Comparison Tables: BBOB 2013 Testbed in 3-D

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2013, 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 ($\mathrm{ERT}_{\mathrm{best}}$ 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 short name	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]
HMLSL 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]
lmmCMA 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: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f1	3.6	8.0	8.0	8.0	8.0	8.0	8.0	15/15
BIPOP-aCMA	**2.7**(2)	3.9(0.7)	4.8(0.5)	6.7(0.2)	7.4(0.2)	10(0.2)	13(0.2)	15/15
BIPOP-saAC	3.4(3)	5.5(3)	10(2)	11(2)	12(2)	16(2)	20(2)	15/15
CMAES hut	4.0(5)	5.8(4)	14(5)	17(4)	22(5)	41(21)	283(312)	2/15
DE pal	**2.6**(2)	10(7)	20(9)	33(9)	48(11)	74(14)	102(12)	15/15
HCMA los	**1.8**(1.0)	**1**(0)	**1**(0)*	**1**(0)$^{\star 3}$	**1**(0)$^{\star 4}$	**1**(0)$^{\star 4}$	**1**(0)$^{\star 4}$	15/15
HMLSL pal	**1.1**(0.6)	**1.3**(0.5)	**1.8**(0.5)	**1.9**(0.5)	**2.3**(0.8)	**3.0**(0.8)	**3.3**(1)	15/15
IPOP-10DDr	**2.0**(2)	6.0(2)	10(3)	16(3)	23(3)	35(2)	47(4)	15/15
IPOP-500 l	**2.0**(2)	6.0(2)	10(3)	16(3)	23(3)	35(2)	47(4)	15/15
IPOP-tany	**2.7**(3)	5.7(2)	11(3)	16(5)	23(5)	37(5)	51(4)	15/15
IPOP-texp	**2.9**(3)	4.7(3)	8.4(6)	16(7)	20(6)	33(8)	45(7)	15/15
IPOP lia	**2.0**(2)	6.0(2)	10(3)	16(3)	23(3)	35(2)	47(4)	15/15
MLSL pal	**1.1**(0.6)	**1.3**(0.5)	**1.8**(0.5)	**1.9**(0.5)	**2.3**(0.8)	**3.0**(0.8)	**3.3**(1)	15/15
OQNLP pal	**3.0**(2)	**1.9**(0.3)	**2.4**(0.5)	**2.7**(0.6)	**2.8**(0.6)	**2.9**(0.6)	**2.9**(0.6)	15/15
P-DCN tra	3.2(3)	23(14)	36(13)	43(12)	55(18)	137(51)	291(112)	15/15
P-zero tra	**2.4**(2)	15(10)	25(14)	29(15)	38(13)	95(33)	515(393)	15/15
SMAC hut	**1.0**(0.7)	**1.3**(0.4)	**2.0**(0.6)	3.2(0.5)	13(19)	∞	∞ *300*	0/15
U-DCN tra	**2.9**(3)	12(10)	41(19)	102(55)	190(134)	558(505)	1305(682)	15/15
U-zero tra	**2.5**(3)	8.3(5)	34(15)	116(73)	327(211)	3006(1733)	3.0e4(2e4)	15/15
fmincon pa	**1.1**(0.6)	**1.3**(0.5)	**1.8**(0.5)	**1.9**(0.5)	**2.3**(0.8)	**3.0**(0.8)	**3.3**(1)	15/15
fminunc pa	**1.5**(1)	**0.99**(0.2)	**1.0**(0.2)	**1.1**(0)	**1.1**(0)	**1.1**(0)	**1.1**(0)	15/15
ga100 hol	**2.9**(3)	25(21)	102(46)	224(74)	528(345)	3022(2131)	6.2e4(7e4)	4/15
grid100 ho	3.2(3)	41(42)	210(85)	668(357)	1634(1166)	2.3e4(2e4)	2.7e5(3e5)	1/15
grid16 hol	4.1(5)	14(9)	42(22)	100(41)	311(236)	3346(2305)	4.2e4(4e4)	6/15
hill hol	6.1(6)	6.1(6)	13(7)	38(25)	162(128)	1358(760)	2.0e4(2e4)	10/15
lmmCMA aug	**1.7**(2)	**2.3**(1)	3.0(0.9)	4.1(0.8)	5.0(0.8)	6.2(0.8)	8.1(0.9)	15/15
memPSODE v	**2.8**(3)	7.9(3)	11(1)	12(1)	14(1)	17(1)	20(1)	15/15
prcga saw	**1.5**(2)	10(9)	34(25)	58(40)	163(306)	472(401)	555(710)	15/15
ring100 ho	**2.9**(5)	40(31)	129(64)	332(148)	720(321)	3298(920)	1.8e4(1e4)	11/15
ring16 hol	4.0(7)	14(8)	45(32)	107(54)	223(84)	1245(495)	1.2e4(5315)	14/15
simplex pa	11(13)	14(13)	22(10)	24(9)	26(7)	31(6)	34(6)	15/15

Table 3: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f2	38	42	43	44	45	47	48	15/15
BIPOP-aCMA	**1.8**(0.4)	**2.0**(0.5)	**2.2**(0.4)	**2.4**(0.1)	**2.6**(0.3)	**2.9**(0.3)	**3.3**(0.2)	15/15
BIPOP-saAC	4.2(1)	4.3(1)	4.5(0.8)	4.8(0.8)	5.1(0.7)	5.5(0.7)	6.0(0.8)	15/15
CMAES hut	22(20)	36(36)	∞	∞	∞	∞	∞ *303*	0/15
DE pal	8.4(2)	11(1)	13(1)	15(2)	17(1)	21(2)	25(1)	15/15
HCMA los	**2.3**(3)	**3.0**(3)	3.4(3)	3.6(3)	3.8(3)	4.1(3)	**4.5**(3)	15/15
HMLSL pal	**1.3**(0.6)	**1.4**(0.6)	**1.5**(0.5)	**1.7**(0.5)	**1.8**(0.5)	**3.1**(2)	5.3(5)	15/15
IPOP-10DDr	13(7)	19(7)	21(4)	22(3)	23(3)	24(4)	25(3)	15/15
IPOP-500 l	13(7)	19(7)	21(4)	22(3)	23(3)	24(4)	25(3)	15/15
IPOP-tany	13(8)	18(6)	21(2)	22(2)	22(2)	23(2)	25(2)	15/15
IPOP-texp	14(7)	20(7)	21(6)	22(3)	23(3)	24(3)	25(2)	15/15
IPOP lia	13(7)	19(7)	21(4)	22(3)	23(3)	24(4)	25(3)	15/15
MLSL pal	**1.3**(0.6)	**1.4**(0.6)	**1.5**(0.5)	**1.7**(0.5)	**1.8**(0.5)	**2.9**(2)	**4.7**(4)	15/15
OQNLP pal	**1.4**(0.5)	**1.9**(0.9)	**2.0**(1.0)	**2.2**(1)	**2.3**(0.9)	**2.5**(0.9)	41(58)	11/15
P-DCN tra	12(12)	19(15)	37(34)	83(76)	179(184)	441(440)	791(1026)	15/15
P-zero tra	14(9)	23(10)	40(22)	109(76)	368(414)	2973(4121)	2.7e4(2e4)	15/15
SMAC hut	26(27)	∞	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	87(58)	158(157)	189(171)	2944(3510)	2989(3423)	3184(3223)	1.0e4(1e4)	14/15
U-zero tra	179(139)	595(672)	1353(1348)	3877(4217)	2.6e4(3e4)	4.4e5(5e5)	∞ *3e6*	0/15
fmincon pa	**1.3**(0.6)	**1.4**(0.6)	**1.5**(0.5)	**1.7**(0.5)	**1.8**(0.5)	**2.8**(2)	**4.6**(3)	15/15
fminunc pa	**2.2**(1)	3.1(1)	3.9(0.6)	4.2(0.7)	4.3(0.8)	4.4(0.8)	**4.6**(0.8)	15/15
ga100 hol	101(72)	413(379)	1701(2112)	3065(3136)	8267(8823)	∞	∞ *2e5*	0/15
grid100 ho	183(101)	375(270)	1455(1037)	7240(7472)	∞	∞	∞ *2e5*	0/15
grid16 hol	102(96)	279(345)	893(1130)	4473(4773)	2.4e4(3e4)	∞	∞ *2e5*	0/15
hill hol	66(98)	202(228)	871(1094)	1835(1872)	5991(5977)	∞	∞ *2e5*	0/15
lmmCMA aug	3.2(1)	3.9(0.7)	4.1(0.8)	4.3(0.8)	4.4(0.8)	4.6(0.8)	4.9(0.8)	15/15
memPSODE v	3.7(2)	4.4(1)	4.8(1)	5.1(1)	5.4(1)	5.6(1)	6.0(0.9)	15/15
prcga saw	16(7)	28(31)	33(40)	172(80)	364(923)	674(902)	685(855)	15/15
ring100 ho	111(46)	287(181)	1221(1300)	4186(5137)	1.1e4(1e4)	∞	∞ *2e5*	0/15
ring16 hol	53(50)	308(276)	918(1050)	6323(7428)	1.1e4(1e4)	∞	∞ *2e5*	0/15
simplex pa	8.7(4)	11(4)	11(4)	11(4)	12(4)	12(3)	12(3)	15/15

Table 4: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f3	38	822	830	835	842	847	853	15/15
BIPOP-aCMA	**2.6**(1)	**0.30**(0.1)	**0.62**(0.1)	**0.64**(0.1)	**0.66**(0.1)	**0.73**(0.1)	**0.77**(0.1)	15/15
BIPOP-saAC	4.0(3)	**2.6**(2)	13(16)	13(16)	13(17)	13(17)	15(17)	15/15
CMAES hut	4.0(3)	**2.7**(3)	5.5(6)	∞	∞	∞	∞ *303*	0/15
DE pal	4.2(3)	**0.87**(0.3)	6.2(0.4)	**6.4**(0.4)	**6.4**(0.4)	**6.6**(0.4)	**6.8**(0.3)	14/15
HCMA los	**2.1**(1)	**0.81**(2)	**1.0**(2)	**1.0**(2)	**1.1**(2)	**1.1**(2)	**1.2**(2)	15/15
HMLSL pal	8.5(6)	**1.4**(0.8)	7.0(1.0)	**7.1**(1.0)	**7.0**(1.0)	**7.0**(1.0)	**7.0**(0.9)	14/15
IPOP-10DDr	**3.3**(2)	4.8(4)	18(16)	18(16)	18(16)	18(16)	18(15)	15/15
IPOP-500 l	**3.3**(2)	5.0(4)	17(20)	20(28)	21(29)	21(29)	22(30)	15/15
IPOP-tany	10(14)	4.0(5)	19(17)	21(20)	21(20)	21(20)	21(20)	15/15
IPOP-texp	12(13)	5.0(5)	14(15)	14(15)	14(15)	14(15)	14(15)	15/15
IPOP lia	**3.3**(2)	5.0(4)	17(20)	47(28)	49(29)	51(29)	53(30)	15/15
MLSL pal	7.7(6)	6.3(6)	76(92)	75(92)	75(92)	74(89)	74(88)	6/15
OQNLP pal	10(7)	**2.7**(3)	10(10)	10(11)	10(10)	**10**(9)	**10**(10)	7/15
P-DCN tra	72(205)	155(182)	362(425)	360(422)	357(418)	356(415)	355(411)	15/15
P-zero tra	102(250)	115(19)	172(98)	171(98)	170(98)	176(95)	255(219)	15/15
SMAC hut	7.5(6)	5.4(6)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	5.9(4)	**2.9**(2)	**4.2**(2)	**5.2**(4)	**7.6**(3)	19(16)	391(425)	14/15
U-zero tra	**3.2**(2)	**2.6**(3)	7.5(6)	19(11)	80(57)	618(456)	2.5e4(3e4)	2/15
fmincon pa	12(13)	8.4(11)	85(94)	85(84)	84(89)	84(91)	83(90)	6/15
fminunc pa	8.2(7)	9.2(16)	57(65)	57(65)	56(63)	56(76)	56(63)	7/15
ga100 hol	14(7)	3.5(2)	8.5(6)	28(28)	66(46)	∞	∞ *2e5*	0/15
grid100 ho	26(20)	10(7)	34(25)	113(108)	1309(1417)	∞	∞ *2e5*	0/15
grid16 hol	8.3(8)	3.1(2)	8.5(6)	23(13)	66(53)	2548(3099)	∞ *2e5*	0/15
hill hol	**2.6**(2)	**1.1**(1)	**3.0**(2)	15(10)	25(13)	640(620)	∞ *2e5*	0/15
lmmCMA aug	3.9(5)	**1.5**(1)	16(18)	16(19)	16(18)	16(20)	16(18)	2/15
memPSODE v	26(33)	3.7(2)	8.8(7)	9.4(7)	9.4(7)	10(7)	10(7)	15/15
prcga saw	4.9(2)	**2.9**(3)	8.7(7)	9.0(7)	10(8)	11(8)	12(8)	15/15
ring100 ho	25(16)	6.2(2)	13(6)	25(10)	52(24)	836(841)	∞ *2e5*	0/15
ring16 hol	7.8(5)	**2.3**(0.9)	**5.1**(3)	14(10)	57(52)	1246(1328)	∞ *2e5*	0/15
simplex pa	15(7)	7.3(7)	106(136)	105(115)	104(122)	104(113)	103(112)	5/15

