Comparison Tables: BBOB 2013 Testbed in 2-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: 02-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	1.8	5.7	5.7	6.2	6.2	6.2	6.2	15/15
BIPOP-aCMA	**2.3**(3)	**2.9**(2)	4.0(0.5)	5.9(0.2)	6.5(0.2)	8.5(1.0)	11(0.2)	15/15
BIPOP-saAC	5.1(5)	4.3(3)	8.6(5)	11(1)	13(1)	17(1)	19(2)	15/15
CMAES hut	4.2(7)	3.8(5)	7.9(3)	12(5)	16(4)	32(17)	95(87)	5/15
DE pal	**1.9**(2)	**3.0**(2)	11(6)	18(13)	28(13)	48(9)	66(15)	15/15
HCMA los	**3.0**(1)	**1.1**(0)	**1.1**(0)*	**0.97**(0)$^{\star 4}$	**0.97**(0)$^{\star 4}$	**0.97**(0)$^{\star 4}$	**0.97**(0)$^{\star 4}$	15/15
HMLSL pal	**1.8**(0.8)	**1.4**(0.5)	**1.9**(0.5)	**1.8**(0.5)	**2.1**(0.7)	**2.7**(0.7)	**2.9**(0.2)	15/15
IPOP-10DDr	**1.9**(2)	3.8(3)	8.1(3)	11(1)	16(3)	24(2)	32(3)	15/15
IPOP-500 l	**1.9**(2)	3.8(3)	8.1(3)	11(1)	16(3)	24(2)	32(3)	15/15
IPOP-tany	**2.9**(2)	**2.2**(2)	7.1(3)	11(2)	15(2)	22(2)	30(3)	15/15
IPOP-texp	5.1(7)	3.4(3)	6.4(2)	9.0(3)	13(5)	21(4)	30(5)	15/15
IPOP lia	**1.9**(2)	3.8(3)	8.1(3)	11(1)	16(3)	24(2)	32(3)	15/15
MLSL pal	**1.8**(0.8)	**1.4**(0.5)	**1.9**(0.5)	**1.8**(0.5)	**2.1**(0.7)	**2.7**(0.7)	**2.9**(0.2)	15/15
OQNLP pal	4.4(3)	**2.2**(0.4)	**2.8**(0.6)	**2.9**(0.6)	3.0(0.7)	3.1(0.7)	3.2(0.7)	15/15
P-DCN tra	**1.0**(0.8)	8.8(13)	20(16)	24(14)	32(14)	87(38)	190(60)	15/15
P-zero tra	**1.0**(0.8)	6.0(6)	14(11)	18(12)	22(14)	62(34)	394(218)	15/15
SMAC hut	**1.6**(1)	**1.2**(0.7)	**2.1**(0.5)	**2.8**(1.0)	5.1(2)	70(68)	∞ *200*	0/15
U-DCN tra	**1.0**(0.8)	4.5(3)	16(12)	38(30)	94(48)	282(268)	1577(2430)	15/15
U-zero tra	**1.0**(0.8)	5.1(4)	16(15)	52(35)	165(160)	1042(980)	1.7e4(1e4)	15/15
fmincon pa	**1.8**(0.8)	**1.4**(0.5)	**1.9**(0.5)	**1.8**(0.5)	**2.1**(0.7)	**2.7**(0.7)	**2.9**(0.2)	15/15
fminunc pa	**2.1**(2)	**1.1**(0.3)	**1.1**(0.3)	**1.1**(0)	**1.1**(0)	**1.1**(0)	**1.1**(0)	15/15
ga100 hol	**2.5**(2)	4.4(4)	37(28)	90(71)	260(161)	2926(2914)	1.3e4(1e4)	11/15
grid100 ho	**2.3**(2)	3.5(4)	63(68)	234(257)	827(816)	4746(3240)	4.4e4(4e4)	5/15
grid16 hol	**1.7**(2)	10(9)	30(19)	63(50)	208(173)	1230(1011)	1.3e4(1e4)	12/15
hill hol	4.7(6)	3.9(3)	10(8)	35(27)	118(125)	760(561)	7541(6889)	14/15
lmmCMA aug	**2.0**(3)	**2.1**(1)	3.5(0.6)	3.8(0.8)	4.8(0.9)	6.0(1)	8.0(0.6)	15/15
memPSODE v	3.1(3)	5.5(4)	16(9)	20(7)	26(11)	45(18)	68(20)	15/15
prcga saw	**2.1**(2)	5.7(8)	20(12)	35(33)	65(45)	123(158)	186(160)	15/15
ring100 ho	**2.2**(2)	6.3(7)	28(37)	134(105)	420(179)	2087(1149)	1.3e4(1e4)	12/15
ring16 hol	**1.5**(1)	4.8(5)	25(16)	58(42)	135(106)	986(496)	1.9e4(2e4)	9/15
simplex pa	14(17)	8.9(5)	12(4)	13(3)	14(3)	17(3)	19(3)	15/15

Table 3: 02-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	16	19	25	25	26	28	29	15/15
BIPOP-aCMA	3.0(0.4)	**3.0**(0.5)	**2.6**(0.2)	**2.7**(0.2)	**2.9**(0.3)	**3.1**(0.4)	**3.7**(0.4)	15/15
BIPOP-saAC	7.0(3)	7.3(2)	6.0(2)	6.3(2)	6.5(2)	6.8(2)	7.5(2)	15/15
CMAES hut	19(21)	38(38)	62(66)	∞	∞	∞	∞ *206*	0/15
DE pal	9.4(4)	12(4)	12(2)	14(3)	16(2)	19(3)	22(3)	15/15
HCMA los	**2.7**(3)	4.5(4)	4.8(3)	5.5(3)	5.7(3)	5.9(3)	6.3(3)	15/15
HMLSL pal	**1.4**(0.4)	**1.5**(0.5)	**1.3**(0.4)	**1.4**(0.5)	**1.6**(0.4)	**2.1**(0.8)	**2.8**(0.8)	15/15
IPOP-10DDr	17(14)	27(3)	23(2)	24(1)	25(2)	26(1)	28(2)	15/15
IPOP-500 l	17(14)	27(3)	23(2)	24(1)	25(2)	26(1)	28(2)	15/15
IPOP-tany	9.3(13)	22(11)	20(8)	22(2)	24(2)	25(2)	27(2)	15/15
IPOP-texp	9.0(12)	20(11)	18(9)	21(9)	23(3)	24(2)	26(3)	15/15
IPOP lia	17(14)	27(3)	23(2)	24(1)	25(2)	26(1)	28(2)	15/15
MLSL pal	**1.4**(0.4)	**1.5**(0.5)	**1.3**(0.4)	**1.4**(0.5)	**1.6**(0.4)	**2.1**(0.8)	**2.8**(0.8)	15/15
OQNLP pal	**2.0**(0.9)	3.6(2)	**3.0**(1)	**3.1**(1)	**3.2**(1)	**3.2**(1)	18(28)	13/15
P-DCN tra	8.3(4)	16(14)	28(21)	48(34)	89(98)	278(269)	1614(374)	15/15
P-zero tra	11(8)	26(20)	31(18)	100(93)	261(406)	2380(2587)	2.8e4(3e4)	14/15
SMAC hut	3.5(3)	11(12)	37(41)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	63(97)	173(255)	205(219)	1504(2255)	1826(2303)	3444(6477)	2.1e4(4e4)	12/15
U-zero tra	201(272)	862(882)	2402(3774)	8468(9861)	1.7e4(2e4)	1.7e5(2e5)	5.0e5(6e5)	2/15
fmincon pa	**1.4**(0.4)	**1.5**(0.5)	**1.3**(0.4)	**1.4**(0.5)	**1.6**(0.4)	**2.1**(0.8)	**2.8**(0.8)	15/15
fminunc pa	**1.9**(2)	**3.0**(2)	3.2(1)	3.5(1)	3.8(1)	3.9(1)	**4.1**(1)	15/15
ga100 hol	86(140)	285(375)	503(466)	3050(3947)	6381(7820)	5.2e4(5e4)	∞ *1e5*	0/15
grid100 ho	104(60)	287(155)	615(672)	3016(3947)	1.2e4(1e4)	∞	∞ *1e5*	0/15
grid16 hol	135(201)	322(189)	894(1367)	2723(3304)	8706(1e4)	5.3e4(6e4)	∞ *1e5*	0/15
hill hol	78(71)	163(160)	635(977)	5329(5921)	1.7e4(2e4)	∞	∞ *1e5*	0/15
lmmCMA aug	3.0(2)	4.9(2)	4.6(0.8)	4.8(0.5)	4.9(0.5)	4.9(0.5)	5.3(0.7)	15/15
memPSODE v	32(63)	64(56)	65(30)	68(25)	67(24)	62(22)	61(22)	15/15
prcga saw	15(6)	18(8)	25(16)	37(46)	54(58)	92(141)	109(137)	15/15
ring100 ho	104(82)	347(531)	976(877)	2324(1974)	5913(7020)	2.4e4(3e4)	∞ *1e5*	0/15
ring16 hol	60(63)	273(422)	1030(1056)	4195(4989)	2.6e4(3e4)	∞	∞ *1e5*	0/15
simplex pa	3.6(0.7)	4.6(2)	4.6(1)	5.1(0.7)	5.3(0.8)	5.4(0.6)	5.8(0.6)	15/15

