	1.5 (1)	1.3 (1)	1.1 (1)	15/15
IPOP lia	1.2 (0.5)	1.4 (0.8)	1.4 (0.9)	1.8 (1.0)	1.3 (0.4)	15/15
ga100 hol	5.4(1.0)	5.6(5)	13(5)	28(28)	∞ <i>2e6</i>	0/15
grid100 ho	6228(6890)	∞	∞	∞	∞ <i>2e6</i>	0/15
grid16 hol	4376(4987)	∞	∞	∞	∞ <i>2e6</i>	0/15
hill hol	9458(9974)	∞	∞	∞	∞ <i>2e6</i>	0/15
memPSODE v	19(13)	4.0(2)	9.4(5)	19(17)	71(64)	13/15
prcga saw	19(14)	5.7(6)	14(10)	7.7(4)	11(13)	11/15
ring100 ho	45(14)	23(9)	753(876)	∞	∞ <i>2e6</i>	0/15
ring16 hol	21(23)	162(181)	∞	∞	∞ <i>2e6</i>	0/15

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