Table 5: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f4	40	808	866	921	952	1015	1044	15/15
BIPOP-aCMA	**3.4**(2)	7.8(14)	795(1732)	748(1628)	724(1576)	679(1478)	661(1438)	13/15
BIPOP-saAC	6.1(10)	100(259)	2769(3506)	3357(4113)	3444(4436)	3231(4162)	3143(3627)	9/15
CMAES hut	12(12)	∞	∞	∞	∞	∞	∞ *303*	0/15
DE pal	6.6(2)	**1.1**(0.4)	26(35)	25(33)	**24**(32)	**23**(30)	**23**(29)	11/15
HCMA los	**4.2**(2)	78(202)	728(1732)	686(1629)	666(1577)	626(1479)	611(1438)	13/15
HMLSL pal	8.0(6)	**1.8**(1)	19(35)	**18**(33)	**18**(32)	**17**(30)	**16**(29)	12/15
IPOP-10DDr	7.5(14)	55(64)	695(790)	654(743)	633(719)	594(675)	578(656)	15/15
IPOP-500 l	7.5(14)	349(381)	∞	∞	∞	∞	∞ *3e6*	0/15
IPOP-tany	**5.6**(2)	36(64)	438(917)	412(862)	398(834)	374(782)	364(761)	15/15
IPOP-texp	10(13)	57(92)	546(905)	513(851)	600(824)	563(773)	548(752)	15/15
IPOP lia	7.5(14)	1099(1773)	1.5e4(2e4)	∞	∞	∞	∞ *3e6*	0/15
MLSL pal	11(15)	32(43)	563(640)	530(575)	512(548)	481(547)	468(531)	1/15
OQNLP pal	21(34)	13(14)	47(45)	44(44)	43(44)	40(39)	**40**(39)	2/15
P-DCN tra	121(195)	108(147)	198(216)	186(203)	181(196)	171(182)	199(185)	15/15
P-zero tra	701(1025)	67(85)	91(81)	86(76)	83(73)	87(72)	155(91)	15/15
SMAC hut	34(35)	∞	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	6.4(4)	3.5(3)	**4.9**(3)	**8.0**(5)	**13**(9)	48(44)	99(177)	15/15
U-zero tra	5.7(6)	**2.7**(2)	**12**(13)	45(41)	112(90)	727(443)	2.0e4(2e4)	2/15
fmincon pa	16(15)	11(16)	278(320)	261(322)	253(275)	237(276)	231(251)	2/15
fminunc pa	19(21)	21(25)	565(652)	531(612)	514(523)	482(572)	469(574)	1/15
ga100 hol	20(8)	6.9(4)	15(11)	26(23)	90(87)	1085(1177)	∞ *2e5*	0/15
grid100 ho	42(33)	18(7)	46(32)	121(101)	736(805)	∞	∞ *2e5*	0/15
grid16 hol	11(4)	4.4(2)	**10**(6)	28(16)	86(52)	∞	∞ *2e5*	0/15
hill hol	**2.8**(2)	**1.6**(1)	**5.9**(3)	**20**(14)	36(16)	1068(1078)	∞ *2e5*	0/15
lmmCMA aug	**4.6**(5)	35(40)	33(37)	31(36)	**30**(35)	**28**(30)	**27**(32)	1/15
memPSODE v	12(9)	6.9(5)	14(6)	**14**(4)	**13**(4)	**13**(5)	**13**(4)	15/15
prcga saw	13(8)	8.0(10)	30(36)	29(34)	34(40)	**39**(47)	43(46)	15/15
ring100 ho	32(14)	7.8(3)	14(4)	33(17)	88(41)	2198(2476)	∞ *2e5*	0/15
ring16 hol	11(3)	**2.5**(1)	**4.9**(3)	**15**(10)	70(66)	1030(1108)	∞ *2e5*	0/15
simplex pa	17(15)	25(25)	145(154)	137(145)	132(141)	124(135)	121(133)	4/15

Table 6: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f5	6.6	6.6	6.6	6.6	6.6	6.6	6.6	15/15
BIPOP-aCMA	**1.2**(0.1)	**1.2**(0)	**1.2**(0)	**1.2**(0)	**1.2**(0)	**1.2**(0)	**1.2**(0)	15/15
BIPOP-saAC	**2.8**(2)	5.2(2)	5.7(2)	5.7(2)	5.7(2)	5.7(2)	5.7(2)	15/15
CMAES hut	3.9(2)	5.6(4)	6.0(4)	6.0(4)	6.0(4)	6.0(4)	6.0(4)	15/15
DE pal	13(11)	49(19)	100(11)	152(23)	208(39)	316(20)	425(30)	15/15
HCMA los	**1.2**(0.3)	**1.5**(0.4)	**1.6**(0.5)	**1.6**(0.5)	**1.6**(0.5)	**1.6**(0.5)	**1.6**(0.5)	15/15
HMLSL pal	**2.0**(0)	**3.2**(0)	4.4(0)	4.4(0)	5.0(0)	5.0(0)	5.6(0)	15/15
IPOP-10DDr	**2.7**(3)	12(31)	13(33)	16(33)	16(33)	16(33)	16(33)	15/15
IPOP-500 l	**2.7**(3)	12(31)	13(33)	16(33)	16(33)	16(33)	16(33)	15/15
IPOP-tany	3.3(2)	6.8(4)	7.8(5)	8.2(6)	8.2(6)	8.2(6)	8.2(6)	15/15
IPOP-texp	10(8)	29(24)	35(32)	39(32)	40(32)	40(32)	40(32)	15/15
IPOP lia	**2.7**(3)	12(31)	13(33)	16(33)	16(33)	16(33)	16(33)	15/15
MLSL pal	**2.0**(0)	**3.2**(0)	4.4(0)	4.4(0)	5.0(0)	5.0(0)	5.6(0)	15/15
OQNLP pal	**2.7**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	15/15
P-DCN tra	8.8(7)	69(63)	86(67)	98(57)	108(50)	138(48)	190(41)	15/15
P-zero tra	25(39)	80(64)	94(73)	101(75)	108(72)	122(69)	140(64)	15/15
SMAC hut	**0.93**(0.3)	**1.1**(0.2)	**1.1**(0.2)	**1.1**(0.2)	**1.1**(0.2)	**1.1**(0.2)	**1.1**(0.2)	15/15
U-DCN tra	11(10)	130(145)	480(257)	3083(3913)	5339(5578)	3.5e5(5e5)	6.7e6(7e6)	1/15
U-zero tra	7.5(3)	86(81)	819(325)	7990(1e4)	2.6e5(2e5)	∞	∞ *3e6*	0/15
fmincon pa	**2.0**(0)	**3.2**(0)	4.4(0)	4.4(0)	5.0(0)	5.0(0)	5.6(0)	15/15
fminunc pa	**1.4**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	15/15
ga100 hol	19(15)	76(13)	102(20)	104(20)	104(20)	104(20)	104(20)	15/15
grid100 ho	30(39)	128(82)	153(89)	154(89)	154(89)	154(89)	154(87)	15/15
grid16 hol	12(13)	35(26)	45(27)	45(27)	45(27)	45(27)	45(27)	15/15
hill hol	4.7(3)	7.8(6)	8.1(6)	8.1(6)	8.1(6)	8.1(6)	8.1(6)	15/15
lmmCMA aug	**2.8**(0.8)	4.3(2)	4.4(2)	4.4(2)	4.4(2)	4.4(2)	4.4(2)	15/15
memPSODE v	**2.2**(2)	12(6)	14(5)	14(5)	14(5)	14(5)	14(5)	15/15
prcga saw	146(30)	2320(1836)	3984(2389)	6125(4369)	1.4e4(6884)	∞	∞ *2e5*	0/15
ring100 ho	19(16)	107(37)	128(24)	132(23)	134(38)	134(38)	134(38)	15/15
ring16 hol	11(8)	28(11)	34(8)	34(9)	34(9)	34(9)	34(9)	15/15
simplex pa	16(11)	44(52)	44(52)	44(52)	44(52)	44(52)	44(52)	15/15

Table 7: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f6	34	56	90	117	149	215	265	15/15
BIPOP-aCMA	**2.7**(2)	3.2(2)	3.2(0.9)	3.1(0.9)	3.1(0.3)	**2.9**(0.4)	3.0(0.3)	15/15
BIPOP-saAC	3.3(2)	4.2(2)	3.6(2)	3.7(2)	3.3(2)	3.1(2)	4.6(1)	15/15
CMAES hut	**2.0**(1)	3.2(0.9)	**3.0**(0.5)	13(13)	∞	∞	∞ *303*	0/15
DE pal	3.3(3)	6.1(2)	7.5(2)	9.2(2)	10(2)	11(1)	13(2)	15/15
HCMA los	**2.9**(2)	5.8(2)	4.9(2)	4.8(2)	4.5(2)	4.3(1)	5.8(1)	15/15
HMLSL pal	**1.5**(1)	**1.5**(0.7)	**1.2**(0.5)	**1.2**(0.6)	**1.2**(0.6)	**1.1**(0.5)	**1.2**(0.4)	15/15
IPOP-10DDr	**2.2**(1)	3.0(1)	**2.9**(0.9)	3.1(0.6)	3.1(0.8)	3.0(0.4)	3.1(0.4)	15/15
IPOP-500 l	**2.2**(1)	3.0(1)	**2.9**(0.9)	3.1(0.6)	3.1(0.8)	3.0(0.4)	3.1(0.4)	15/15
IPOP-tany	**1.8**(0.9)	**2.5**(0.7)	3.0(1)	3.4(0.8)	3.5(0.7)	3.4(0.3)	3.5(0.3)	15/15
IPOP-texp	**1.8**(0.9)	3.1(2)	3.1(0.8)	3.4(0.7)	3.8(0.6)	3.4(0.4)	3.5(0.5)	15/15
IPOP lia	**2.2**(1)	3.0(1)	**2.9**(0.9)	3.1(0.6)	3.1(0.8)	3.0(0.4)	3.1(0.4)	15/15
MLSL pal	**1.5**(1)	**1.5**(0.7)	**1.2**(0.5)	**1.2**(0.6)	**1.2**(0.6)	**1.1**(0.5)	**1.2**(0.4)	15/15
OQNLP pal	**1.4**(0.7)	**1.7**(1)	**2.0**(0.8)	**2.0**(2)	**2.8**(2)	3.6(2)	4.5(2)	15/15
P-DCN tra	8.9(8)	11(8)	9.1(6)	10(5)	23(18)	157(302)	213(242)	15/15
P-zero tra	11(18)	12(13)	11(10)	15(12)	36(44)	787(1629)	6484(6535)	11/15
SMAC hut	**1.1**(1)	36(43)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	3.6(3)	14(13)	47(41)	175(307)	508(792)	7245(8368)	7.7e4(8e4)	2/15
U-zero tra	3.4(3)	25(35)	137(134)	1463(2405)	3445(3493)	1.3e4(2e4)	∞ *3e6*	0/15
fmincon pa	**1.5**(1)	**1.5**(0.7)	**1.2**(0.5)	**1.2**(0.6)	**1.2**(0.6)	**1.1**(0.5)	**1.2**(0.4)	15/15
fminunc pa	**2.4**(2)	3.3(2)	**2.5**(1.0)	**2.2**(0.8)	**2.1**(0.8)	**2.1**(1)	3.5(2)	15/15
ga100 hol	10(7)	26(14)	77(43)	255(321)	1889(2141)	∞	∞ *2e5*	0/15
grid100 ho	10(13)	70(42)	310(289)	1210(1122)	4464(5031)	∞	∞ *2e5*	0/15
grid16 hol	5.1(5)	16(11)	70(66)	445(555)	1948(2253)	1.0e4(1e4)	∞ *2e5*	0/15
hill hol	3.4(4)	21(27)	145(175)	371(650)	886(1073)	3127(3494)	∞ *2e5*	0/15
lmmCMA aug	**2.6**(3)	3.2(2)	**2.9**(2)	3.4(2)	3.1(1)	3.3(2)	3.7(1)	15/15
memPSODE v	**2.0**(1.0)	**2.1**(0.8)	**1.7**(0.6)	**1.6**(0.4)	**1.5**(0.6)	**1.4**(0.4)	**1.5**(0.4)	15/15
prcga saw	7.4(14)	41(121)	51(79)	118(118)	155(134)	199(130)	220(136)	15/15
ring100 ho	8.8(13)	35(18)	94(50)	251(140)	696(581)	1.0e4(1e4)	∞ *2e5*	0/15
ring16 hol	4.9(6)	13(7)	33(19)	355(652)	680(988)	2226(2462)	∞ *2e5*	0/15
simplex pa	5.9(5)	7.3(3)	4.8(2)	4.3(2)	3.7(2)	**2.9**(1)	**2.6**(0.8)	15/15