Table 4: 02-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	15	271	445	446	450	454	464	15/15
BIPOP-aCMA	**2.2**(1)	**0.81**(1)	**0.82**(0.9)	**0.86**(0.9)	**0.94**(1.0)	**1.0**(1.0)	**1.1**(1)	15/15
BIPOP-saAC	6.5(11)	**2.8**(3)	4.7(5)	6.1(6)	6.3(6)	6.3(6)	6.9(6)	15/15
CMAES hut	4.3(4)	3.5(4)	3.3(4)	6.9(7)	6.8(8)	∞	∞ *206*	0/15
DE pal	3.7(3)	**0.98**(0.2)	**0.81**(0.3)	**0.96**(0.3)	**1.1**(0.3)	**1.4**(0.3)	**1.6**(0.3)	15/15
HCMA los	**2.3**(1)	**0.63**(0.2)	**0.94**(0.2)	**0.97**(0.1)	**1.00**(0.2)	**1.1**(0.2)	**1.1**(0.2)	15/15
HMLSL pal	6.0(5)	**1.1**(0.9)	**1.7**(1.0)	**1.9**(1)	**2.0**(1)	**2.1**(2)	**2.1**(2)	15/15
IPOP-10DDr	3.1(2)	**2.9**(4)	5.0(6)	5.2(6)	5.4(6)	5.5(6)	5.6(6)	15/15
IPOP-500 l	3.1(2)	**2.9**(4)	4.9(5)	5.0(5)	5.2(5)	5.4(5)	5.6(5)	15/15
IPOP-tany	**2.9**(3)	3.0(3)	5.2(7)	6.6(8)	7.4(9)	7.6(9)	7.6(9)	15/15
IPOP-texp	4.1(4)	4.2(4)	5.9(8)	6.2(8)	6.3(8)	6.6(8)	6.7(8)	15/15
IPOP lia	3.1(2)	**2.9**(4)	4.9(5)	5.0(5)	5.2(5)	5.4(5)	5.6(5)	15/15
MLSL pal	6.3(5)	**1.4**(2)	4.7(5)	4.7(5)	4.6(5)	4.6(5)	4.5(5)	15/15
OQNLP pal	12(8)	**1.9**(1)	**2.1**(2)	**2.2**(2)	**2.2**(2)	**2.2**(2)	**2.1**(2)	15/15
P-DCN tra	13(4)	123(197)	283(409)	282(407)	280(404)	279(400)	277(390)	15/15
P-zero tra	26(13)	180(292)	419(337)	418(336)	415(333)	414(327)	434(293)	15/15
SMAC hut	3.1(3)	**2.5**(3)	3.3(4)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	4.6(4)	3.3(3)	3.1(3)	4.3(4)	7.3(5)	244(752)	1063(2160)	13/15
U-zero tra	4.6(3)	3.7(3)	7.5(8)	13(9)	73(90)	778(1061)	1.2e4(1e4)	5/15
fmincon pa	5.9(5)	**1.3**(2)	6.9(8)	6.9(8)	6.9(7)	6.8(7)	6.7(7)	15/15
fminunc pa	5.1(5)	**2.3**(1)	5.5(7)	5.5(7)	5.5(7)	5.4(7)	5.3(7)	15/15
ga100 hol	5.8(6)	4.9(2)	8.9(8)	26(19)	51(35)	1588(1718)	∞ *1e5*	0/15
grid100 ho	10(11)	10(9)	19(18)	51(39)	221(173)	∞	∞ *1e5*	0/15
grid16 hol	6.0(6)	3.4(3)	5.4(4)	18(15)	53(65)	540(590)	∞ *1e5*	0/15
hill hol	**2.3**(2)	**1.3**(0.9)	**2.7**(2)	8.5(5)	33(28)	447(466)	∞ *1e5*	0/15
lmmCMA aug	**2.7**(0.9)	**1.8**(2)	3.1(3)	3.5(3)	4.1(4)	4.2(4)	4.1(4)	9/15
memPSODE v	5.3(4)	4.7(8)	8.2(8)	8.4(9)	8.4(9)	8.6(9)	8.9(8)	15/15
prcga saw	3.2(4)	5.4(11)	7.5(12)	8.0(12)	8.6(12)	9.3(12)	10(12)	15/15
ring100 ho	12(12)	6.4(3)	10(6)	19(15)	50(28)	260(213)	∞ *1e5*	0/15
ring16 hol	6.5(7)	**2.5**(1)	4.7(6)	17(17)	34(27)	310(306)	∞ *1e5*	0/15
simplex pa	14(7)	**3.0**(2)	8.9(7)	8.9(7)	8.8(7)	8.8(7)	8.6(7)	15/15

Table 5: 02-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	22	344	459	496	523	544	566	15/15
BIPOP-aCMA	**1.8**(1)	**1.8**(3)	11(37)	14(34)	22(32)	21(31)	21(30)	15/15
BIPOP-saAC	**2.7**(2)	7.8(9)	26(24)	38(41)	75(80)	108(184)	105(178)	15/15
CMAES hut	**2.2**(2)	8.8(10)	6.6(8)	∞	∞	∞	∞ *206*	0/15
DE pal	3.2(3)	**0.92**(0.5)	7.2(0.6)	**6.8**(0.5)	**6.6**(0.5)	**6.6**(0.4)	**6.6**(0.4)	14/15
HCMA los	**2.0**(1)	**1.4**(3)	**4.5**(11)	11(10)	11(10)	11(9)	11(8)	15/15
HMLSL pal	4.7(4)	**1.2**(0.6)	**5.5**(1)	**5.2**(2)	**5.0**(2)	**4.9**(2)	**4.7**(2)	15/15
IPOP-10DDr	10(16)	13(15)	91(144)	99(131)	94(125)	91(120)	88(115)	15/15
IPOP-500 l	10(16)	8.3(8)	32(30)	76(50)	77(49)	83(52)	82(51)	15/15
IPOP-tany	4.3(3)	7.6(9)	112(129)	138(155)	137(147)	132(142)	127(136)	15/15
IPOP-texp	**1.0**(1)	11(16)	113(139)	193(150)	195(131)	192(107)	184(103)	15/15
IPOP lia	10(16)	8.3(8)	33(30)	78(57)	80(56)	101(63)	101(63)	15/15
MLSL pal	4.9(5)	**1.6**(1)	13(15)	12(14)	11(13)	11(12)	10(12)	14/15
OQNLP pal	8.7(6)	6.2(7)	11(10)	10(9)	10(9)	10(9)	**9.2**(9)	6/15
P-DCN tra	5.4(4)	208(300)	517(417)	479(387)	455(367)	438(354)	425(338)	15/15
P-zero tra	**2.5**(1)	141(386)	552(39)	511(36)	485(35)	471(34)	516(87)	15/15
SMAC hut	**2.5**(3)	8.4(10)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	3.7(2)	**2.4**(2)	**3.1**(3)	**4.6**(3)	**8.9**(8)	64(54)	542(462)	14/15
U-zero tra	3.3(2)	3.0(3)	7.6(4)	19(17)	61(80)	693(848)	1.6e4(2e4)	3/15
fmincon pa	4.6(4)	**2.4**(4)	9.4(9)	**8.8**(8)	**8.3**(8)	**8.0**(7)	**7.7**(7)	14/15
fminunc pa	3.6(3)	**2.8**(3)	10(13)	10(12)	9.2(12)	**8.9**(11)	**8.5**(11)	15/15
ga100 hol	6.9(6)	4.6(2)	8.7(8)	24(14)	100(72)	908(920)	∞ *1e5*	0/15
grid100 ho	14(12)	12(9)	20(9)	43(36)	162(132)	∞	∞ *1e5*	0/15
grid16 hol	6.0(5)	**2.7**(1)	6.7(5)	23(25)	45(27)	2753(3035)	∞ *1e5*	0/15
hill hol	**1.7**(2)	**1.4**(1)	**3.8**(3)	12(11)	24(17)	440(501)	∞ *1e5*	0/15
lmmCMA aug	**2.2**(2)	4.3(5)	51(57)	47(55)	45(49)	43(50)	41(48)	1/15
memPSODE v	3.6(2)	**2.6**(4)	8.6(8)	**8.2**(8)	**8.0**(8)	**7.9**(7)	11(7)	15/15
prcga saw	**2.9**(2)	4.0(5)	10(14)	16(18)	20(16)	24(24)	26(23)	15/15
ring100 ho	12(10)	6.9(3)	12(6)	30(22)	62(36)	1345(1471)	∞ *1e5*	0/15
ring16 hol	5.3(5)	3.2(2)	**4.6**(4)	14(11)	42(33)	1329(1380)	∞ *1e5*	0/15
simplex pa	11(5)	**3.0**(2)	13(12)	12(11)	11(11)	11(10)	10(10)	15/15

Table 6: 02-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	3.7	4.4	4.4	4.4	4.4	4.4	4.4	15/15
BIPOP-aCMA	**1.1**(0.3)	**1.4**(0)	**1.4**(0)	**1.4**(0)	**1.4**(0)	**1.4**(0)	**1.4**(0)	15/15
BIPOP-saAC	3.5(2)	5.0(2)	5.3(2)	5.5(2)	5.5(2)	5.5(2)	5.5(2)	15/15
CMAES hut	3.5(2)	5.2(3)	5.5(3)	5.5(3)	5.5(3)	5.5(3)	5.5(3)	15/15
DE pal	4.3(3)	29(15)	68(14)	109(24)	154(18)	225(25)	316(21)	15/15
HCMA los	**1.1**(0.3)	**1.5**(0.2)	**1.5**(0.2)	**1.5**(0.2)	**1.5**(0.2)	**1.5**(0.2)	**1.5**(0.2)	15/15
HMLSL pal	**1.1**(0)	**2.5**(0)	**3.2**(0)	3.9(0)	3.9(0)	4.5(0)	5.2(0)	15/15
IPOP-10DDr	**1.8**(0.1)	3.6(0.5)	3.8(0.5)	**3.8**(0.5)	**3.8**(0.5)	**3.8**(0.5)	**3.8**(0.5)	15/15
IPOP-500 l	**1.8**(0.1)	3.6(0.5)	3.8(0.5)	**3.8**(0.5)	**3.8**(0.5)	**3.8**(0.5)	**3.8**(0.5)	15/15
IPOP-tany	**2.1**(0.3)	5.8(3)	8.6(6)	8.6(6)	8.6(6)	8.6(6)	8.6(6)	15/15
IPOP-texp	5.7(1.0)	42(28)	43(27)	43(27)	43(27)	43(27)	43(27)	15/15
IPOP lia	**1.8**(0.1)	3.6(0.5)	3.8(0.5)	**3.8**(0.5)	**3.8**(0.5)	**3.8**(0.5)	**3.8**(0.5)	15/15
MLSL pal	**1.1**(0)	**2.5**(0)	**3.2**(0)	3.9(0)	3.9(0)	4.5(0)	5.2(0)	15/15
OQNLP pal	4.1(0)	4.1(0)	4.1(0)	4.1(0)	4.1(0)	4.1(0)	4.1(0)	15/15
P-DCN tra	**2.4**(1)	81(63)	112(66)	122(71)	131(65)	163(77)	198(64)	15/15
P-zero tra	3.0(3)	50(44)	67(49)	74(51)	81(47)	96(45)	109(44)	15/15
SMAC hut	**1.0**(0.1)	**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	**2.4**(1)	95(70)	536(988)	1487(2542)	2089(2626)	4.9e5(5e5)	3.2e6(3e6)	2/15
U-zero tra	**1.9**(0.5)	47(25)	884(424)	1.2e4(1870)	1.4e5(7e4)	∞	∞ *2e6*	0/15
fmincon pa	**1.1**(0)	**2.5**(0)	**3.2**(0)	3.9(0)	3.9(0)	4.5(0)	5.2(0)	15/15
fminunc pa	**1.9**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	**3.0**(0)	15/15
ga100 hol	5.1(5)	43(27)	55(30)	59(26)	59(30)	59(30)	59(30)	15/15
grid100 ho	5.4(5)	65(42)	85(76)	85(76)	85(76)	85(76)	85(76)	15/15
grid16 hol	4.1(5)	28(15)	34(23)	35(23)	35(23)	35(23)	35(23)	15/15
hill hol	3.5(4)	6.4(4)	7.2(5)	7.2(5)	7.2(5)	7.2(5)	7.2(5)	15/15
lmmCMA aug	3.7(2)	5.0(2)	5.1(2)	5.1(2)	5.1(2)	5.1(2)	5.1(2)	15/15
memPSODE v	**2.5**(1)	6.5(4)	8.3(6)	8.4(6)	8.4(6)	8.4(6)	8.4(6)	15/15
prcga saw	113(66)	944(825)	2010(1382)	2904(1314)	4102(1832)	1.1e4(9432)	1.7e5(2e5)	2/15
ring100 ho	6.1(5)	56(42)	78(40)	78(40)	78(40)	78(40)	78(40)	15/15
ring16 hol	5.4(5)	26(13)	33(20)	33(20)	33(20)	33(20)	33(20)	15/15
simplex pa	11(0.1)	36(41)	37(41)	37(41)	37(41)	37(41)	37(41)	15/15

Table 7: 02-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	13	23	41	54	67	95	124	15/15
BIPOP-aCMA	4.2(4)	4.7(3)	4.2(2)	4.3(1)	4.4(1)	4.3(1)	4.3(0.9)	15/15
BIPOP-saAC	**2.7**(3)	4.0(4)	4.0(3)	4.5(4)	4.3(3)	4.3(3)	4.7(2)	15/15
CMAES hut	**2.5**(3)	3.5(2)	4.1(3)	4.5(3)	15(15)	33(33)	∞ *206*	0/15
DE pal	**1.7**(2)	3.5(2)	5.0(3)	7.3(4)	8.5(3)	10(3)	10(4)	15/15
HCMA los	3.1(2)	5.9(3)	4.6(2)	4.7(2)	4.6(1)	4.9(2)	4.8(2)	15/15
HMLSL pal	**1.7**(1.0)	**1.6**(0.6)	**1.3**(0.7)	**1.1**(0.5)	**1.1**(0.4)	**1.2**(0.5)	**1.4**(1)	15/15
IPOP-10DDr	**1.5**(1)	3.8(3)	3.8(2)	3.7(2)	3.8(1)	4.1(1)	4.3(0.9)	15/15
IPOP-500 l	**1.5**(1)	3.8(3)	3.8(2)	3.7(2)	3.8(1)	4.1(1)	4.3(0.9)	15/15
IPOP-tany	**1.6**(2)	**3.0**(2)	**2.9**(0.9)	3.1(0.4)	3.2(0.8)	3.9(0.6)	4.1(0.5)	15/15
IPOP-texp	**2.3**(2)	3.9(3)	3.6(2)	4.1(2)	4.1(2)	4.4(2)	4.8(1)	15/15
IPOP lia	**1.5**(1)	3.8(3)	3.8(2)	3.7(2)	3.8(1)	4.1(1)	4.3(0.9)	15/15
MLSL pal	**1.7**(1.0)	**1.6**(0.6)	**1.3**(0.7)	**1.1**(0.5)	**1.1**(0.4)	**1.2**(0.5)	**1.4**(1)	15/15
OQNLP pal	**2.3**(1)	**2.5**(2)	**1.8**(1)	**1.6**(0.7)	**1.4**(0.6)	**2.3**(2)	3.6(3)	15/15
P-DCN tra	3.9(5)	6.7(6)	5.9(3)	6.6(3)	12(7)	32(18)	205(69)	15/15
P-zero tra	4.4(9)	8.2(7)	6.6(5)	6.7(4)	11(7)	76(57)	2719(2124)	14/15
SMAC hut	**1.3**(1.0)	9.2(9)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**1.5**(2)	6.2(5)	15(17)	98(38)	160(142)	3093(3200)	4.8e4(6e4)	4/15
U-zero tra	**0.98**(0.9)	12(19)	40(69)	153(174)	2582(635)	1.3e4(1e4)	2.3e5(3e5)	1/15
fmincon pa	**1.7**(1.0)	**1.6**(0.6)	**1.3**(0.7)	**1.1**(0.5)	**1.1**(0.5)	**1.1**(0.4)	**1.6**(2)	15/15
fminunc pa	**1.8**(2)	**2.6**(2)	**1.8**(1)	**1.9**(0.8)	**1.8**(0.9)	**2.0**(1)	**1.9**(1)	15/15
ga100 hol	**2.5**(2)	16(15)	40(27)	132(111)	621(392)	7504(8210)	∞ *1e5*	0/15
grid100 ho	3.4(3)	22(23)	78(52)	351(351)	1558(1660)	∞	∞ *1e5*	0/15
grid16 hol	3.6(4)	17(18)	37(26)	155(141)	827(781)	3338(3701)	∞ *1e5*	0/15
hill hol	**1.6**(1)	5.6(4)	11(11)	43(35)	218(311)	2042(2134)	∞ *1e5*	0/15
lmmCMA aug	**2.2**(2)	**2.6**(2)	**2.5**(0.8)	**2.6**(0.8)	**2.7**(1)	**2.7**(0.7)	**2.7**(0.6)	15/15
memPSODE v	3.3(2)	4.1(2)	4.8(3)	5.5(3)	6.0(2)	6.9(2)	10(3)	15/15
prcga saw	**2.3**(2)	26(43)	108(116)	153(214)	157(191)	176(229)	175(185)	15/15
ring100 ho	3.0(4)	13(15)	63(56)	138(92)	612(534)	4967(5339)	∞ *1e5*	0/15
ring16 hol	**2.9**(4)	13(9)	25(15)	86(78)	222(252)	3384(3365)	∞ *1e5*	0/15
simplex pa	4.6(3)	4.4(2)	**2.9**(0.9)	**2.5**(1)	**2.2**(0.7)	**1.9**(0.6)	**1.7**(0.5)	15/15