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Table 8: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f7	11	65	342	464	482	482	535	15/15
BIPOP-aCMA	**3.0**(3)	**2.1**(2)	**1.0**(0.8)	**0.99**(0.9)	**1.1**(0.8)	**1.1**(0.8)	**1.1**(0.9)	15/15
BIPOP-saAC	**2.5**(2)	**1.9**(1)	**0.75**(0.6)	**0.95**(0.8)	**1.0**(0.8)	**1.0**(0.8)	**1.2**(0.8)	15/15
CMAES hut	**2.7**(2)	**1.6**(0.9)	**0.84**(0.9)	**0.87**(0.7)	**0.87**(0.7)	**0.87**(0.7)	**1.1**(0.9)	7/15
DE pal	4.0(3)	**2.9**(2)	**1.3**(0.6)	**1.7**(0.5)	**2.0**(0.6)	**2.0**(0.6)	**2.1**(0.8)	15/15
HCMA los	**1.9**(2)	**2.0**(2)	**0.84**(0.4)	**1.0**(0.8)	**1.1**(0.9)	**1.1**(0.9)	**1.1**(0.8)	15/15
HMLSL pal	3.8(3)	5.1(3)	**2.4**(1)	3.3(1)	3.9(2)	3.9(2)	3.8(2)	15/15
IPOP-10DDr	4.2(2)	4.0(3)	**1.5**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	**1.2**(0.9)	15/15
IPOP-500 l	4.2(2)	4.0(3)	**1.5**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	**1.2**(0.9)	15/15
IPOP-tany	3.2(3)	**1.6**(0.8)	**0.84**(0.6)	**1.1**(0.6)	**1.1**(0.6)	**1.1**(0.6)	**1.0**(0.5)	15/15
IPOP-texp	**2.2**(1)	5.0(8)	**2.1**(2)	**2.1**(2)	**2.2**(2)	**2.2**(2)	**2.1**(1)	15/15
IPOP lia	4.2(2)	4.0(3)	**1.5**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	**1.2**(0.9)	15/15
MLSL pal	4.7(6)	23(26)	174(181)	∞	∞	∞	∞ *3e4*	0/15
OQNLP pal	4.9(6)	4.3(2)	**2.2**(1)	4.3(4)	4.9(4)	4.9(4)	5.7(5)	6/15
P-DCN tra	40(70)	649(524)	151(99)	112(72)	111(69)	111(69)	100(63)	15/15
P-zero tra	14(22)	123(206)	101(98)	76(73)	74(71)	74(71)	66(65)	15/15
SMAC hut	**1.2**(1)	**0.92**(0.5)	**0.81**(0.7)	∞	∞	∞	∞ *300*	0/15
U-DCN tra	6.8(9)	18(17)	312(521)	1071(1165)	4023(6227)	4023(6227)	3624(5607)	10/15
U-zero tra	4.4(4)	29(78)	278(385)	455(685)	622(1193)	622(1193)	566(1074)	15/15
fmincon pa	5.0(4)	22(16)	125(150)	951(1006)	∞	∞	∞ *3e4*	0/15
fminunc pa	4.0(4)	25(32)	140(147)	∞	∞	∞	∞ *3e4*	0/15
ga100 hol	4.7(5)	7.3(5)	8.6(4)	22(17)	61(127)	61(127)	63(119)	15/15
grid100 ho	5.6(4)	24(17)	76(73)	166(201)	375(385)	375(463)	884(1001)	4/15
grid16 hol	6.1(6)	8.6(7)	54(43)	112(177)	225(314)	225(312)	209(262)	10/15
hill hol	6.0(7)	9.4(16)	44(56)	173(198)	249(311)	249(311)	229(282)	10/15
lmmCMA aug	**1.5**(1)	**2.2**(3)	**1.1**(1)	**1.0**(1)	**1.1**(1)	**1.1**(1)	**1.0**(1.0)	15/15
memPSODE v	6.3(3)	22(22)	12(7)	12(5)	13(5)	13(5)	13(6)	15/15
prcga saw	**2.6**(4)	7.2(5)	7.3(7)	7.8(8)	20(17)	20(17)	18(16)	14/15
ring100 ho	3.4(3)	14(7)	8.6(6)	32(23)	92(156)	92(162)	96(144)	13/15
ring16 hol	5.0(6)	5.2(4)	8.2(9)	72(143)	111(158)	111(156)	104(145)	13/15
simplex pa	**2.9**(3)	8.0(6)	20(18)	103(103)	277(314)	277(315)	249(286)	3/15

Table 9: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f8	27	45	152	179	188	198	208	15/15
BIPOP-aCMA	4.7(1)	8.3(5)	4.0(1)	4.1(1)	4.3(1)	4.6(1)	4.8(1)	15/15
BIPOP-saAC	**2.9**(1)	4.5(2)	**2.0**(0.9)	**2.0**(0.7)	**2.1**(0.6)	**2.1**(0.6)	**2.1**(0.6)	15/15
CMAES hut	3.7(3)	10(10)	30(33)	∞	∞	∞	∞ *303*	0/15
DE pal	6.6(4)	14(18)	9.4(5)	11(6)	13(3)	17(4)	20(4)	15/15
HCMA los	**2.5**(2)	6.6(3)	**2.7**(1)	**2.5**(1)	**2.5**(1)	**2.6**(1.0)	**2.6**(1)	15/15
HMLSL pal	**1.1**(0.4)	**1.5**(2)	**0.63**(0.5)	**0.62**(0.5)	**0.64**(0.4)	**0.69**(0.4)	**0.68**(0.4)	15/15
IPOP-10DDr	**3.0**(1)	8.7(8)	5.0(3)	5.1(2)	5.4(2)	5.8(2)	6.0(2)	15/15
IPOP-500 l	**3.0**(1)	8.7(8)	5.0(3)	5.1(2)	5.4(2)	5.8(2)	6.0(2)	15/15
IPOP-tany	**2.3**(1)	7.1(5)	4.7(2)	5.0(2)	5.3(2)	5.6(2)	5.9(2)	15/15
IPOP-texp	**2.7**(1)	7.1(9)	4.7(4)	5.0(2)	5.3(2)	5.6(2)	5.6(2)	15/15
IPOP lia	**3.0**(1)	8.7(8)	5.0(3)	5.1(2)	5.4(2)	5.8(2)	6.0(2)	15/15
MLSL pal	**1.1**(0.4)	**1.5**(2)	**0.63**(0.5)	**0.62**(0.5)	**0.64**(0.4)	**0.69**(0.4)	**0.68**(0.4)	15/15
OQNLP pal	**1.1**(0.7)	**1.5**(1)	**0.69**(0.3)	**0.72**(0.3)	**0.75**(0.3)	**0.78**(0.3)	**2.9**(4)	15/15
P-DCN tra	12(11)	168(539)	198(183)	342(275)	990(881)	4251(2492)	1.4e4(1e4)	11/15
P-zero tra	48(13)	585(1169)	521(459)	1524(889)	2273(885)	7.6e4(8e4)	∞ *3e6*	0/15
SMAC hut	3.3(2)	10(8)	9.3(10)	∞	∞	∞	∞ *300*	0/15
U-DCN tra	9.1(6)	286(209)	2671(3435)	5.1e4(6e4)	1.0e5(1e5)	∞	∞ *3e6*	0/15
U-zero tra	7.7(5)	80(37)	6.0e4(7e4)	2.4e5(3e5)	∞	∞	∞ *3e6*	0/15
fmincon pa	**1.1**(0.4)	**1.5**(2)	**0.63**(0.6)	**0.62**(0.5)	**0.65**(0.4)	**0.69**(0.4)	**0.68**(0.4)	15/15
fminunc pa	**0.99**(0.7)	**1.5**(1.0)	**0.73**(0.3)	**0.73**(0.2)	**0.76**(0.2)	**0.77**(0.2)	**0.75**(0.2)	15/15
ga100 hol	14(10)	48(31)	238(304)	2593(2940)	1.1e4(1e4)	∞	∞ *2e5*	0/15
grid100 ho	32(25)	130(84)	1721(2097)	6125(6646)	∞	∞	∞ *2e5*	0/15
grid16 hol	11(8)	301(204)	4090(4942)	5816(6838)	∞	∞	∞ *2e5*	0/15
hill hol	4.0(3)	554(1675)	1666(2009)	5562(6299)	∞	∞	∞ *2e5*	0/15
lmmCMA aug	**1.6**(0.6)	**2.2**(0.8)	**1.1**(0.3)	**1.2**(0.2)	**1.2**(0.2)	**1.3**(0.2)	**1.3**(0.2)	15/15
memPSODE v	**3.0**(0.3)	**2.9**(2)	**1.1**(0.7)	**1.1**(0.6)	**1.1**(0.6)	**1.2**(0.5)	**1.3**(0.5)	15/15
prcga saw	4.1(3)	42(66)	258(259)	570(710)	1268(1403)	3131(3042)	6363(5832)	2/15
ring100 ho	24(19)	62(38)	106(75)	421(469)	1512(1677)	∞	∞ *2e5*	0/15
ring16 hol	9.3(6)	35(26)	787(999)	2331(2940)	3320(3994)	∞	∞ *2e5*	0/15
simplex pa	4.5(4)	4.8(3)	**1.8**(0.9)	**1.9**(0.6)	**1.9**(0.6)	**2.0**(0.5)	**2.0**(0.5)	15/15

Table 10: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_9, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f9	21	65	127	149	159	169	178	15/15
BIPOP-aCMA	4.5(2)	7.4(8)	5.9(5)	5.9(4)	5.9(3)	6.2(3)	6.3(3)	15/15
BIPOP-saAC	**2.9**(2)	**2.6**(2)	**2.4**(1.0)	**2.4**(0.9)	**2.4**(0.8)	**2.5**(0.8)	**2.5**(0.7)	15/15
CMAES hut	3.4(1)	6.7(7)	∞	∞	∞	∞	∞ *303*	0/15
DE pal	8.6(4)	10(6)	11(5)	12(5)	14(4)	18(5)	22(6)	15/15
HCMA los	**2.7**(3)	4.2(2)	3.1(1)	3.0(1)	3.0(1)	3.0(1)	3.0(1)	15/15
HMLSL pal	**0.53**(0)$_{\downarrow 4}$	**0.44**(0)	**0.41**(0)	**0.48**(0)	**0.50**(0)	**0.52**(0)	**0.54**(0)	15/15
IPOP-10DDr	4.3(3)	6.9(5)	6.3(4)	6.6(3)	6.7(3)	7.0(3)	7.2(3)	15/15
IPOP-500 l	4.3(3)	6.9(5)	6.3(4)	6.6(3)	6.7(3)	7.0(3)	7.2(3)	15/15
IPOP-tany	3.0(1)	5.6(6)	5.6(3)	6.1(3)	6.2(2)	6.5(2)	6.8(2)	15/15
IPOP-texp	**1.9**(1)	5.0(5)	5.7(3)	6.4(3)	6.5(2)	6.8(2)	7.0(2)	15/15
IPOP lia	4.3(3)	6.9(5)	6.3(4)	6.6(3)	6.7(3)	7.0(3)	7.2(3)	15/15
MLSL pal	**0.53**(0)$_{\downarrow 4}$	**0.44**(0)	**0.41**(0)	**0.48**(0)	**0.50**(0)	**0.52**(0)	**0.54**(0)	15/15
OQNLP pal	**0.48**(0)$_{\downarrow 4}$	**0.21**(0.0)$_{\downarrow 4}$	**0.38**(0.0)	**0.48**(0.0)	**0.52**(0.0)	**0.58**(0.0)	**0.60**(0.0)	15/15
P-DCN tra	13(15)	456(1362)	318(702)	550(625)	1177(851)	5381(5280)	1.9e4(2e4)	9/15
P-zero tra	13(13)	1304(3119)	909(1815)	1281(1569)	2937(2663)	4.7e4(5e4)	2.5e5(3e5)	1/15
SMAC hut	7.0(6)	68(73)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	14(13)	254(157)	3792(4933)	2.4e4(3e4)	4.8e4(5e4)	∞	∞ *3e6*	0/15
U-zero tra	10(7)	897(1778)	2.0e4(2e4)	3.0e5(3e5)	∞	∞	∞ *3e6*	0/15
fmincon pa	**0.53**(0)$_{\downarrow 4}$	**0.44**(0)	**0.41**(0)	**0.48**(0)	**0.50**(0)	**0.52**(0)	**0.54**(0)	15/15
fminunc pa	**0.43**(0)$^{\star}_{\downarrow 4}$	**0.14**(0)$^{\star 4}_{\downarrow 4}$	**0.37**(0.0)	**0.45**(0.0)	**0.48**(0.0)	**0.51**(0.0)	**0.51**(0.0)	15/15
ga100 hol	16(11)	39(22)	392(595)	2284(2517)	1.3e4(2e4)	∞	∞ *2e5*	0/15
grid100 ho	31(19)	257(228)	1524(1870)	7212(8032)	1.4e4(2e4)	∞	∞ *2e5*	0/15
grid16 hol	17(13)	550(1151)	2462(2968)	1.5e4(2e4)	∞	∞	∞ *2e5*	0/15
hill hol	7.2(8)	424(1148)	2603(3302)	1.4e4(2e4)	1.4e4(1e4)	∞	∞ *2e5*	0/15
lmmCMA aug	**1.6**(0.6)	**1.6**(0.7)	**1.4**(0.5)	**1.5**(0.4)	**1.5**(0.4)	**1.6**(0.4)	**1.6**(0.4)	15/15
memPSODE v	3.8(0.6)	**2.4**(1)	**1.6**(0.9)	**1.6**(0.7)	**1.6**(0.6)	**1.7**(0.6)	**1.7**(0.6)	15/15
prcga saw	4.8(4)	22(60)	393(482)	1097(1283)	2399(3248)	1.8e4(2e4)	∞ *2e5*	0/15
ring100 ho	30(28)	46(30)	199(98)	860(1065)	1915(1923)	1.3e4(2e4)	∞ *2e5*	0/15
ring16 hol	13(7)	58(65)	1583(1780)	1.4e4(2e4)	∞	∞	∞ *2e5*	0/15
simplex pa	**1.3**(0.0)	**1.1**(0.4)	**1.5**(0.3)	**1.5**(0.2)	**1.5**(0.2)	**1.5**(0.2)	**1.6**(0.2)	15/15

Table 11: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_{10}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f10	114	152	168	180	194	218	242	15/15
BIPOP-aCMA	3.7(1)	3.8(0.7)	3.7(0.6)	3.8(0.5)	3.7(0.6)	3.7(0.5)	3.7(0.4)	15/15
BIPOP-saAC	**1.5**(0.3)	**1.3**(0.3)	**1.3**(0.2)	**1.3**(0.2)	**1.3**(0.1)	**1.3**(0.2)	**1.3**(0.2)	15/15
CMAES hut	9.3(9)	∞	∞	∞	∞	∞	∞ *303*	0/15
DE pal	9.3(5)	10(5)	12(4)	14(4)	16(4)	19(3)	21(4)	15/15
HCMA los	**1.9**(0.3)	**1.7**(0.2)	**1.6**(0.2)	**1.6**(0.2)	**1.6**(0.2)	**1.5**(0.2)	**1.5**(0.2)	15/15
HMLSL pal	**0.45**(0.3)$_{\downarrow 2}$	**0.38**(0.2)$_{\downarrow 4}$	**0.40**(0.2)$_{\downarrow 4}$	**0.41**(0.2)$_{\downarrow 4}$	**0.83**(0.2)	10(19)	40(67)	15/15
IPOP-10DDr	5.3(3)	5.8(1)	5.8(0.5)	5.7(0.6)	5.6(0.5)	5.4(0.5)	5.3(0.4)	15/15
IPOP-500 l	5.3(3)	5.8(1)	5.8(0.5)	5.7(0.6)	5.6(0.5)	5.4(0.5)	5.3(0.4)	

Table 12: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_{11}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f11	67	105	227	263	277	302	327	15/15
BIPOP-aCMA	6.7(3)	5.2(1)	**2.7**(0.5)	**2.6**(0.3)	**2.6**(0.4)	**2.7**(0.3)	**2.8**(0.3)	15/15
BIPOP-saAC	**2.6**(0.6)	**2.0**(0.4)	**0.97**(0.1)	**0.90**(0.1)	**0.91**(0.2)	**0.94**(0.2)	**0.97**(0.2)	15/15
CMAES hut	65(72)	∞	∞	∞	∞	∞	∞ *303*	0/15
DE pal	9.3(4)	11(3)	8.3(2)	8.8(2)	10(2)	13(2)	15(2)	15/15
HCMA los	**2.6**(2)	**2.3**(0.2)	**1.1**(0.1)	**1.0**(0.1)	**1.0**(0.1)	**1.0**(0.1)	**1.1**(0.1)	15/15
HMLSL pal	**0.35**(0.1)	**0.27**(0.1)	**0.15**(0.0)	**0.15**(0.0)	**0.60**(1)	10(24)	49(58)	15/15
IPOP-10DDr	10(6)	8.4(2)	4.5(0.9)	4.1(0.7)	4.1(0.7)	4.1(0.6)	4.1(0.6)	15/15
IPOP-500 l	10(6)	8.4(2)	4.5(0.9)	4.1(0.7)	4.1(0.7)	4.1(0.6)	4.1(0.6)	15/15
IPOP-tany	10(5)	8.0(2)	4.2(0.7)	3.9(0.5)	3.9(0.5)	3.9(0.3)	3.9(0.5)	15/15
IPOP-texp	8.7(5)	7.9(1)	4.0(0.7)	3.6(0.7)	3.6(0.5)	3.6(0.5)	3.6(0.5)	15/15
IPOP lia	10(6)	8.4(2)	4.5(0.9)	4.1(0.7)	4.1(0.7)	4.1(0.6)	4.1(0.6)	15/15
MLSL pal	**0.35**(0.1)	**0.27**(0.1)	**0.15**(0.0)	**0.15**(0.0)	**2.1**(1)	9.2(17)	201(281)	8/15
OQNLP pal	**0.73**(0.2)	**0.52**(0.1)	**0.37**(0.1)	**1.6**(2)	5.5(6)	36(40)	∞ *1e4*	0/15
P-DCN tra	138(290)	480(308)	333(163)	414(167)	755(390)	8308(9502)	∞ *3e6*	0/15
P-zero tra	527(636)	1092(638)	720(333)	773(427)	1528(1163)	3.5e4(3e4)	∞ *3e6*	0/15
SMAC hut	5.7(7)	41(47)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	143(138)	767(971)	1.2e4(1e4)	∞	∞	∞	∞ *3e6*	0/15
U-zero tra	194(153)	1904(2135)	7118(6869)	5.0e4(5e4)	1.6e5(2e5)	∞	∞ *3e6*	0/15
fmincon pa	**0.35**(0.1)	**0.27**(0.1)	**0.15**(0.0)	**0.15**(0.0)	**1.4**(0.6)	37(69)	179(179)	10/15
fminunc pa	**0.85**(0.6)	**0.91**(0.2)	**0.79**(0.7)	**1.6**(1)	4.6(7)	55(78)	406(476)	4/15
ga100 hol	651(1131)	2590(2853)	9355(1e4)	∞	∞	∞	∞ *2e5*	0/15
grid100 ho	694(1154)	3358(3770)	9899(1e4)	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	274(473)	1069(1115)	4862(4927)	∞	∞	∞	∞ *2e5*	0/15
hill hol	197(142)	502(551)	∞	∞	∞	∞	∞ *2e5*	0/15
lmmCMA aug	**1.4**(0.9)	**1.6**(0.5)	**0.88**(0.2)	**0.80**(0.2)	**0.79**(0.2)	**0.79**(0.2)	**0.79**(0.2)	15/15
memPSODE v	3.0(1)	**2.6**(0.5)	**1.4**(0.3)	**1.3**(0.3)	**1.2**(0.2)	**1.2**(0.2)	**1.2**(0.2)	15/15
prcga saw	155(186)	963(1073)	4747(5055)	4169(4441)	∞	∞	∞ *2e5*	0/15
ring100 ho	71(87)	587(508)	1508(1691)	∞	∞	∞	∞ *2e5*	0/15
ring16 hol	54(46)	925(1001)	2837(3291)	8153(8840)	∞	∞	∞ *2e5*	0/15
simplex pa	4.8(4)	5.4(2)	**2.7**(0.7)	**2.5**(0.6)	**2.4**(0.5)	**2.3**(0.5)	**2.2**(0.5)	15/15

Table 13: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_{12}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f12	65	168	338	401	445	696	790	15/15
BIPOP-aCMA	12(16)	8.4(9)	5.7(5)	5.6(5)	5.5(5)	4.2(3)	4.8(6)	15/15
BIPOP-saAC	3.2(2)	3.6(6)	**2.9**(3)	**3.0**(3)	4.3(3)	6.1(11)	12(19)	15/15
CMAES hut	6.6(5)	27(34)	∞	∞	∞	∞	∞ *303*	0/15
DE pal	27(26)	27(27)	21(18)	21(15)	21(15)	17(11)	17(9)	15/15
HCMA los	3.9(4)	4.6(5)	**2.8**(2)	**2.6**(2)	3.2(2)	4.1(8)	14(20)	15/15
HMLSL pal	**0.89**(0.3)	**0.77**(0.8)	**0.66**(0.6)	**0.67**(0.6)	**0.68**(0.6)	4.9(4)	16(27)	14/15
IPOP-10DDr	8.0(8)	6.8(6)	4.8(4)	4.9(3)	5.0(3)	4.2(2)	**4.3**(2)	15/15
IPOP-500 l	8.0(8)	6.8(6)	4.8(4)	4.9(3)	5.0(3)	4.2(2)	**4.3**(2)	15/15
IPOP-tany	7.5(5)	7.4(7)	5.4(5)	5.5(4)	5.5(3)	4.5(3)	4.6(3)	15/15
IPOP-texp	10(10)	10(10)	7.2(6)	6.9(6)	6.8(5)	5.3(4)	5.2(4)	15/15
IPOP lia	8.0(8)	6.8(6)	4.8(4)	4.9(3)	5.0(3)	4.2(2)	**4.3**(2)	15/15
MLSL pal	**0.89**(0.3)	**0.77**(0.8)	**0.66**(0.6)	**0.67**(0.6)	**0.68**(0.6)	3.2(6)	31(46)	10/15
OQNLP pal	**1.4**(1)	**1.4**(1)	11(29)	10(24)	12(23)	42(51)	106(127)	2/15
P-DCN tra	1.8e4(2e4)	1.6e4(2e4)	2.0e4(2e4)	5.0e4(6e4)	9.5e4(1e5)	∞	∞ *3e6*	0/15
P-zero tra	2.6e4(5e4)	4.9e4(6e4)	5.8e4(6e4)	1.0e5(1e5)	∞	∞	∞ *3e6*	0/15
SMAC hut	22(22)	∞	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	1.2e4(2e4)	2.7e4(4e4)	5.8e4(7e4)	1.1e5(1e5)	∞	∞	∞ *3e6*	0/15
U-zero tra	1.4e4(2e4)	3.6e4(4e4)	3.6e4(5e4)	5.0e4(6e4)	9.9e4(1e5)	∞	∞ *3e6*	0/15
fmincon pa	**0.88**(0.3)	**0.77**(0.8)	**0.65**(0.6)	**0.66**(0.6)	**0.68**(0.6)	**1.8**(4)	10(14)	14/15
fminunc pa	**0.93**(1)	**0.80**(0.8)	**0.64**(0.5)	**0.63**(0.5)	**0.67**(0.4)	**1.4**(2)	32(41)	11/15
ga100 hol	1019(1327)	3758(4475)	6393(6883)	∞	∞	∞	∞ *2e5*	0/15
grid100 ho	986(1188)	2852(3189)	∞	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	1786(2351)	5967(6712)	∞	∞	∞	∞	∞ *2e5*	0/15
hill hol	2092(3461)	2503(3134)	6491(7105)	∞	∞	∞	∞ *2e5*	0/15
lmmCMA aug	**2.3**(1)	**1.6**(1)	**1.4**(1)	**1.4**(1)	**1.4**(1)	**1.2**(1)	**1.2**(1)	14/15
memPSODE v	3.5(3)	**2.6**(2)	**1.8**(1)	**1.6**(1)	**1.6**(1)	**1.2**(1.0)	**1.6**(1.0)	15/15
prcga saw	86(129)	213(335)	246(320)	365(418)	686(805)	∞	∞ *9e4*	0/15
ring100 ho	337(272)	712(680)	920(890)	∞	∞	∞	∞ *2e5*	0/15
ring16 hol	730(1208)	1983(2303)	3063(3330)	∞	∞	∞	∞ *2e5*	0/15
simplex pa	3.9(3)	**2.9**(2)	**1.9**(1)	**1.8**(1)	**1.8**(1)	**1.4**(0.8)	**1.4**(0.8)	15/15