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Table 8: 02-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	3.2	21	60	193	217	217	241	15/15
BIPOP-aCMA	4.3(4)	3.7(3)	**2.7**(2)	**1.2**(0.8)	**1.2**(0.7)	**1.2**(0.7)	**1.4**(0.6)	15/15
BIPOP-saAC	5.4(3)	4.7(5)	**3.0**(2)	**1.2**(0.9)	**1.5**(0.9)	**1.5**(0.9)	**1.5**(0.9)	15/15
CMAES hut	5.9(6)	4.3(4)	**2.7**(2)	**1.5**(1)	**1.7**(1)	**1.7**(1)	**2.4**(2)	5/15
DE pal	4.6(6)	**3.1**(2)	3.4(2)	**1.5**(0.6)	**1.7**(0.4)	**1.7**(0.4)	**2.0**(0.7)	15/15
HCMA los	**2.8**(1)	3.9(5)	**2.7**(2)	**1.6**(1)	**1.7**(0.9)	**1.7**(0.9)	**1.7**(0.9)	15/15
HMLSL pal	3.9(5)	**3.4**(2)	4.5(3)	**2.8**(2)	3.2(2)	3.2(2)	3.4(1)	15/15
IPOP-10DDr	4.1(4)	7.0(12)	4.1(5)	**1.7**(2)	**1.7**(2)	**1.7**(2)	**1.8**(1)	15/15
IPOP-500 l	4.1(4)	7.0(12)	4.1(5)	**1.7**(2)	**1.7**(2)	**1.7**(2)	**1.8**(1)	15/15
IPOP-tany	3.6(3)	5.9(8)	5.7(6)	**2.1**(2)	**2.0**(2)	**2.0**(2)	**2.0**(2)	15/15
IPOP-texp	3.9(4)	4.0(6)	4.2(3)	**1.6**(1.0)	**1.5**(0.7)	**1.5**(0.7)	**1.7**(0.8)	15/15
IPOP lia	4.1(4)	7.0(12)	4.1(5)	**1.7**(2)	**1.7**(2)	**1.7**(2)	**1.8**(1)	15/15
MLSL pal	4.7(5)	6.5(9)	18(16)	56(60)	135(148)	135(164)	122(132)	7/15
OQNLP pal	6.4(5)	**2.7**(3)	3.4(1)	**1.6**(0.6)	**1.8**(0.5)	**1.8**(0.5)	**2.1**(0.8)	15/15
P-DCN tra	22(30)	1.4e4(5e4)	5119(2e4)	1600(5172)	1429(4617)	1429(4617)	1284(4147)	13/15
P-zero tra	10(17)	1.5e4(5e4)	5254(2e4)	1642(5173)	1466(4620)	1466(4618)	1317(4147)	13/15
SMAC hut	**2.0**(2)	**1.1**(0.8)	**1.1**(0.7)	**2.5**(3)	14(14)	14(14)	∞ *200*	0/15
U-DCN tra	5.6(7)	3.9(3)	40(37)	111(210)	272(272)	272(272)	248(245)	15/15
U-zero tra	5.0(5)	3.8(5)	69(107)	122(90)	193(206)	193(206)	183(191)	15/15
fmincon pa	3.9(5)	5.8(5)	16(18)	57(49)	196(201)	196(195)	177(176)	6/15
fminunc pa	4.9(5)	3.8(4)	28(21)	80(88)	125(141)	125(136)	135(125)	7/15
ga100 hol	**2.4**(2)	4.2(4)	12(10)	15(18)	23(20)	23(20)	39(41)	15/15
grid100 ho	6.4(7)	8.5(12)	19(15)	44(32)	75(120)	75(120)	106(110)	15/15
grid16 hol	4.2(4)	4.7(6)	11(13)	18(11)	46(73)	46(73)	64(110)	15/15
hill hol	6.2(10)	6.9(8)	10(10)	44(74)	71(96)	71(96)	70(96)	15/15
lmmCMA aug	**3.5**(3)	**2.2**(3)	**1.3**(1)	**0.58**(0.6)	**0.60**(0.5)	**0.60**(0.5)	**0.60**(0.5)	15/15
memPSODE v	5.5(8)	16(22)	24(22)	10(8)	11(9)	11(9)	11(9)	15/15
prcga saw	**3.5**(2)	5.5(2)	7.0(8)	3.9(4)	4.6(4)	4.6(4)	5.0(4)	15/15
ring100 ho	4.1(5)	7.3(7)	16(13)	16(12)	33(24)	33(24)	57(47)	15/15
ring16 hol	7.0(9)	4.1(3)	10(12)	19(26)	25(38)	25(38)	27(35)	15/15
simplex pa	5.5(6)	4.0(2)	6.8(8)	7.8(11)	11(13)	11(13)	10(11)	15/15

Table 9: 02-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	5.4	12	37	46	86	94	112	15/15
BIPOP-aCMA	6.1(4)	13(17)	9.2(8)	9.1(6)	5.2(3)	5.7(3)	5.3(2)	15/15
BIPOP-saAC	4.2(4)	9.4(11)	5.5(5)	5.6(4)	3.3(2)	3.4(2)	3.0(2)	15/15
CMAES hut	8.9(5)	9.1(11)	12(11)	15(16)	11(12)	∞	∞ *206*	0/15
DE pal	6.8(6)	12(12)	10(6)	12(7)	9.0(2)	11(2)	12(2)	15/15
HCMA los	**2.0**(0.7)	7.2(8)	7.2(5)	7.6(3)	4.4(2)	4.4(2)	3.8(1)	15/15
HMLSL pal	**2.4**(2)	**4.0**(3)	**1.9**(1)	**1.8**(1)	**1.0**(0.7)	**1.1**(0.5)	**0.95**(0.5)	15/15
IPOP-10DDr	3.1(3)	6.2(6)	9.1(4)	9.4(3)	5.9(1)	6.3(2)	6.0(1)	15/15
IPOP-500 l	3.1(3)	6.2(6)	9.1(4)	9.4(3)	5.9(1)	6.3(2)	6.0(1)	15/15
IPOP-tany	4.9(4)	6.0(5)	8.0(2)	8.8(2)	5.6(0.8)	5.9(0.8)	5.8(0.9)	15/15
IPOP-texp	5.4(3)	**3.5**(2)	6.7(5)	8.8(2)	5.5(0.8)	6.0(0.9)	5.7(0.9)	15/15
IPOP lia	3.1(3)	6.2(6)	9.1(4)	9.4(3)	5.9(1)	6.3(2)	6.0(1)	15/15
MLSL pal	**2.4**(2)	**4.0**(3)	**1.9**(1)	**1.8**(1)	**1.0**(0.7)	**1.1**(0.5)	**0.95**(0.5)	15/15
OQNLP pal	**2.5**(2)	**2.9**(4)	**1.8**(2)	**1.8**(1)	**1.0**(0.7)	**1.1**(0.7)	**1.5**(0.7)	15/15
P-DCN tra	13(11)	41(37)	47(53)	60(69)	45(52)	114(84)	1553(1691)	15/15
P-zero tra	47(66)	114(241)	59(92)	65(89)	46(45)	262(378)	3.7e4(5e4)	5/15
SMAC hut	**2.5**(3)	5.0(6)	25(28)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	9.3(7)	11(9)	37(71)	273(346)	2177(4626)	1.4e5(2e5)	∞ *2e6*	0/15
U-zero tra	5.5(4)	16(20)	148(334)	1474(2116)	5619(7564)	6.8e4(7e4)	∞ *2e6*	0/15
fmincon pa	**2.4**(2)	**4.0**(3)	**1.9**(1)	**1.8**(1)	**1.0**(0.7)	**1.1**(0.5)	**0.95**(0.5)	15/15
fminunc pa	**1.8**(2)	**2.2**(3)	**1.5**(1)	**1.6**(0.9)	**0.94**(0.5)	**0.94**(0.5)	**0.83**(0.4)	15/15
ga100 hol	7.5(8)	17(20)	30(26)	102(85)	325(289)	7563(7979)	∞ *1e5*	0/15
grid100 ho	5.7(5)	27(34)	58(23)	507(725)	1212(1580)	∞	∞ *1e5*	0/15
grid16 hol	10(11)	33(25)	67(81)	450(498)	1157(1435)	∞	∞ *1e5*	0/15
hill hol	9.0(9)	43(85)	44(58)	455(770)	1361(1925)	∞	∞ *1e5*	0/15
lmmCMA aug	**2.5**(2)	**3.8**(3)	**2.6**(1)	**2.7**(1)	**1.6**(0.6)	**1.7**(0.6)	**1.5**(0.5)	15/15
memPSODE v	12(7)	25(24)	22(27)	30(18)	19(9)	18(8)	16(5)	15/15
prcga saw	4.8(5)	5.0(3)	51(148)	111(194)	99(150)	162(147)	193(124)	15/15
ring100 ho	8.3(7)	27(20)	51(41)	175(153)	382(313)	2758(2898)	∞ *1e5*	0/15
ring16 hol	8.4(10)	17(17)	46(39)	196(167)	565(683)	1.5e4(2e4)	∞ *1e5*	0/15
simplex pa	6.3(7)	5.2(5)	**2.9**(2)	**2.8**(1)	**1.6**(0.8)	**1.7**(0.7)	**1.5**(0.6)	15/15