Table 14: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f13	49	85	108	136	215	281	365	15/15
BIPOP-aCMA	4.1(2)	4.0(2)	4.2(1)	4.2(0.9)	3.1(0.5)	3.4(0.4)	3.4(0.5)	15/15
BIPOP-saAC	**2.0**(0.9)	**1.6**(0.4)	**1.7**(0.4)	**1.7**(0.3)	**1.3**(0.4)	**1.3**(0.3)	**1.2**(0.2)	15/15
CMAES hut	4.0(2)	10(9)	∞	∞	∞	∞	∞ *303*	0/15
DE pal	6.1(2)	9.0(4)	15(3)	17(3)	16(3)	18(4)	19(3)	15/15
HCMA los	**2.3**(1)	**2.2**(1)	**2.5**(0.4)	**2.2**(0.5)	**1.6**(0.3)	**1.5**(0.3)	**1.4**(0.2)	15/15
HMLSL pal	**0.89**(0.2)	**0.70**(0.1)	**0.75**(0.1)	**0.75**(0.1)	**0.76**(0.1)	26(22)	45(7)	15/15
IPOP-10DDr	3.7(1)	6.6(4)	7.3(3)	6.9(2)	5.0(0.8)	5.5(1.0)	5.2(0.7)	15/15
IPOP-500 l	3.7(1)	6.6(4)	7.3(3)	6.9(2)	5.0(0.8)	5.5(1.0)	5.2(0.7)	15/15
IPOP-tany	3.3(1)	5.3(3)	5.8(3)	6.9(1)	5.1(1)	5.2(0.6)	4.9(0.8)	15/15
IPOP-texp	3.4(2)	5.5(3)	6.5(2)	6.4(1)	4.7(0.8)	4.9(1.0)	4.8(0.6)	15/15
IPOP lia	3.7(1)	6.6(4)	7.3(3)	6.9(2)	5.0(0.8)	5.5(1.0)	5.2(0.7)	15/15
MLSL pal	**0.89**(0.2)	**0.70**(0.1)	**0.75**(0.1)	**0.75**(0.1)	**0.83**(0.1)	114(131)	∞ *4e4*	0/15
OQNLP pal	**1.3**(0.4)	**1.0**(0.4)	**0.96**(0.3)	**1.3**(0.5)	7.2(7)	434(449)	∞ *9210*	0/15
P-DCN tra	148(178)	1372(1906)	1.7e4(2e4)	4.0e4(4e4)	6.3e4(7e4)	1.6e5(2e5)	∞ *3e6*	0/15
P-zero tra	3371(3795)	8682(1e4)	5.1e4(6e4)	1.5e5(2e5)	∞	∞	∞ *3e6*	0/15
SMAC hut	**1.6**(0.8)	8.7(9)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	4142(6949)	3.1e4(4e4)	6.5e4(8e4)	∞	∞	∞	∞ *3e6*	0/15
U-zero tra	696(467)	4.9e4(7e4)	1.3e5(1e5)	∞	∞	∞	∞ *3e6*	0/15
fmincon pa	**0.89**(0.2)	**0.70**(0.1)	**0.75**(0.1)	**0.75**(0.1)	**0.79**(0.1)	155(199)	∞ *3e4*	0/15
fminunc pa	**1.0**(0.3)	**1.0**(0.2)	**1.1**(0.2)	**1.0**(0.2)	**1.5**(1)	1914(1898)	∞ *4e4*	0/15
ga100 hol	45(22)	1021(1740)	4612(4881)	∞	∞	∞	∞ *2e5*	0/15
grid100 ho	598(858)	4373(4739)	∞	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	243(490)	5043(6176)	9675(1e4)	∞	∞	∞	∞ *2e5*	0/15
hill hol	418(839)	2218(2612)	9732(9755)	∞	∞	∞	∞ *2e5*	0/15
lmmCMA aug	**1.4**(0.4)	**1.8**(0.9)	**1.8**(0.5)	**1.8**(0.4)	**1.3**(0.3)	**1.3**(0.3)	**1.3**(0.3)	15/15
memPSODE v	**2.8**(1)	**2.1**(0.9)	**2.4**(1)	**2.1**(0.9)	**1.5**(0.5)	**1.5**(0.9)	**1.5**(0.9)	15/15
prcga saw	9.4(4)	408(333)	638(859)	1470(1939)	1676(2060)	3695(4382)	5765(7276)	1/15
ring100 ho	57(34)	393(155)	2837(2900)	1.6e4(2e4)	∞	∞	∞ *2e5*	0/15
ring16 hol	44(29)	2154(3510)	6322(6761)	∞	∞	∞	∞ *2e5*	0/15
simplex pa	6.5(7)	7.1(3)	6.7(2)	5.9(2)	3.9(1)	**3.3**(1)	**2.7**(0.9)	15/15

Table 15: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f14	2.2	17	28	43	71	110	194	15/15
BIPOP-aCMA	3.7(5)	3.4(1)	4.0(2)	4.1(1)	3.9(1.0)	5.1(0.9)	4.1(0.5)	15/15
BIPOP-saAC	**2.9**(3)	**2.7**(2)	3.0(0.7)	3.2(0.9)	**2.7**(0.5)	**2.5**(0.4)	**1.9**(0.2)	15/15
CMAES hut	3.2(4)	**2.5**(2)	3.8(1)	3.6(2)	4.9(3)	∞	∞ *303*	0/15
DE pal	**1.4**(2)	3.4(3)	7.6(3)	8.5(2)	10(2)	16(5)	17(3)	15/15
HCMA los	4.3(4)	**1.8**(2)	3.5(2)	4.4(0.8)	3.5(0.5)	3.1(0.4)	**2.3**(0.2)	15/15
HMLSL pal	**1.3**(1)	**0.72**(0.2)	**0.77**(0.2)	**0.83**(0.2)	**0.69**(0.2)	**0.86**(0.2)	36(19)	15/15
IPOP-10DDr	**2.3**(3)	**2.6**(2)	3.6(1)	4.3(2)	5.3(2)	7.9(1)	7.0(0.8)	15/15
IPOP-500 l	**2.3**(3)	**2.6**(2)	3.6(1)	4.3(2)	5.3(2)	7.9(1)	7.0(0.8)	15/15
IPOP-tany	**2.7**(4)	**2.1**(2)	3.4(1.0)	3.7(1)	5.0(1)	7.2(2)	6.8(0.4)	15/15
IPOP-texp	**2.8**(6)	**2.2**(2)	**2.8**(2)	3.8(2)	4.9(2)	6.9(2)	6.1(0.7)	15/15
IPOP lia	**2.3**(3)	**2.6**(2)	3.6(1)	4.3(2)	5.3(2)	7.9(1)	7.0(0.8)	15/15
MLSL pal	**1.3**(1)	**0.72**(0.2)	**0.77**(0.2)	**0.83**(0.2)	**0.69**(0.2)	**0.86**(0.2)	1071(1384)	2/15
OQNLP pal	**2.7**(3)	**1.3**(0.6)	**1.2**(0.5)	**1.2**(0.5)	**0.98**(0.3)	5.3(4)	103(112)	5/15
P-DCN tra	**1.7**(2)	10(9)	11(7)	10(3)	22(17)	4816(5017)	2.2e5(2e5)	1/15
P-zero tra	**1.5**(2)	8.1(8)	9.0(6)	10(6)	42(75)	1.9e4(3e4)	∞ *3e6*	0/15
SMAC hut	**1**(0.9)	**1.9**(1)	4.1(1)	9.2(4)	∞	∞	∞ *300*	0/15
U-DCN tra	**1.9**(2)	3.8(3)	14(9)	67(71)	887(990)	∞	∞ *3e6*	0/15
U-zero tra	**1.5**(2)	3.3(2)	12(10)	111(135)	1.9e4(3e4)	3.9e5(4e5)	∞ *3e6*	0/15
fmincon pa	**1.3**(1)	**0.72**(0.2)	**0.77**(0.2)	**0.83**(0.2)	**0.69**(0.2)	**0.86**(0.2)	661(809)	3/15
fminunc pa	**1.5**(2)	**0.91**(0.6)	**1.0**(0.6)	**1.00**(0.5)	**0.87**(0.3)	**0.89**(0.2)	165(245)	8/15
ga100 hol	**2.0**(1)	7.4(6)	27(14)	68(42)	385(332)	9385(1e4)	∞ *2e5*	0/15
grid100 ho	**2.4**(2)	18(28)	57(36)	275(528)	3540(3756)	∞	∞ *2e5*	0/15
grid16 hol	**2.4**(3)	8.2(7)	15(7)	191(379)	4121(4464)	∞	∞ *2e5*	0/15
hill hol	4.6(4)	**2.8**(2)	5.8(4)	93(95)	3718(4329)	∞	∞ *2e5*	0/15
lmmCMA aug	**1.7**(2)	**1.7**(0.6)	**1.6**(0.5)	**1.7**(0.4)	**1.8**(0.4)	**2.1**(0.2)	**1.7**(0.2)	15/15
memPSODE v	3.5(3)	3.3(2)	3.3(0.6)	**2.8**(0.5)	**2.0**(0.4)	**1.8**(0.2)	**1.3**(0.1)*	15/15
prcga saw	**2.0**(1)	5.0(4)	9.1(6)	40(69)	99(99)	1196(1383)	1.2e4(1e4)	1/15
ring100 ho	3.2(2)	9.1(8)	53(32)	104(63)	558(669)	∞	∞ *2e5*	0/15
ring16 hol	**1.8**(2)	7.5(7)	15(9)	75(110)	2373(3151)	∞	∞ *2e5*	0/15
simplex pa	8.5(10)	7.2(4)	6.7(2)	5.1(1)	3.5(0.7)	**2.8**(0.3)	**1.9**(0.2)	15/15

Table 16: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_{15}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f15	121	1372	6285	8282	8429	8787	9041	15/15
BIPOP-aCMA	**1.2**(0.6)	**1.6**(1)	**1.6**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1.0)	15/15
BIPOP-saAC	**1.4**(0.9)	**1.8**(2)	**0.80**(0.8)	**0.62**(0.6)	**0.62**(0.6)	**0.61**(0.6)	**0.60**(0.6)	15/15
CMAES hut	**1.2**(0.7)	∞	∞	∞	∞	∞	∞ *303*	0/15
DE pal	**1.7**(1.0)	**2.7**(2)	**2.2**(5)	**1.7**(4)	**1.8**(4)	**1.7**(3)	**1.7**(3)	13/15
HCMA los	**1.8**(0.9)	**1.2**(1)	**0.76**(0.5)	**0.59**(0.4)	**0.59**(0.4)	**0.58**(0.4)	**0.57**(0.4)	15/15
HMLSL pal	**2.9**(1)	**1.4**(0.9)	**2.4**(5)	**1.8**(4)	**1.8**(4)	**1.7**(3)	**1.7**(3)	13/15
IPOP-10DDr	**1.6**(0.6)	**2.6**(3)	**1.9**(2)	**1.4**(2)	**1.4**(2)	**1.4**(2)	**1.4**(2)	15/15
IPOP-500 l	**1.6**(0.6)	**2.6**(3)	**1.5**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	15/15
IPOP-tany	**1.1**(0.6)	**1.8**(2)	**1.4**(1)	**1.1**(0.9)	**1.1**(0.9)	**1.1**(0.8)	**1.1**(0.8)	15/15
IPOP-texp	**2.2**(4)	**2.1**(2)	**2.1**(2)	**1.7**(1)	**1.7**(1)	**1.7**(1)	**1.6**(1)	15/15
IPOP lia	**1.6**(0.6)	**2.6**(3)	**1.5**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	15/15
MLSL pal	**2.5**(1)	4.9(4)	6.2(7)	4.7(6)	4.6(5)	4.4(6)	4.3(4)	8/15
OQNLP pal	**3.0**(0.3)	**1.5**(1)	**0.71**(0.7)	**0.54**(0.5)	**0.53**(0.5)	**0.51**(0.5)	**0.53**(0.5)	11/15
P-DCN tra	2728(5575)	1449(2187)	6701(7398)	5086(5886)	4997(5873)	4794(5633)	4660(5309)	1/15
P-zero tra	4291(1e4)	1844(2308)	3387(3677)	2570(2754)	2526(2847)	2430(2561)	2380(2736)	2/15
SMAC hut	**2.3**(2)	∞	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	4.3(4)	430(1095)	574(744)	436(564)	429(546)	421(527)	720(840)	5/15
U-zero tra	10(9)	356(428)	836(1169)	639(798)	637(724)	1116(1212)	∞ *3e6*	0/15
fmincon pa	3.0(1)	4.3(5)	7.7(9)	5.8(7)	5.7(7)	5.5(6)	5.4(6)	7/15
fminunc pa	**2.8**(2)	3.4(4)	14(14)	11(10)	11(11)	10(10)	10(10)	5/15
ga100 hol	5.4(4)	62(75)	32(38)	26(29)	40(36)	∞	∞ *2e5*	0/15
grid100 ho	10(8)	118(133)	∞	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	4.0(5)	92(95)	71(85)	57(63)	78(88)	∞	∞ *2e5*	0/15
hill hol	3.2(5)	144(141)	338(346)	258(308)	257(276)	∞	∞ *2e5*	0/15
lmmCMA aug	**1.3**(2)	**0.74**(0.6)	**0.79**(0.9)	**0.60**(0.7)	**0.59**(0.7)	**0.57**(0.6)	**0.56**(0.6)	5/15
memPSODE v	7.9(14)	5.4(4)	4.2(3)	3.2(2)	3.1(2)	3.0(2)	**2.9**(2)	15/15
prcga saw	**2.4**(1)	16(18)	19(28)	18(22)	18(22)	23(29)	23(28)	9/15
ring100 ho	7.0(6)	42(34)	44(48)	48(46)	128(137)	∞	∞ *2e5*	0/15
ring16 hol	3.4(3)	61(71)	68(84)	53(63)	56(71)	∞	∞ *2e5*	0/15
simplex pa	4.7(1)	5.9(6)	14(17)	11(12)	11(12)	10(12)	10(11)	5/15

Table 17: 03-D, running time excess ERT/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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f16	41	319	582	789	1864	3204	3361	15/15
BIPOP-aCMA	**1.9**(2)	**2.0**(3)	**2.4**(3)	3.1(3)	**1.4**(1)	**0.86**(0.7)	**0.86**(0.7)	15/15
BIPOP-saAC	**2.4**(2)	3.1(3)	**2.8**(4)	3.2(3)	**1.4**(1)	**0.93**(1)	**1.1**(1.0)	15/15
CMAES hut	**1.2**(1)	**1.1**(1.0)	**1.9**(2)	**2.9**(3)	**2.4**(3)	∞	∞ *303*	0/15
DE pal	**1.2**(2)	4.4(3)	9.2(6)	12(9)	7.9(6)	4.9(3)	4.8(3)	14/15
HCMA los	**1.3**(1)	3.4(4)	3.2(3)	**2.8**(2)	**1.2**(1)	**0.78**(0.6)	**0.79**(0.6)	15/15
HMLSL pal	3.0(3)	6.4(5)	18(13)	55(46)	37(32)	25(23)	24(22)	9/15
IPOP-10DDr	**1.1**(1)	**2.0**(3)	**2.1**(2)	**2.6**(3)	**2.3**(3)	**1.4**(2)	**1.4**(2)	15/15
IPOP-500 l	**1.1**(1)	**2.0**(3)	**2.1**(2)	**2.6**(3)	117(3)	68(2)	65(2)	14/15
IPOP-tany	**1.5**(3)	3.0(3)	**2.9**(3)	**2.3**(2)	**1.0**(0.9)	**0.67**(0.6)	**0.67**(0.5)	15/15
IPOP-texp	**2.2**(3)	**3.0**(3)	**2.3**(2)	**1.9**(1)	**0.87**(0.5)	**0.61**(0.3)	**0.63**(0.3)	15/15
IPOP lia	**1.1**(1)	**2.0**(3)	**2.1**(2)	**2.6**(3)	6.0(3)	3.7(2)	3.6(2)	15/15
MLSL pal	3.3(4)	5.0(8)	40(36)	171(180)	∞	∞	∞ *4e4*	0/15
OQNLP pal	5.1(3)	11(14)	26(29)	164(180)	69(71)	∞	∞ *8425*	0/15
P-DCN tra	**0.93**(1)	680(31)	715(2171)	553(1614)	445(814)	1289(1464)	5864(6695)	2/15
P-zero tra	3.1(0.8)	4803(9416)	3111(4954)	2494(3804)	1330(1746)	2925(3196)	6428(7588)	2/15
SMAC hut	**0.64**(0.8)	**0.68**(0.8)	3.7(4)	∞	∞	∞	∞ *300*	0/15
U-DCN tra	**1.0**(1)	18(3)	40(69)	2079(2617)	6725(7928)	∞	∞ *3e6*	0/15
U-zero tra	**1.2**(1)	3.7(6)	237(396)	2003(2509)	4928(5607)	∞	∞ *3e6*	0/15
fmincon pa	3.4(3)	7.0(6)	24(24)	133(143)	317(368)	∞	∞ *4e4*	0/15
fminunc pa	4.7(4)	21(14)	66(63)	785(876)	∞	∞	∞ *4e4*	0/15
ga100 hol	**1.9**(2)	4.6(3)	194(257)	804(944)	1147(1288)	∞	∞ *2e5*	0/15
grid100 ho	**1.5**(1)	14(15)	300(360)	831(922)	∞	∞	∞ *2e5*	0/15
grid16 hol	**1.2**(2)	16(19)	73(77)	842(951)	579(604)	∞	∞ *2e5*	0/15
hill hol	**1.4**(2)	10(13)	98(139)	305(385)	529(603)	∞	∞ *2e5*	0/15
lmmCMA aug	**1.5**(1)	**2.1**(2)	**2.3**(2)	**2.0**(2)	**0.93**(1.0)	**0.69**(0.7)	**0.68**(0.7)	9/15
memPSODE v	**2.0**(1)	16(14)	17(15)	21(7)	11(4)	8.1(4)	9.0(4)	15/15
prcga saw	**1.7**(2)	4.8(1)	21(36)	54(64)	37(53)	39(48)	54(64)	9/15
ring100 ho	**1.3**(2)	7.2(6)	23(12)	114(148)	136(127)	∞	∞ *2e5*	0/15
ring16 hol	**1.2**(1)	**2.9**(4)	76(131)	305(383)	∞	∞	∞ *2e5*	0/15
simplex pa	7.4(2)	**2.9**(3)	7.6(9)	15(9)	10(6)	11(10)	15(15)	10/15

Table 18: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f17	3.6	78	282	491	1134	2347	3469	15/15
BIPOP-aCMA	**2.6**(3)	4.2(6)	**1.6**(2)	**1.6**(1)	**0.80**(0.6)	**1.0**(0.8)	**1.0**(0.6)	15/15
BIPOP-saAC	5.4(6)	**3.0**(0.9)	**2.1**(2)	**2.5**(2)	**1.5**(0.9)	**1.6**(2)	**1.6**(1)	15/15
CMAES hut	**2.6**(3)	**1.4**(1.0)	**0.95**(0.6)	3.0(3)	∞	∞	∞ *303*	0/15
DE pal	**2.7**(3)	**2.6**(1)	**2.6**(1.0)	**2.8**(1)	**1.8**(0.5)	**1.6**(0.4)	**1.5**(0.4)	15/15
HCMA los	4.2(5)	**2.0**(1)	**2.0**(2)	**2.2**(2)	**1.5**(0.9)	**1.7**(1)	**1.6**(1)	15/15
HMLSL pal	23(49)	17(35)	14(12)	13(10)	7.9(5)	5.1(3)	7.0(10)	13/15
IPOP-10DDr	**2.5**(2)	**2.9**(0.6)	**1.5**(0.4)	**1.6**(2)	**1.2**(1)	**1.3**(0.7)	**1.2**(0.5)	15/15
IPOP-500 l	**2.5**(2)	**2.9**(0.6)	**1.5**(0.4)	**1.6**(2)	**1.2**(1)	**1.3**(0.7)	**1.2**(0.5)	15/15
IPOP-tany	**3.0**(2)	**1.2**(0.4)	**1.7**(0.4)	**1.5**(2)	**0.89**(0.8)	**0.89**(0.7)	**0.97**(0.6)	15/15
IPOP-texp	20(16)	3.5(5)	**2.3**(3)	**2.2**(2)	**1.5**(0.9)	**0.99**(0.2)	**0.83**(0.1)	15/15
IPOP lia	**2.5**(2)	**2.9**(0.6)	**1.5**(0.4)	**1.6**(2)	**1.2**(1)	**1.3**(0.7)	**1.2**(0.5)	15/15
MLSL pal	23(51)	53(67)	274(333)	∞	∞	∞	∞ *6e4*	0/15
OQNLP pal	15(18)	7.0(6)	26(30)	62(62)	110(116)	∞	∞ *8929*	0/15
P-DCN tra	**2.4**(3)	6110(2e4)	9900(2e4)	5687(9170)	2497(3169)	8337(9577)	∞ *3e6*	0/15
P-zero tra	**2.3**(2)	1.9e4(4e4)	2.1e4(3e4)	1.2e4(2e4)	7362(9308)	∞	∞ *3e6*	0/15
SMAC hut	**1.9**(2)	**2.2**(2)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	**2.3**(2)	7.3(6)	2124(4554)	6059(9167)	8263(1e4)	∞	∞ *3e6*	0/15
U-zero tra	**2.3**(3)	32(15)	2149(5333)	1.8e4(2e4)	1.8e4(2e4)	∞	∞ *3e6*	0/15
fmincon pa	21(37)	100(115)	248(217)	∞	∞	∞	∞ *5e4*	0/15
fminunc pa	10(18)	7.8(6)	494(532)	∞	∞	∞	∞ *3e4*	0/15
ga100 hol	3.3(3)	7.6(6)	17(15)	315(289)	∞	∞	∞ *2e5*	0/15
grid100 ho	3.1(4)	20(11)	160(184)	2210(2361)	∞	∞	∞ *2e5*	0/15
grid16 hol	3.2(5)	33(8)	206(275)	1436(1413)	∞	∞	∞ *2e5*	0/15
hill hol	5.5(5)	140(10)	118(266)	450(518)	1963(2117)	∞	∞ *2e5*	0/15
lmmCMA aug	**0.94**(1)	**1.5**(2)	**0.92**(1)	**1.1**(0.9)	**0.67**(0.8)	**0.52**(0.6)	**0.56**(0.5)	10/15
memPSODE v	3.2(2)	29(28)	22(9)	20(10)	13(5)	10(4)	15(12)	15/15
prcga saw	**1.5**(2)	**2.8**(2)	15(36)	30(31)	29(30)	20(14)	20(22)	14/15
ring100 ho	3.6(5)	11(5)	35(22)	158(116)	∞	∞	∞ *2e5*	0/15
ring16 hol	**2.4**(2)	5.3(4)	87(179)	298(332)	963(992)	∞	∞ *2e5*	0/15
simplex pa	24(32)	21(20)	132(152)	211(222)	∞	∞	∞ *3e4*	0/15

Table 19: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f18	40	145	1289	3084	3523	4738	5527	15/15
BIPOP-aCMA	**2.1**(2)	**2.2**(0.8)	**0.64**(0.7)	**0.48**(0.4)	**0.68**(0.6)	**0.71**(0.3)	**0.67**(0.3)	15/15
BIPOP-saAC	**1.3**(0.9)	**2.7**(3)	**1.2**(0.8)	**0.63**(0.5)	**0.68**(0.5)	**0.97**(0.4)	**1.4**(1)	15/15
CMAES hut	**1.3**(0.9)	**2.2**(2)	**1.7**(2)	∞	∞	∞	∞ *303*	0/15
DE pal	**1.8**(1)	3.6(2)	**1.2**(0.6)	**0.90**(0.4)	**1.1**(0.4)	**2.3**(0.5)	**2.3**(0.4)	14/15
HCMA los	**1.5**(1)	**2.1**(1)	**1.1**(0.8)	**0.75**(0.7)	**0.76**(0.6)	**1.1**(0.4)	**1.3**(1)	15/15
HMLSL pal	8.4(6)	15(14)	4.7(2)	3.2(1)	3.9(1)	5.0(2)	5.2(2)	14/15
IPOP-10DDr	3.1(1)	6.5(10)	**1.2**(1)	**1.2**(0.9)	**1.1**(0.6)	**0.96**(0.5)	**0.90**(0.4)	15/15
IPOP-500 l	3.1(1)	6.5(10)	**1.2**(1)	**1.2**(0.9)	**1.1**(0.6)	**0.96**(0.5)	**0.90**(0.4)	15/15
IPOP-tany	**1.6**(0.9)	**3.0**(2)	**1.7**(2)	**1.3**(0.9)	**1.3**(0.6)	**1.1**(0.5)	**1.0**(0.5)	15/15
IPOP-texp	**1.5**(1)	4.7(8)	**2.2**(2)	**1.7**(0.8)	**1.6**(0.7)	**1.4**(0.5)	**1.3**(0.5)	15/15
IPOP lia	3.1(1)	6.5(10)	**1.2**(1)	**1.2**(0.9)	**1.1**(0.6)	**0.96**(0.5)	**0.90**(0.4)	15/15
MLSL pal	10(6)	109(99)	∞	∞	∞	∞	∞ *5e4*	0/15
OQNLP pal	7.7(3)	18(20)	13(11)	∞	∞	∞	∞ *9112*	0/15
P-DCN tra	36(22)	1.0e4(2e4)	4658(5820)	2027(2538)	5549(6813)	∞	∞ *3e6*	0/15
P-zero tra	37(5)	1.8e4(2e4)	1.5e4(2e4)	1.4e4(1e4)	1.2e4(1e4)	∞	∞ *3e6*	0/15
SMAC hut	**1.0**(0.9)	10(10)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	**2.8**(4)	1549(3003)	3148(3892)	∞	∞	∞	∞ *3e6*	0/15
U-zero tra	**2.3**(3)	824(1280)	3074(4265)	6697(7610)	1.2e4(1e4)	∞	∞ *3e6*	0/15
fmincon pa	8.1(4)	168(111)	572(671)	∞	∞	∞	∞ *5e4*	0/15
fminunc pa	4.9(3)	71(76)	∞	∞	∞	∞	∞ *3e4*	0/15
ga100 hol	**2.9**(3)	25(9)	72(87)	328(389)	∞	∞	∞ *2e5*	0/15
grid100 ho	4.7(5)	254(387)	∞	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	5.2(3)	324(529)	528(582)	∞	∞	∞	∞ *2e5*	0/15
hill hol	**2.9**(3)	138(189)	787(873)	∞	∞	∞	∞ *2e5*	0/15
lmmCMA aug	**0.74**(0.4)	**1.8**(2)	**0.94**(1.0)	**0.74**(0.7)	**0.77**(0.8)	**0.64**(0.6)	**0.96**(0.9)	5/15
memPSODE v	14(21)	34(15)	19(26)	11(11)	11(10)	11(7)	23(19)	15/15
prcga saw	**2.0**(2)	46(94)	35(45)	45(58)	136(140)	220(247)	406(464)	1/15
ring100 ho	6.3(8)	27(22)	56(64)	345(389)	∞	∞	∞ *2e5*	0/15
ring16 hol	3.5(3)	10(7)	208(233)	∞	∞	∞	∞ *2e5*	0/15
simplex pa	9.1(1)	31(32)	40(47)	∞	∞	∞	∞ *4e4*	0/15