Table 10: 02-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	1	18	30	44	68	81	92	15/15
BIPOP-aCMA	17(18)	7.2(7)	10(7)	9.1(5)	6.7(4)	6.5(3)	6.4(3)	15/15
BIPOP-saAC	25(22)	5.3(4)	7.2(5)	6.8(4)	4.7(2)	4.2(2)	3.9(2)	15/15
CMAES hut	24(34)	7.6(7)	9.5(11)	16(16)	22(23)	∞	∞ *206*	0/15
DE pal	37(31)	7.1(6)	9.1(6)	13(6)	10(4)	12(3)	13(3)	15/15
HCMA los	18(10)	4.5(6)	6.7(5)	5.7(3)	4.2(2)	3.8(2)	3.6(1)	15/15
HMLSL pal	**1**(0)	**0.62**(0)	**0.77**(0)	**0.75**(0)	**0.60**(0.0)	**0.60**(0.0)	**0.61**(0.0)	15/15
IPOP-10DDr	30(17)	6.2(4)	10(9)	10(6)	7.4(4)	7.0(4)	7.0(3)	15/15
IPOP-500 l	30(17)	6.2(4)	10(9)	10(6)	7.4(4)	7.0(4)	7.0(3)	15/15
IPOP-tany	20(18)	5.2(4)	7.9(6)	9.2(2)	6.7(2)	6.6(2)	6.8(1)	15/15
IPOP-texp	14(5)	**2.2**(2)	8.0(5)	8.4(4)	6.3(3)	6.4(2)	6.3(2)	15/15
IPOP lia	30(17)	6.2(4)	10(9)	10(6)	7.4(4)	7.0(4)	7.0(3)	15/15
MLSL pal	**1**(0)	**0.62**(0)	**0.77**(0)	**0.75**(0)	**0.60**(0.0)	**0.60**(0.0)	**0.61**(0.0)	15/15
OQNLP pal	**1**(0)	**0.54**(0.0)	**0.99**(0.0)	**0.89**(0.1)	**0.78**(0.1)	**0.78**(0.0)	**0.74**(0.0)	15/15
P-DCN tra	31(38)	37(89)	79(92)	78(78)	61(71)	188(139)	1681(2599)	15/15
P-zero tra	21(18)	64(109)	84(71)	88(57)	72(38)	581(773)	1.2e4(1e4)	12/15
SMAC hut	**1**(0)	4.2(4)	23(24)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	18(20)	5.7(6)	47(74)	666(945)	3206(3277)	3.2e4(4e4)	3.0e5(4e5)	1/15
U-zero tra	22(26)	16(18)	145(204)	1954(3605)	7613(1e4)	4.3e4(5e4)	∞ *2e6*	0/15
fmincon pa	**1**(0)	**0.62**(0)	**0.77**(0)	**0.75**(0)	**0.60**(0.0)	**0.60**(0.0)	**0.61**(0.0)	15/15
fminunc pa	**1**(0)	**0.39**(0)$^{\star 2}$	**0.93**(0)	**0.96**(0.0)	**0.75**(0.1)	**0.72**(0.0)	**0.68**(0.0)	15/15
ga100 hol	34(30)	10(10)	22(24)	112(190)	545(712)	5448(6189)	∞ *1e5*	0/15
grid100 ho	59(80)	23(22)	86(124)	567(804)	2746(3238)	∞	∞ *1e5*	0/15
grid16 hol	53(50)	15(18)	37(51)	443(936)	3616(4128)	∞	∞ *1e5*	0/15
hill hol	36(30)	15(11)	70(80)	379(472)	1252(1458)	5629(5528)	∞ *1e5*	0/15
lmmCMA aug	**1**(0)	**2.2**(2)	**2.8**(2)	**2.7**(1)	**2.0**(0.8)	**1.8**(0.6)	**1.8**(0.6)	15/15
memPSODE v	54(66)	19(31)	20(27)	26(20)	22(12)	21(9)	19(7)	15/15
prcga saw	30(27)	4.3(3)	62(83)	115(152)	104(120)	142(148)	169(111)	15/15
ring100 ho	30(24)	24(14)	60(55)	134(113)	405(381)	8361(9706)	∞ *1e5*	0/15
ring16 hol	40(26)	10(8)	32(28)	247(251)	1170(1479)	∞	∞ *1e5*	0/15
simplex pa	**1**(0)	**1.4**(0.0)	**2.3**(0.8)	**2.1**(0.3)	**1.6**(0.2)	**1.5**(0.2)	**1.5**(0.1)	15/15

Table 11: 02-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	30	46	54	61	68	82	98	15/15
BIPOP-aCMA	8.0(5)	7.5(3)	7.2(1)	7.1(1)	6.7(1)	6.2(0.7)	**5.8**(0.8)	15/15
BIPOP-saAC	3.8(2)	**3.0**(0.9)	**2.7**(0.6)	**2.5**(0.5)	**2.5**(0.4)	**2.3**(0.3)	**2.2**(0.4)	15/15
CMAES hut	10(11)	12(13)	29(31)	∞	∞	∞	∞ *206*	0/15
DE pal	11(4)	11(4)	11(3)	12(2)	12(3)	14(2)	14(2)	15/15
HCMA los	3.6(2)	3.7(0.8)	3.4(0.6)	3.2(0.5)	3.1(0.6)	**2.9**(0.5)	**2.7**(0.4)	15/15
HMLSL pal	**0.71**(0.2)	**0.52**(0.2)	**0.50**(0.1)	**0.51**(0.1)	**1.2**(2)	11(23)	27(34)	15/15
IPOP-10DDr	12(8)	11(5)	10(4)	10(4)	10(1)	8.7(1)	8.1(0.7)	15/15
IPOP-500 l	12(8)	11(5)	10(4)	10(4)	10(1)	8.7(1)	8.1(0.7)	15/15
IPOP-tany	8.9(8)	8.8(5)	10(0.7)	10(0.6)	9.2(0.9)	8.7(0.8)	8.0(0.5)	15/15
IPOP-texp	9.4(6)	11(0.9)	10(0.9)	9.1(1)	8.6(0.8)	8.0(0.5)	7.6(0.7)	15/15
IPOP lia	12(8)	11(5)	10(4)	10(4)	10(1)	8.7(1)	8.1(0.7)	15/15
MLSL pal	**0.71**(0.2)	**0.52**(0.2)	**0.50**(0.1)	**0.51**(0.1)	**0.99**(1)	**5.5**(5)	91(164)	13/15
OQNLP pal	**1.2**(0.7)	**1.5**(0.7)	**1.4**(0.7)	**2.4**(4)	7.9(10)	17(18)	54(61)	8/15
P-DCN tra	392(597)	679(893)	845(867)	899(670)	1354(1234)	1.7e4(2e4)	1.3e5(2e5)	2/15
P-zero tra	385(880)	961(1114)	1288(1170)	1350(1121)	1522(968)	2.7e4(3e4)	3.1e5(3e5)	1/15
SMAC hut	**1.3**(1)	3.0(2)	53(56)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	164(243)	1295(2252)	5775(9068)	4.7e4(6e4)	2.1e5(2e5)	∞	∞ *2e6*	0/15
U-zero tra	269(456)	1000(1366)	9932(2e4)	3.4e4(5e4)	1.2e5(1e5)	∞	∞ *2e6*	0/15
fmincon pa	**0.71**(0.2)	**0.52**(0.2)	**0.50**(0.1)	**0.51**(0.1)	**1.0**(2)	12(29)	121(183)	12/15
fminunc pa	**1.1**(1.0)	**1.2**(0.8)	**1.3**(0.7)	**1.5**(0.6)	**1.5**(0.3)	6.9(8)	154(176)	12/15
ga100 hol	386(725)	1414(2189)	2914(3622)	2.4e4(3e4)	∞	∞	∞ *1e5*	0/15
grid100 ho	311(511)	2506(2858)	2.6e4(3e4)	∞	∞	∞	∞ *1e5*	0/15
grid16 hol	45(38)	764(1025)	5900(6175)	2.4e4(2e4)	∞	∞	∞ *1e5*	0/15
hill hol	265(433)	691(1093)	4692(4653)	2.4e4(3e4)	∞	∞	∞ *1e5*	0/15
lmmCMA aug	**2.4**(1)	**1.9**(0.9)	**1.9**(0.6)	**1.9**(0.3)	**1.8**(0.3)	**1.7**(0.2)	**1.6**(0.2)	15/15
memPSODE v	22(35)	31(22)	29(15)	27(13)	25(11)	25(15)	29(15)	15/15
prcga saw	88(128)	661(1041)	873(1038)	1354(1435)	1654(1560)	3186(3250)	5880(6327)	3/15
ring100 ho	58(71)	209(273)	1705(1758)	4110(4202)	∞	∞	∞ *1e5*	0/15
ring16 hol	63(61)	269(360)	2871(3027)	7576(8366)	∞	∞	∞ *1e5*	0/15
simplex pa	**2.4**(2)	**2.3**(1)	**2.2**(0.6)	**2.1**(0.6)	**2.0**(0.4)	**1.9**(0.3)	**1.7**(0.3)	15/15

Table 12: 02-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	35	45	50	62	67	81	97	15/15
BIPOP-aCMA	6.4(4)	7.6(1)	7.6(1)	6.7(0.8)	6.6(0.8)	6.1(0.7)	**5.8**(0.6)	15/15
BIPOP-saAC	**2.8**(1)	**2.8**(1.0)	**3.0**(0.5)	**2.6**(0.6)	**2.5**(0.6)	**2.4**(0.4)	**2.2**(0.4)	15/15
CMAES hut	5.2(4)	22(23)	20(20)	∞	∞	∞	∞ *206*	0/15
DE pal	8.8(5)	10(3)	10(3)	11(4)	12(2)	14(1)	14(1)	15/15
HCMA los	**2.6**(2)	3.6(0.7)	3.7(0.9)	3.2(0.6)	3.1(0.6)	**2.9**(0.5)	**2.6**(0.5)	15/15
HMLSL pal	**0.62**(0.4)$_{\downarrow 2}$	**0.57**(0.3)	**0.58**(0.2)	**0.54**(0.2)	**0.60**(0.3)	11(10)	16(14)	15/15
IPOP-10DDr	8.0(6)	12(1)	12(0.9)	10(0.6)	10(0.7)	9.2(0.5)	8.3(0.4)	15/15
IPOP-500 l	8.0(6)	12(1)	12(0.9)	10(0.6)	10(0.7)	9.2(0.5)	8.3(0.4)	15/15
IPOP-tany	5.6(7)	10(5)	12(1)	10(0.9)	10(1)	8.9(0.4)	8.3(0.6)	15/15
IPOP-texp	8.0(6)	11(1)	12(1)	10(0.9)	10(1)	9.0(1)	8.2(0.8)	15/15
IPOP lia	8.0(6)	12(1)	12(0.9)	10(0.6)	10(0.7)	9.2(0.5)	8.3(0.4)	15/15
MLSL pal	**0.62**(0.4)$_{\downarrow 2}$	**0.57**(0.3)	**0.58**(0.2)	**0.54**(0.2)	**0.60**(0.3)	8.7(6)	64(149)	13/15
OQNLP pal	**1.2**(0.5)	**1.7**(1)	**2.8**(4)	5.6(5)	10(8)	18(15)	51(54)	9/15
P-DCN tra	158(240)	410(450)	572(506)	571(497)	1142(1012)	1.3e4(2e4)	8.8e4(9e4)	3/15
P-zero tra	173(508)	680(829)	1092(899)	1171(895)	1688(1243)	1.5e4(2e4)	1.5e5(2e5)	2/15
SMAC hut	**1.4**(1)	4.7(4)	59(61)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	21(17)	709(1148)	9577(8664)	4.5e4(5e4)	2.0e5(2e5)	∞	∞ *2e6*	0/15
U-zero tra	104(132)	675(384)	1.1e4(2e4)	4.2e4(5e4)	4.2e5(5e5)	∞	∞ *2e6*	0/15
fmincon pa	**0.62**(0.4)$_{\downarrow 2}$	**0.57**(0.3)	**0.58**(0.2)	**0.54**(0.2)	**0.60**(0.3)	3.9(3)	73(97)	14/15
fminunc pa	**0.79**(0.6)	**1.4**(0.8)	**1.6**(0.3)	**1.4**(0.4)	**1.7**(0.4)	**3.8**(4)	61(142)	13/15
ga100 hol	28(18)	2325(2978)	8852(8947)	2.4e4(3e4)	∞	∞	∞ *1e5*	0/15
grid100 ho	86(127)	1227(1514)	6056(7582)	1.1e4(1e4)	∞	∞	∞ *1e5*	0/15
grid16 hol	96(123)	807(996)	5355(5160)	2.4e4(3e4)	∞	∞	∞ *1e5*	0/15
hill hol	124(200)	478(622)	2239(2511)	1.2e4(1e4)	∞	∞	∞ *1e5*	0/15
lmmCMA aug	**2.0**(1.0)	**2.0**(1.0)	**2.2**(0.4)	**1.9**(0.3)	**1.8**(0.3)	**1.7**(0.3)	**1.6**(0.2)	15/15
memPSODE v	21(29)	38(24)	36(16)	30(13)	27(12)	28(10)	31(6)	15/15
prcga saw	42(86)	330(682)	672(793)	1316(1623)	2407(2601)	4205(4027)	6040(6379)	3/15
ring100 ho	37(25)	197(216)	1166(1225)	5410(5721)	2.2e4(2e4)	∞	∞ *1e5*	0/15
ring16 hol	47(46)	557(580)	4785(5052)	7104(8160)	1.0e4(1e4)	∞	∞ *1e5*	0/15
simplex pa	**1.9**(0.9)	**2.5**(0.7)	**2.5**(0.2)	**2.1**(0.2)	**2.1**(0.2)	**1.9**(0.1)	**1.7**(0.1)	15/15