Table 20: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f19	1	1	109	6764	7367	7399	7441	15/15
BIPOP-aCMA	8.0(9)	676(772)	57(90)	3.7(5)	**4.6**(5)	**4.6**(5)	**4.6**(5)	15/15
BIPOP-saAC	6.5(6)	247(408)	40(39)	**2.3**(2)	**2.7**(3)	**2.7**(3)	**2.7**(3)	15/15
CMAES hut	10(12)	150(159)	41(46)	∞	∞	∞	∞ *303*	0/15
DE pal	11(10)	191(166)	22(17)	**2.9**(3)	6.2(8)	7.4(8)	7.5(8)	9/15
HCMA los	9.3(8)	126(249)	38(40)	**2.4**(2)	**2.7**(2)	**2.8**(2)	**2.8**(2)	15/15
HMLSL pal	**1**(0)	**1**(0)	**0.16**(0)	10(8)	14(15)	16(19)	16(17)	6/15
IPOP-10DDr	10(14)	179(258)	152(270)	7.5(9)	10(8)	10(8)	10(8)	15/15
IPOP-500 l	10(14)	179(258)	152(270)	5.7(7)	7.0(8)	7.0(8)	7.0(8)	15/15
IPOP-tany	7.3(7)	157(118)	177(265)	10(13)	11(12)	11(12)	11(12)	15/15
IPOP-texp	**2.7**(1)	60(48)	135(296)	7.2(7)	7.5(9)	7.5(9)	7.5(9)	15/15
IPOP lia	10(14)	179(258)	152(270)	5.7(7)	7.0(8)	7.0(8)	7.0(8)	15/15
MLSL pal	**1**(0)	**1**(0)	**0.16**(0)	29(31)	36(44)	36(47)	36(42)	3/15
OQNLP pal	**1**(0)	**1**(0)	**0.11**(0)$^{\star 4}$	**0.80**(0.8)	**1.6**(2)	**1.6**(2)	**2.0**(2)	8/15
P-DCN tra	16(15)	407(347)	171(362)	1263(1634)	2724(2978)	2726(3006)	2761(3206)	2/15
P-zero tra	12(10)	946(1374)	2382(4313)	2884(3326)	∞	∞	∞ *3e6*	0/15
SMAC hut	**1**(0)	**1**(0)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	12(12)	360(556)	353(919)	255(345)	391(416)	1313(1554)	5820(6451)	1/15
U-zero tra	9.2(6)	268(224)	304(723)	369(443)	1302(1523)	5850(6487)	∞ *3e6*	0/15
fmincon pa	**1**(0)	**1**(0)	**0.16**(0)	31(34)	59(65)	59(60)	59(67)	2/15
fminunc pa	**1**(0)	**1**(0)	**0.16**(0.0)	4.8(4)	8.3(8)	8.3(8)	8.2(7)	8/15
ga100 hol	4.9(6)	373(532)	58(42)	13(11)	51(53)	302(329)	∞ *2e5*	0/15
grid100 ho	11(11)	590(699)	122(152)	69(78)	143(155)	286(335)	∞ *2e5*	0/15
grid16 hol	5.7(6)	466(430)	216(487)	42(46)	73(71)	∞	∞ *2e5*	0/15
hill hol	13(12)	531(307)	81(107)	96(102)	139(158)	140(158)	297(353)	1/15
lmmCMA aug	**1**(0)	**1**(0)	27(24)	**1.4**(1)	**2.0**(2)	**2.0**(2)	**2.0**(2)	2/15
memPSODE v	14(8)	1190(1882)	78(49)	5.7(4)	24(21)	24(20)	25(20)	14/15
prcga saw	4.5(3)	108(64)	12(5)	7.4(10)	10(12)	34(33)	61(71)	5/15
ring100 ho	7.1(9)	451(495)	77(77)	21(23)	67(70)	293(314)	∞ *2e5*	0/15
ring16 hol	11(10)	319(268)	48(18)	16(17)	47(57)	289(304)	∞ *2e5*	0/15
simplex pa	**1**(0)	**1**(0)	**0.14**(0.0)	3.5(3)	14(14)	14(14)	14(15)	6/15

Table 21: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ 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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f20	8.3	385	2291	2398	2481	2573	2776	15/15
BIPOP-aCMA	4.4(2)	3.2(4)	6.9(7)	6.9(7)	6.7(7)	6.7(7)	6.3(6)	15/15
BIPOP-saAC	**2.0**(2)	**2.1**(2)	**3.6**(3)	**3.8**(3)	**3.7**(3)	**3.6**(3)	**3.3**(3)	15/15
CMAES hut	**2.7**(3)	**2.6**(3)	∞	∞	∞	∞	∞ *303*	0/15
DE pal	5.0(5)	**2.0**(1)	31(39)	29(38)	29(37)	28(35)	26(33)	7/15
HCMA los	**1.2**(0.2)	4.2(5)	**3.2**(3)	**3.1**(3)	**3.1**(3)	**3.1**(3)	**2.9**(3)	15/15
HMLSL pal	**1.9**(0)	**1.6**(1)	14(26)	13(25)	13(13)	12(23)	11(22)	10/15
IPOP-10DDr	3.9(1)	4.6(4)	15(11)	14(11)	14(11)	13(10)	12(9)	15/15
IPOP-500 l	3.9(1)	4.6(4)	10(0.8)	10(1)	10(0.7)	10(0.8)	10(0.7)	15/15
IPOP-tany	3.0(2)	8.5(8)	15(17)	15(16)	14(15)	14(15)	13(14)	15/15
IPOP-texp	**0.96**(0.3)	**2.5**(2)	21(25)	21(24)	21(23)	20(23)	19(21)	15/15
IPOP lia	3.9(1)	4.6(4)	10(0.8)	10(1)	10(0.7)	10(0.8)	10(0.7)	15/15
MLSL pal	**1.9**(0)	**1.5**(2)	**2.4**(2)	**2.3**(2)	**2.2**(2)	**2.2**(2)	**2.0**(2)	15/15
OQNLP pal	**1.8**(0)	**2.0**(2)	**5.0**(6)	**4.8**(6)	**4.6**(5)	**4.4**(6)	**4.1**(5)	4/15
P-DCN tra	4.3(4)	485(928)	1.9e4(2e4)	1.8e4(2e4)	1.8e4(2e4)	1.7e4(2e4)	1.6e4(2e4)	1/15
P-zero tra	7.5(6)	3223(3570)	6084(6548)	5812(5895)	5618(6303)	5419(6076)	5041(5612)	3/15
SMAC hut	**0.96**(0.5)	5.7(5)	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	3.6(2)	8.7(2)	376(673)	360(644)	348(630)	345(600)	389(565)	12/15
U-zero tra	**2.7**(2)	30(18)	258(417)	247(396)	247(383)	331(360)	1942(1621)	7/15
fmincon pa	**1.9**(0)	**1.6**(1)	5.9(8)	**5.7**(8)	**5.5**(7)	**5.3**(7)	**4.9**(7)	13/15
fminunc pa	**1.1**(0)	**2.2**(2)	6.0(7)	5.8(7)	5.6(7)	5.4(7)	5.0(6)	13/15
ga100 hol	7.4(9)	3.9(3)	6.8(2)	9.2(4)	16(8)	102(92)	∞ *2e5*	0/15
grid100 ho	6.1(8)	8.0(7)	58(66)	111(118)	419(466)	∞	∞ *2e5*	0/15
grid16 hol	3.3(4)	4.0(4)	41(48)	62(70)	92(94)	870(933)	∞ *2e5*	0/15
hill hol	5.4(4)	8.2(16)	27(35)	27(35)	30(34)	103(93)	803(865)	1/15
lmmCMA aug	**1.4**(0.8)	8.6(9)	13(14)	12(13)	12(13)	12(11)	11(11)	1/15
memPSODE v	4.5(4)	7.0(6)	15(22)	14(21)	14(20)	13(19)	13(18)	15/15
prcga saw	**1.6**(1)	8.1(13)	21(27)	21(25)	21(26)	21(24)	21(22)	14/15
ring100 ho	4.1(6)	6.3(3)	**5.2**(3)	9.3(4)	19(9)	122(89)	∞ *2e5*	0/15
ring16 hol	6.0(6)	**2.2**(1)	18(33)	19(32)	22(32)	74(64)	787(865)	1/15
simplex pa	5.8(0.1)	3.6(3)	9.3(10)	8.9(9)	8.6(9)	8.3(9)	7.7(10)	12/15

Table 22: 03-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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f21	5.9	184	425	439	458	469	482	15/15
BIPOP-aCMA	**2.6**(3)	8.1(16)	12(7)	12(7)	12(7)	12(7)	12(7)	15/15
BIPOP-saAC	**1.1**(0.9)	8.6(20)	7.8(12)	7.8(12)	7.6(12)	7.5(11)	7.4(11)	15/15
CMAES hut	**2.1**(0.9)	**2.2**(3)	**1.7**(2)	**1.7**(2)	**1.7**(2)	**1.7**(2)	**1.7**(2)	5/15
DE pal	**2.1**(2)	**2.2**(3)	23(71)	22(69)	22(66)	22(64)	22(62)	13/15
HCMA los	**2.3**(2)	3.3(7)	7.5(5)	7.9(5)	7.8(5)	7.9(5)	7.7(5)	15/15
HMLSL pal	4.2(6)	**2.4**(2)	**1.7**(1)	**1.8**(1)	**1.7**(1)	**1.8**(1)	**1.8**(1)	15/15
IPOP-10DDr	**1.6**(1)	4.9(6)	9.5(15)	12(15)	11(14)	11(14)	11(14)	15/15
IPOP-500 l	**1.6**(1)	4.9(6)	18(15)	44(57)	62(154)	62(154)	61(150)	15/15
IPOP-tany	**1.1**(1)	4.9(6)	9.5(13)	10(13)	10(12)	10(12)	10(12)	15/15
IPOP-texp	**1.3**(2)	4.9(6)	8.6(11)	10(13)	10(12)	10(12)	10(12)	15/15
IPOP lia	**1.6**(1)	4.9(6)	15(15)	38(59)	131(60)	221(64)	217(63)	15/15
MLSL pal	4.0(6)	**1.2**(0.9)	**1.5**(2)	**1.5**(2)	**1.4**(2)	**1.4**(2)	**1.5**(2)	15/15
OQNLP pal	4.0(4)	**1.5**(1)	**1.8**(2)	**1.9**(2)	**1.8**(2)	**1.8**(2)	**2.4**(2)	13/15
P-DCN tra	**1.5**(2)	3.3e4(4e4)	4.6e4(5e4)	4.4e4(5e4)	4.3e4(5e4)	4.2e4(5e4)	4.0e4(5e4)	2/15
P-zero tra	**1.4**(2)	1.9e4(2e4)	1.4e4(2e4)	1.4e4(2e4)	1.3e4(2e4)	1.3e4(2e4)	1.2e4(2e4)	5/15
SMAC hut	**1.2**(1)	**0.74**(0.5)	**0.56**(0.4)	**1.3**(1)	**2.4**(2)	∞	∞ *300*	0/15
U-DCN tra	**1.2**(2)	**2.9**(5)	**2.9**(3)	4.1(4)	6.2(5)	15(14)	32(27)	15/15
U-zero tra	**0.99**(1)	7.5(10)	11(18)	13(22)	17(20)	40(48)	120(122)	15/15
fmincon pa	4.3(6)	**1.6**(2)	**1.1**(1)	**1.1**(1)	**1.1**(1)	**1.1**(1)	**1.2**(1)	15/15
fminunc pa	4.7(7)	**1.9**(2)	**1.7**(1)	**1.7**(1)	**1.6**(1)	**1.6**(1)	**1.7**(1)	15/15
ga100 hol	**0.87**(0.8)	3.0(3)	3.1(2)	5.0(2)	7.1(4)	15(5)	38(23)	15/15
grid100 ho	**1.3**(2)	10(7)	30(9)	47(49)	105(173)	284(315)	816(839)	5/15
grid16 hol	**1.1**(0.9)	**2.4**(4)	11(17)	20(35)	29(36)	91(93)	240(245)	11/15
hill hol	5.5(9)	186(408)	130(182)	126(176)	122(168)	127(166)	170(212)	12/15
lmmCMA aug	**2.2**(2)	**2.1**(3)	**2.2**(3)	**2.6**(4)	**2.5**(3)	**2.6**(4)	**2.8**(4)	10/15
memPSODE v	**2.3**(2)	7.8(13)	18(11)	19(11)	18(12)	18(14)	25(52)	15/15
prcga saw	**0.72**(0.9)	9.2(9)	15(20)	18(19)	27(29)	41(38)	47(54)	15/15
ring100 ho	**1.5**(2)	4.0(4)	3.1(3)	7.7(3)	11(6)	34(15)	158(156)	13/15
ring16 hol	**1.5**(2)	4.1(3)	3.5(2)	4.5(3)	6.6(6)	22(22)	83(68)	15/15
simplex pa	19(21)	**2.4**(1)	**1.6**(1)	**1.6**(1)	**1.6**(1)	**1.6**(1)	**1.6**(1)	15/15