Table 13: 02-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	35	46	75	94	105	153	195	15/15
BIPOP-aCMA	5.3(5)	8.7(3)	6.4(1)	5.6(1)	5.5(1)	4.5(1)	**4.0**(1)	15/15
BIPOP-saAC	4.7(2)	5.3(3)	3.8(3)	4.3(4)	4.5(5)	4.0(4)	**4.9**(5)	15/15
CMAES hut	12(13)	21(23)	20(23)	32(34)	∞	∞	∞ *206*	0/15
DE pal	7.4(5)	15(12)	14(10)	16(10)	16(10)	16(12)	16(12)	15/15
HCMA los	3.4(3)	5.6(5)	5.8(6)	5.1(5)	5.1(4)	4.6(6)	**4.3**(7)	15/15
HMLSL pal	**0.83**(0.4)	**1.0**(0.9)	**1.00**(1)	**0.96**(2)	**0.98**(2)	**2.8**(2)	16(20)	15/15
IPOP-10DDr	9.1(7)	14(17)	14(12)	14(12)	13(12)	11(12)	10(11)	15/15
IPOP-500 l	9.1(7)	14(17)	14(12)	14(12)	13(12)	11(12)	10(11)	15/15
IPOP-tany	9.3(6)	10(5)	8.1(3)	8.2(4)	8.0(4)	6.8(6)	6.1(7)	15/15
IPOP-texp	6.8(6)	10(6)	9.4(8)	10(11)	10(10)	8.0(8)	7.5(7)	15/15
IPOP lia	9.1(7)	14(17)	14(12)	14(12)	13(12)	11(12)	10(11)	15/15
MLSL pal	**0.83**(0.4)	**1.0**(0.9)	**1.00**(1)	**0.96**(2)	**0.98**(2)	**2.5**(2)	17(26)	14/15
OQNLP pal	**1.6**(1)	**2.5**(3)	**3.0**(4)	3.9(3)	8.1(9)	22(35)	47(58)	6/15
P-DCN tra	73(166)	209(368)	206(258)	317(259)	480(707)	6391(7733)	2.9e4(4e4)	4/15
P-zero tra	62(130)	295(320)	433(289)	528(424)	715(579)	6538(6653)	7.0e4(7e4)	2/15
SMAC hut	3.3(2)	6.8(7)	39(42)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	40(33)	438(798)	1065(851)	1.2e4(2e4)	1.9e4(3e4)	8.5e4(1e5)	1.4e5(2e5)	1/15
U-zero tra	72(103)	965(1441)	6632(1e4)	1.0e4(1e4)	2.3e4(3e4)	1.9e5(2e5)	∞ *2e6*	0/15
fmincon pa	**0.83**(0.4)	**1.0**(0.9)	**1.00**(1)	**0.96**(2)	**0.98**(2)	**1.4**(2)	12(7)	14/15
fminunc pa	**1.1**(0.9)	**1.6**(3)	**1.7**(2)	**1.7**(2)	**1.6**(2)	**1.9**(2)	41(78)	12/15
ga100 hol	29(24)	379(493)	864(1331)	1487(1727)	2142(2418)	∞	∞ *1e5*	0/15
grid100 ho	88(57)	792(1007)	1312(1547)	2650(3012)	4540(4551)	∞	∞ *1e5*	0/15
grid16 hol	108(194)	528(578)	1194(1563)	7191(7701)	1.4e4(1e4)	∞	∞ *1e5*	0/15
hill hol	79(100)	409(525)	1692(1991)	2678(2961)	6774(7629)	∞	∞ *1e5*	0/15
lmmCMA aug	**1.9**(1)	3.6(4)	3.5(3)	3.4(3)	3.5(3)	3.2(3)	**2.9**(2)	14/15
memPSODE v	21(30)	30(22)	21(12)	17(10)	16(8)	13(4)	13(8)	15/15
prcga saw	31(72)	274(441)	513(665)	727(837)	686(757)	498(620)	520(574)	8/15
ring100 ho	50(37)	177(398)	512(525)	1473(2105)	6710(7152)	∞	∞ *1e5*	0/15
ring16 hol	38(45)	218(196)	1391(1826)	4400(5288)	1.3e4(2e4)	∞	∞ *1e5*	0/15
simplex pa	**2.4**(0.9)	**3.0**(2)	**2.3**(2)	**2.1**(2)	**2.0**(2)	**1.6**(1)	**1.4**(1)	15/15

Table 14: 02-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	23	35	46	60	71	95	122	15/15
BIPOP-aCMA	3.9(2)	5.9(3)	5.8(2)	5.6(1)	5.5(0.7)	**6.0**(1.0)	**5.7**(0.9)	15/15
BIPOP-saAC	3.3(2)	3.2(0.9)	3.2(0.8)	**2.9**(0.8)	**2.9**(0.8)	**2.7**(0.6)	**2.7**(1.0)	15/15
CMAES hut	3.2(2)	5.4(4)	8.7(7)	51(53)	∞	∞	∞ *206*	0/15
DE pal	4.9(2)	8.0(3)	10(4)	11(2)	13(3)	14(4)	15(2)	15/15
HCMA los	**2.9**(3)	3.7(0.9)	3.6(1)	3.2(0.8)	3.3(0.7)	**3.2**(0.7)	**3.0**(0.5)	15/15
HMLSL pal	**0.77**(0.3)	**0.72**(0.3)	**0.74**(0.2)	**0.73**(0.1)	**0.76**(0.2)	29(24)	43(5)	15/15
IPOP-10DDr	4.3(7)	7.5(7)	10(5)	8.5(4)	9.3(1.0)	8.5(0.7)	9.1(2)	15/15
IPOP-500 l	4.3(7)	7.5(7)	10(5)	8.5(4)	9.3(1.0)	8.5(0.7)	9.1(2)	15/15
IPOP-tany	5.9(8)	11(6)	10(4)	9.3(2)	9.0(1)	8.3(0.7)	9.1(1)	15/15
IPOP-texp	7.4(10)	8.9(6)	9.1(5)	8.4(3)	8.9(2)	8.3(1.0)	7.9(2)	15/15
IPOP lia	4.3(7)	7.5(7)	10(5)	8.5(4)	9.3(1.0)	8.5(0.6)	9.1(2)	15/15
MLSL pal	**0.77**(0.3)	**0.72**(0.3)	**0.74**(0.2)	**0.73**(0.1)	**0.76**(0.2)	380(486)	∞ *2e4*	0/15
OQNLP pal	**1.2**(0.6)	**1.0**(0.5)	**0.94**(0.3)	**1.3**(0.4)	**2.3**(2)	10(11)	385(413)	1/15
P-DCN tra	21(30)	80(103)	158(182)	285(232)	954(1080)	5.9e4(7e4)	∞ *2e6*	0/15
P-zero tra	37(102)	144(242)	219(263)	544(592)	2876(3173)	∞	∞ *2e6*	0/15
SMAC hut	**1.6**(1)	6.3(6)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	10(10)	321(488)	8219(1e4)	4.4e4(5e4)	8.8e4(1e5)	∞	∞ *2e6*	0/15
U-zero tra	11(11)	454(1067)	7804(1e4)	2.0e4(2e4)	2.0e5(2e5)	∞	∞ *2e6*	0/15
fmincon pa	**0.77**(0.3)	**0.72**(0.3)	**0.74**(0.2)	**0.73**(0.1)	**0.76**(0.2)	181(255)	∞ *2e4*	0/15
fminunc pa	5.2(5)	12(14)	127(235)	382(548)	726(801)	∞	∞ *2e4*	0/15
ga100 hol	11(12)	86(122)	825(1170)	2754(3017)	2.1e4(2e4)	∞	∞ *1e5*	0/15
grid100 ho	24(21)	156(185)	3630(3768)	2.4e4(3e4)	∞	∞	∞ *1e5*	0/15
grid16 hol	15(25)	157(198)	1177(1384)	1.1e4(1e4)	∞	∞	∞ *1e5*	0/15
hill hol	13(18)	150(282)	1972(2158)	1.2e4(1e4)	∞	∞	∞ *1e5*	0/15
lmmCMA aug	**2.0**(2)	**3.1**(2)	**3.2**(2)	**2.9**(0.9)	**2.9**(0.7)	**2.9**(0.5)	**2.8**(0.5)	15/15
memPSODE v	12(19)	26(28)	25(20)	21(11)	19(10)	15(7)	102(16)	15/15
prcga saw	33(63)	149(173)	720(1231)	827(1086)	2084(2265)	1.7e4(2e4)	∞ *1e5*	0/15
ring100 ho	15(17)	92(96)	408(196)	2871(2829)	∞	∞	∞ *1e5*	0/15
ring16 hol	10(8)	176(154)	1488(1616)	5442(6217)	∞	∞	∞ *1e5*	0/15
simplex pa	4.1(2)	3.9(2)	3.5(1.0)	**3.0**(0.8)	**2.7**(0.7)	**2.2**(0.5)	**2.0**(0.5)	15/15

Table 15: 02-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	1.4	7.4	16	24	38	67	90	15/15
BIPOP-aCMA	**2.3**(2)	4.8(6)	5.1(2)	5.6(3)	6.0(2)	5.7(0.8)	**6.3**(1)	15/15
BIPOP-saAC	**2.6**(3)	3.4(4)	3.7(2)	3.8(1)	3.2(0.6)	**2.9**(0.4)	**2.9**(0.2)	15/15
CMAES hut	**1.3**(1)	**2.5**(3)	3.5(2)	4.5(2)	12(11)	45(50)	∞ *206*	0/15
DE pal	**1.7**(1)	3.7(3)	6.9(3)	7.6(2)	8.5(2)	10(3)	13(2)	15/15
HCMA los	**2.3**(2)	3.0(5)	3.1(3)	4.9(3)	4.3(3)	3.6(0.8)	**3.3**(0.5)	15/15
HMLSL pal	**1.9**(2)	**1.1**(0.8)	**1.0**(0.5)	**1**(0.4)	**0.94**(0.3)	**1.1**(0.2)	21(20)	15/15
IPOP-10DDr	**1.1**(0.7)	**1.9**(2)	3.5(2)	4.3(0.9)	5.0(2)	7.4(0.7)	8.1(0.7)	15/15
IPOP-500 l	**1.1**(0.7)	**1.9**(2)	3.5(2)	4.3(0.9)	5.0(2)	7.4(0.7)	8.1(0.7)	15/15
IPOP-tany	**1.7**(2)	**2.0**(2)	3.3(1)	4.2(0.8)	6.0(2)	7.5(0.8)	7.8(0.9)	15/15
IPOP-texp	**2.9**(6)	**2.5**(2)	**2.7**(2)	4.0(2)	5.5(3)	7.7(0.9)	7.8(0.7)	15/15
IPOP lia	**1.1**(0.7)	**1.9**(2)	3.5(2)	4.3(0.9)	5.0(2)	7.4(0.7)	8.1(0.7)	15/15
MLSL pal	**1.9**(2)	**1.1**(0.8)	**1.0**(0.5)	**1**(0.4)	**0.94**(0.3)	**1.1**(0.2)	382(470)	6/15
OQNLP pal	3.4(4)	**2.1**(2)	**1.6**(0.8)	**1.4**(0.6)	**1.2**(0.3)	**2.0**(3)	11(11)	14/15
P-DCN tra	**1.4**(1)	6.2(7)	7.7(5)	10(6)	12(6)	740(963)	3.0e4(3e4)	7/15
P-zero tra	**1.4**(1)	5.8(9)	6.4(5)	6.6(4)	11(8)	900(1216)	3.2e4(4e4)	7/15
SMAC hut	**0.76**(0)	**1.8**(1)	**2.7**(1)	4.4(1)	12(11)	∞	∞ *200*	0/15
U-DCN tra	**1.4**(1)	3.0(3)	10(9)	85(181)	2049(4115)	8.8e4(1e5)	∞ *2e6*	0/15
U-zero tra	**1.4**(1)	**2.4**(2)	11(10)	234(433)	4595(6891)	2.1e5(2e5)	∞ *2e6*	0/15
fmincon pa	**1.9**(2)	**1.1**(0.8)	**1.0**(0.5)	**1**(0.4)	**0.94**(0.3)	**1.1**(0.2)	473(591)	5/15
fminunc pa	**1.6**(1)	**1.7**(2)	**1.5**(1)	**1.4**(1.0)	**1.2**(0.6)	**1.0**(0.4)	241(332)	9/15
ga100 hol	**2.1**(2)	**2.3**(2)	30(18)	56(31)	162(210)	2.2e4(2e4)	∞ *1e5*	0/15
grid100 ho	**1.2**(0.4)	3.2(2)	33(40)	72(79)	1028(1386)	∞	∞ *1e5*	0/15
grid16 hol	**1.3**(0.7)	4.5(8)	14(12)	40(25)	1098(1368)	∞	∞ *1e5*	0/15
hill hol	3.8(4)	**2.5**(2)	3.8(4)	46(71)	699(1337)	∞	∞ *1e5*	0/15
lmmCMA aug	**0.95**(0)	**1.8**(2)	**1.9**(0.6)	**2.1**(0.6)	**2.1**(0.5)	**2.1**(0.3)	**2.3**(0.4)	15/15
memPSODE v	**2.4**(2)	3.5(3)	5.4(2)	6.6(4)	11(10)	11(6)	17(14)	15/15
prcga saw	**1.5**(1)	**2.3**(2)	5.9(4)	13(3)	25(36)	198(148)	1046(1261)	10/15
ring100 ho	**1.4**(0.7)	4.2(4)	33(25)	87(50)	295(247)	∞	∞ *1e5*	0/15
ring16 hol	**2.0**(1)	3.3(4)	12(7)	27(20)	947(1385)	2.1e4(2e4)	∞ *1e5*	0/15
simplex pa	8.2(11)	7.9(6)	4.7(2)	4.0(1)	**2.9**(0.5)	**2.0**(0.3)	**1.8**(0.2)	15/15

Table 16: 02-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	37	291	1033	1066	1113	1231	1412	5/5
BIPOP-aCMA	**1.4**(2)	**2.6**(2)	**2.3**(3)	**2.9**(3)	3.3(5)	3.1(4)	**2.8**(4)	15/15
BIPOP-saAC	**1.1**(0.7)	**1.3**(1)	**2.3**(4)	**2.3**(4)	**2.3**(4)	**2.1**(3)	**1.9**(3)	15/15
CMAES hut	**0.98**(0.8)	**2.5**(2)	**2.9**(3)	∞	∞	∞	∞ *206*	0/15
DE pal	**1.6**(1)	**2.2**(1)	6.8(19)	6.8(19)	6.7(18)	6.2(16)	5.5(14)	13/15
HCMA los	**1.1**(0.8)	**1.7**(1)	**1.7**(2)	**1.7**(2)	**1.7**(2)	**1.6**(2)	**1.4**(1)	15/15
HMLSL pal	3.0(2)	**1.4**(1.0)	5.2(10)	5.1(10)	4.9(9)	4.4(8)	3.9(7)	14/15
IPOP-10DDr	**1.1**(0.7)	**2.8**(3)	3.2(4)	3.4(3)	3.3(3)	3.1(3)	**2.8**(3)	15/15
IPOP-500 l	**1.1**(0.7)	**2.7**(3)	**2.8**(4)	3.2(3)	3.1(3)	**2.9**(3)	**2.7**(3)	15/15
IPOP-tany	**0.91**(0.6)	**2.9**(3)	**2.6**(1)	**2.7**(1)	**2.7**(1)	**2.5**(1.0)	**2.3**(0.8)	15/15
IPOP-texp	**1.1**(0.9)	3.6(4)	4.0(5)	4.6(6)	4.5(6)	4.2(6)	3.7(5)	15/15
IPOP lia	**1.1**(0.7)	**2.7**(3)	**2.8**(4)	3.2(3)	3.1(3)	**2.9**(3)	**2.7**(3)	15/15
MLSL pal	**2.6**(2)	**1.7**(2)	**2.0**(3)	**1.9**(3)	**1.8**(3)	**1.7**(2)	**1.4**(2)	15/15
OQNLP pal	4.6(4)	**1.3**(1)	**0.91**(0.4)	**0.89**(0.4)	**0.86**(0.3)	**0.79**(0.3)	**0.91**(0.9)	14/15
P-DCN tra	5.7(13)	1278(3435)	1787(2909)	1733(2814)	1660(2696)	1503(2437)	1317(2126)	8/15
P-zero tra	4.9(6)	827(2222)	3453(4110)	3348(4097)	3209(4472)	2913(3566)	2569(2834)	6/15
SMAC hut	**1.4**(1)	**1.9**(2)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**2.0**(3)	24(30)	71(117)	72(113)	85(108)	479(570)	5864(7084)	3/15
U-zero tra	**1.3**(1)	69(115)	43(48)	54(51)	100(53)	546(835)	1.0e4(1e4)	2/15
fmincon pa	3.3(2)	**1.6**(1)	**1.2**(1)	**1.2**(1)	**1.1**(1)	**1.0**(0.9)	**0.91**(0.8)	15/15
fminunc pa	**3.0**(2)	**1.5**(1)	**2.8**(3)	**2.8**(3)	**2.6**(3)	**2.4**(3)	**2.1**(2)	15/15
ga100 hol	**2.7**(3)	9.3(12)	9.0(10)	48(53)	182(181)	∞	∞ *1e5*	0/15
grid100 ho	**2.7**(4)	18(16)	42(49)	166(190)	607(718)	∞	∞ *1e5*	0/15
grid16 hol	4.7(5)	13(22)	24(26)	42(52)	95(104)	1218(1279)	∞ *1e5*	0/15
hill hol	**2.6**(2)	42(43)	19(20)	27(23)	67(64)	595(650)	∞ *1e5*	0/15
lmmCMA aug	**0.74**(0.5)	**1.2**(1)	**0.72**(0.7)	**0.82**(0.9)	**0.80**(0.8)	**0.74**(0.8)	**0.71**(0.8)	12/15
memPSODE v	**1.6**(1)	4.8(5)	6.6(5)	6.4(5)	6.4(5)	5.9(4)	6.3(9)	15/15
prcga saw	**1.3**(1)	**2.8**(5)	8.7(9)	8.9(9)	8.9(8)	9.2(11)	9.0(9)	15/15
ring100 ho	3.1(5)	11(12)	9.0(4)	38(21)	116(105)	1215(1218)	∞ *1e5*	0/15
ring16 hol	3.1(2)	25(46)	15(23)	31(38)	67(75)	1192(1320)	∞ *1e5*	0/15
simplex pa	4.8(3)	3.5(3)	4.3(4)	4.2(4)	4.0(4)	3.7(4)	3.2(3)	15/15