Table 23: 03-D, running time excess ERT/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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f22	18	170	354	362	384	401	414	15/15
BIPOP-aCMA	**1.4**(1.0)	6.9(7)	11(16)	12(16)	15(20)	14(20)	14(19)	15/15
BIPOP-saAC	**2.4**(1)	4.5(5)	15(17)	15(16)	15(15)	14(15)	14(14)	15/15
CMAES hut	**3.0**(3)	**1.7**(2)	**2.0**(2)	**2.0**(2)	**2.6**(3)	5.4(6)	5.4(6)	2/15
DE pal	**1.4**(1)	56(177)	86(169)	85(166)	81(156)	79(149)	77(145)	10/15
HCMA los	**1.3**(1)	3.5(8)	12(12)	23(12)	22(11)	27(38)	26(37)	15/15
HMLSL pal	**2.3**(3)	**1.7**(2)	**1.4**(1)	**1.4**(1)	**1.4**(1)	**1.4**(1)	**1.5**(0.9)	15/15
IPOP-10DDr	**1.7**(2)	3.4(3)	11(26)	47(37)	45(39)	43(38)	42(36)	15/15
IPOP-500 l	**1.7**(2)	3.4(3)	41(120)	108(246)	163(232)	1577(3738)	1823(3622)	12/15
IPOP-tany	**1.4**(2)	8.3(9)	20(25)	39(65)	58(109)	60(105)	58(101)	15/15
IPOP-texp	5.0(2)	11(12)	11(19)	12(19)	11(18)	11(17)	11(17)	15/15
IPOP lia	**1.7**(2)	3.4(3)	37(113)	101(213)	351(814)	1881(3744)	1823(3622)	12/15
MLSL pal	**2.0**(2)	**1.3**(0.8)	**1.7**(2)	**1.7**(2)	**1.6**(2)	**1.6**(2)	**1.8**(2)	15/15
OQNLP pal	**3.0**(4)	3.3(4)	**1.8**(2)	**1.8**(2)	**1.7**(2)	**1.7**(2)	**2.9**(3)	11/15
P-DCN tra	**2.0**(3)	1.2e4(2e4)	2.3e4(3e4)	2.3e4(3e4)	2.1e4(3e4)	2.1e4(3e4)	2.0e4(3e4)	4/15
P-zero tra	**2.3**(2)	3.5e4(4e4)	5.5e4(6e4)	5.4e4(7e4)	5.1e4(6e4)	4.9e4(6e4)	4.7e4(5e4)	2/15
SMAC hut	**0.80**(0.8)	**0.58**(0.6)	**1.4**(2)	**2.1**(2)	5.3(6)	∞	∞ *300*	0/15
U-DCN tra	**1.4**(2)	**2.3**(2)	4.3(4)	21(41)	51(90)	180(322)	587(884)	15/15
U-zero tra	**1.8**(2)	3.5(3)	5.3(7)	106(109)	136(151)	1869(3644)	3728(4276)	11/15
fmincon pa	**2.4**(3)	**1.1**(0.8)	**0.93**(0.9)	**0.96**(0.9)	**0.96**(0.8)	**1.00**(0.8)	**1.1**(0.8)	15/15
fminunc pa	**1.8**(2)	**1.2**(1.0)	**0.86**(0.5)	**0.90**(0.5)	**0.90**(0.3)	**0.98**(0.5)	**1.1**(0.4)	15/15
ga100 hol	**1.7**(1)	65(3)	39(39)	55(85)	127(202)	239(372)	424(482)	8/15
grid100 ho	**1.6**(2)	**2.7**(3)	41(17)	109(208)	154(215)	934(973)	2591(2691)	2/15
grid16 hol	**1.8**(2)	7.4(4)	83(212)	138(209)	167(220)	323(408)	879(988)	5/15
hill hol	**2.1**(2)	298(442)	335(429)	358(424)	427(569)	795(951)	1620(1742)	3/15
lmmCMA aug	**1.3**(1.0)	5.1(7)	10(12)	13(15)	12(14)	12(14)	11(15)	5/15
memPSODE v	**1.2**(0.9)	17(26)	23(37)	23(38)	22(36)	22(34)	21(33)	15/15
prcga saw	**1.5**(2)	9.4(20)	31(63)	59(116)	69(109)	113(135)	129(148)	15/15
ring100 ho	**2.0**(2)	3.3(4)	4.6(5)	8.3(5)	43(13)	194(215)	376(389)	9/15
ring16 hol	**3.0**(3)	4.2(8)	92(212)	96(209)	106(195)	342(425)	516(507)	8/15
simplex pa	10(9)	3.3(3)	**1.9**(1)	**2.0**(1)	**1.9**(1)	**1.8**(1.0)	**1.8**(1.0)	15/15

Table 24: 03-D, running time excess ERT/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.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f23	2.6	407	906	1215	2214	2293	2393	15/15
BIPOP-aCMA	5.9(6)	5.2(4)	5.3(5)	4.3(4)	**2.4**(2)	**2.5**(2)	**2.5**(2)	15/15
BIPOP-saAC	3.4(3)	8.0(9)	5.8(6)	5.2(5)	**2.9**(3)	3.1(3)	3.3(3)	15/15
CMAES hut	3.7(3)	∞	∞	∞	∞	∞	∞ *303*	0/15
DE pal	4.1(4)	6.3(6)	18(5)	21(4)	13(3)	13(3)	13(3)	15/15
HCMA los	7.4(8)	5.3(5)	6.1(6)	5.0(4)	3.2(3)	3.3(3)	3.5(3)	15/15
HMLSL pal	14(16)	**1.7**(2)	**3.7**(4)	**3.0**(3)	4.2(5)	∞	∞ *6e4*	0/15
IPOP-10DDr	3.8(4)	5.2(4)	6.8(8)	5.2(6)	**2.9**(3)	**3.0**(3)	**3.0**(3)	15/15
IPOP-500 l	3.8(4)	5.2(4)	6.8(8)	5.2(6)	**2.9**(3)	**3.0**(3)	**3.0**(3)	15/15
IPOP-tany	**2.9**(2)	7.1(6)	7.4(5)	5.7(4)	3.2(2)	3.3(2)	3.3(2)	15/15
IPOP-texp	3.7(4)	4.3(4)	4.4(3)	**3.5**(2)	**2.0**(1)	**2.1**(1)	**2.1**(1)	15/15
IPOP lia	3.8(4)	5.2(4)	6.8(8)	5.2(6)	**2.9**(3)	**3.0**(3)	**3.0**(3)	15/15
MLSL pal	15(16)	**1.2**(0.9)	**2.7**(3)	4.8(6)	4.1(3)	150(163)	∞ *5e4*	0/15
OQNLP pal	14(33)	**2.1**(3)	16(17)	27(28)	42(44)	∞	∞ *1e4*	0/15
P-DCN tra	3.6(5)	6.7(4)	1299(1749)	1.0e4(1e4)	2.0e4(2e4)	∞	∞ *3e6*	0/15
P-zero tra	3.8(4)	15(9)	1215(1671)	1.6e4(2e4)	∞	∞	∞ *3e6*	0/15
SMAC hut	3.5(3)	∞	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	**2.9**(3)	11(11)	4413(5130)	∞	∞	∞	∞ *3e6*	0/15
U-zero tra	**2.6**(3)	24(28)	4660(5393)	∞	∞	∞	∞ *3e6*	0/15
fmincon pa	13(15)	**0.95**(0.7)	**2.4**(2)	**4.2**(3)	4.4(3)	50(56)	∞ *5e4*	0/15
fminunc pa	11(21)	**3.0**(4)	66(68)	∞	∞	∞	∞ *4e4*	0/15
ga100 hol	4.7(3)	23(22)	1195(1211)	∞	∞	∞	∞ *2e5*	0/15
grid100 ho	4.2(3)	22(20)	2439(2732)	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	3.3(5)	20(20)	1201(1303)	∞	∞	∞	∞ *2e5*	0/15
hill hol	6.4(7)	15(28)	2420(2400)	∞	∞	∞	∞ *2e5*	0/15
lmmCMA aug	5.5(5)	**2.5**(3)	**3.7**(4)	**4.0**(4)	**2.2**(2)	**2.2**(2)	**2.1**(2)	5/15
memPSODE v	**2.7**(3)	3.8(6)	8.6(7)	8.5(10)	5.0(5)	6.0(6)	5.7(6)	15/15
prcga saw	4.5(5)	7.5(9)	31(27)	85(103)	99(106)	153(172)	151(158)	5/15
ring100 ho	**3.2**(3)	33(36)	2412(2400)	∞	∞	∞	∞ *2e5*	0/15
ring16 hol	4.2(6)	9.4(9)	1191(1159)	∞	∞	∞	∞ *2e5*	0/15
simplex pa	80(104)	**2.0**(1)	**2.1**(1)	**1.9**(1)	**1.4**(2)	**1.5**(2)	**1.5**(1)	15/15

Table 25: 03-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_{24}, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-2	1e-3	1e-5	1e-7	#succ
f24	97	10391	1.0e5	3.6e5	3.6e5	3.6e5	3.6e5	2/15
BIPOP-aCMA	**2.2**(1)	6.2(10)	9.0(8)	5.2(6)	7.3(8)	7.3(8)	7.3(8)	10/15
BIPOP-saAC	**1.6**(1)	3.3(4)	9.0(12)	5.7(5)	7.2(7)	7.2(7)	8.2(8)	10/15
CMAES hut	**1.6**(1)	∞	∞	∞	∞	∞	∞ *303*	0/15
DE pal	3.1(3)	24(29)	**3.9**(5)	**1.1**(1)	**1.1**(1)	**1.1**(1)	**1.1**(1)	2/15
HCMA los	**1.6**(0.8)	6.5(10)	10(15)	10(11)	10(13)	10(12)	10(13)	8/15
HMLSL pal	**2.4**(2)	10(12)	**2.7**(3)	**0.78**(0.9)	**0.78**(0.8)	**0.79**(0.8)	**0.79**(0.8)	3/15
IPOP-10DDr	**2.2**(3)	115(167)	136(141)	61(67)	61(67)	61(63)	61(67)	2/15
IPOP-500 l	**2.2**(3)	∞	∞	∞	∞	∞	∞ *3e6*	0/15
IPOP-tany	**1.8**(1)	57(52)	75(81)	122(138)	122(126)	122(117)	122(143)	1/15
IPOP-texp	**1.7**(1)	**2.2**(2)	**4.2**(4)	**2.4**(2)	**2.4**(2)	**2.4**(2)	**2.4**(2)	15/15
IPOP lia	**2.2**(3)	∞	∞	∞	∞	∞	∞ *3e6*	0/15
MLSL pal	**2.0**(1)	**2.2**(2)	∞	∞	∞	∞	∞ *3e4*	0/15
OQNLP pal	4.1(1)	**0.67**(0.8)	**0.24**(0.3)	**0.17**(0.2)	**0.17**(0.2)	**0.17**(0.2)	**0.17**(0.2)	2/15
P-DCN tra	52(111)	1159(1445)	119(146)	35(41)	35(42)	35(41)	35(42)	3/15
P-zero tra	310(349)	∞	∞	∞	∞	∞	∞ *3e6*	0/15
SMAC hut	4.3(5)	∞	∞	∞	∞	∞	∞ *300*	0/15
U-DCN tra	5.1(6)	143(171)	∞	∞	∞	∞	∞ *3e6*	0/15
U-zero tra	4.4(4)	466(473)	∞	∞	∞	∞	∞ *3e6*	0/15
fmincon pa	**1.9**(1)	**2.7**(3)	∞	∞	∞	∞	∞ *4e4*	0/15
fminunc pa	3.4(2)	**3.0**(3)	∞	∞	∞	∞	∞ *4e4*	0/15
ga100 hol	4.6(4)	∞	∞	∞	∞	∞	∞ *2e5*	0/15
grid100 ho	8.5(9)	210(238)	∞	∞	∞	∞	∞ *2e5*	0/15
grid16 hol	6.8(6)	101(108)	∞	∞	∞	∞	∞ *2e5*	0/15
hill hol	5.3(7)	96(115)	∞	∞	∞	∞	∞ *2e5*	0/15
lmmCMA aug	**1.5**(1)	**0.84**(0.9)	∞	∞	∞	∞	∞ *2010*	0/15
memPSODE v	9.2(11)	31(33)	**3.5**(4)	**1.0**(1.0)	**1.1**(1.0)	**1.1**(1.0)	**1.1**(1.0)	14/15
prcga saw	**2.7**(3)	5.1(5)	4.5(5)	7.1(8)	∞	∞	∞ *2e5*	0/15
ring100 ho	10(8)	27(29)	∞	∞	∞	∞	∞ *2e5*	0/15
ring16 hol	5.9(6)	42(46)	∞	∞	∞	∞	∞ *2e5*	0/15
simplex pa	5.5(2)	7.0(7)	∞	∞	∞	∞	∞ *4e4*	0/15

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