Table 17: 02-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	9.1	50	174	326	358	409	538	15/15
BIPOP-aCMA	**2.8**(3)	4.5(10)	**3.9**(6)	**2.5**(4)	**2.6**(4)	**2.5**(3)	**2.1**(2)	15/15
BIPOP-saAC	3.1(2)	**2.7**(2)	**1.6**(2)	**1.2**(1)	**1.2**(1.0)	**1.6**(1)	**1.5**(1)	15/15
CMAES hut	4.1(5)	3.1(3)	**2.2**(2)	4.6(5)	4.3(5)	∞	∞ *206*	0/15
DE pal	**2.5**(4)	5.8(9)	5.1(5)	5.2(4)	6.0(3)	6.0(3)	5.0(2)	15/15
HCMA los	**2.9**(2)	7.3(10)	4.6(4)	**2.9**(2)	**2.9**(2)	**2.9**(2)	**2.5**(2)	15/15
HMLSL pal	8.0(7)	5.7(7)	5.4(6)	10(9)	31(34)	34(31)	29(23)	14/15
IPOP-10DDr	**2.4**(2)	3.1(2)	6.2(9)	4.7(5)	4.4(4)	4.1(4)	3.3(3)	15/15
IPOP-500 l	**2.4**(2)	3.1(2)	6.2(9)	4.7(5)	4.4(4)	4.1(4)	3.3(3)	15/15
IPOP-tany	**1.7**(2)	**2.8**(2)	3.9(3)	**2.4**(2)	**2.3**(2)	**2.3**(1)	**2.1**(2)	15/15
IPOP-texp	**2.3**(2)	6.6(10)	**3.4**(4)	**2.9**(3)	**2.9**(3)	**2.8**(3)	**2.3**(2)	15/15
IPOP lia	**2.4**(2)	3.1(2)	6.2(9)	4.7(5)	4.4(4)	4.1(4)	3.3(3)	15/15
MLSL pal	9.1(10)	10(10)	7.0(10)	18(19)	109(128)	847(1005)	∞ *2e4*	0/15
OQNLP pal	16(14)	12(9)	10(10)	13(12)	37(39)	∞	∞ *3744*	0/15
P-DCN tra	4.1(3)	2861(13)	1766(5734)	944(3064)	1401(2798)	1274(2471)	2561(3506)	10/15
P-zero tra	3.3(3)	4601(1e4)	1789(5734)	957(3064)	877(2797)	1047(2458)	8260(1e4)	5/15
SMAC hut	**1.8**(3)	**1.9**(2)	3.9(4)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**2.6**(3)	3.4(3)	9.2(16)	28(51)	407(708)	1.4e4(2e4)	1.5e4(2e4)	3/15
U-zero tra	**2.4**(4)	4.2(6)	19(18)	123(108)	876(1401)	8863(1e4)	∞ *2e6*	0/15
fmincon pa	9.0(8)	7.3(9)	9.5(12)	15(12)	113(123)	422(445)	∞ *2e4*	0/15
fminunc pa	13(10)	12(17)	20(14)	35(22)	112(113)	∞	∞ *2e4*	0/15
ga100 hol	**2.3**(2)	4.4(6)	11(7)	146(199)	605(704)	3474(4154)	∞ *1e5*	0/15
grid100 ho	**2.6**(4)	**2.3**(3)	25(28)	244(299)	631(721)	3557(3666)	∞ *1e5*	0/15
grid16 hol	**2.9**(4)	11(4)	29(26)	97(157)	455(559)	∞	∞ *1e5*	0/15
hill hol	**2.8**(3)	10(18)	29(43)	76(90)	331(370)	∞	∞ *1e5*	0/15
lmmCMA aug	**2.4**(2)	**2.4**(4)	**1.9**(3)	**1.5**(2)	**1.5**(2)	**1.4**(1)	**1.1**(1)	14/15
memPSODE v	3.8(3)	10(11)	8.8(6)	6.9(4)	6.4(3)	11(15)	11(15)	15/15
prcga saw	3.7(5)	8.7(3)	10(11)	10(8)	22(41)	28(35)	25(41)	15/15
ring100 ho	3.7(5)	7.9(9)	21(20)	47(46)	147(172)	1058(1190)	∞ *1e5*	0/15
ring16 hol	**2.6**(2)	5.2(4)	15(16)	73(154)	322(418)	815(855)	2749(3069)	1/15
simplex pa	15(4)	5.8(3)	4.0(6)	**2.8**(4)	**2.8**(4)	3.0(4)	**2.6**(4)	15/15

Table 18: 02-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	2.7	61	133	275	396	1086	1657	5/5
BIPOP-aCMA	3.8(2)	**2.0**(2)	**1.6**(0.8)	**1.2**(1.0)	**1.5**(1)	**1.3**(0.5)	**1.0**(0.1)	15/15
BIPOP-saAC	10(8)	**1.7**(1)	**1.5**(0.8)	**1.2**(0.7)	**1.6**(1)	**1.7**(1)	**2.0**(2)	15/15
CMAES hut	3.2(5)	**0.79**(0.5)	**1.1**(0.5)	**1.8**(1)	∞	∞	∞ *206*	0/15
DE pal	**2.9**(3)	**1.6**(0.8)	**2.3**(0.8)	**1.7**(0.5)	**2.2**(0.4)	**1.4**(0.3)	**1.2**(0.2)	15/15
HCMA los	**2.4**(2)	3.0(4)	**2.4**(2)	**2.3**(2)	**2.3**(2)	**2.9**(1)	**2.7**(2)	15/15
HMLSL pal	12(17)	17(30)	19(13)	15(7)	13(7)	9.4(4)	7.0(3)	14/15
IPOP-10DDr	**2.4**(2)	5.0(7)	3.3(3)	**1.9**(2)	**1.8**(1)	**1.2**(0.5)	**0.95**(0.4)	15/15
IPOP-500 l	**2.4**(2)	5.0(7)	3.3(3)	**1.9**(2)	**1.8**(1)	**1.2**(0.5)	**0.95**(0.4)	15/15
IPOP-tany	3.0(4)	**0.70**(0.4)	**2.5**(3)	**1.7**(2)	**1.6**(1)	**1.4**(0.2)	**1.1**(0.5)	15/15
IPOP-texp	29(70)	3.7(5)	6.0(6)	3.2(3)	**2.9**(2)	**1.7**(1)	**1.3**(0.7)	15/15
IPOP lia	**2.4**(2)	5.0(7)	3.3(3)	**1.9**(2)	**1.8**(1)	**1.2**(0.5)	**0.95**(0.4)	15/15
MLSL pal	12(16)	58(57)	68(76)	307(323)	1200(1274)	∞	∞ *3e4*	0/15
OQNLP pal	25(27)	3.6(0.9)	7.0(4)	10(4)	71(78)	53(56)	∞ *3936*	0/15
P-DCN tra	7.0(6)	9.1(14)	5.4(6)	4.2(3)	18(20)	2321(3114)	1534(2038)	7/15
P-zero tra	**2.6**(2)	27(62)	15(29)	10(14)	43(76)	6169(6448)	∞ *2e6*	0/15
SMAC hut	**1.5**(0.9)	**1.8**(2)	22(23)	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**2.9**(3)	3.3(4)	36(87)	2895(4103)	3142(5059)	∞	∞ *2e6*	0/15
U-zero tra	**2.6**(3)	3.3(3)	15(18)	1163(2882)	3259(3782)	∞	∞ *2e6*	0/15
fmincon pa	12(17)	32(40)	89(64)	410(451)	∞	∞	∞ *3e4*	0/15
fminunc pa	5.3(5)	4.8(6)	26(32)	235(256)	755(833)	∞	∞ *2e4*	0/15
ga100 hol	**1.7**(2)	3.2(3)	14(9)	254(325)	3681(3790)	∞	∞ *1e5*	0/15
grid100 ho	**1.9**(2)	5.1(4)	50(60)	435(455)	1788(1919)	∞	∞ *1e5*	0/15
grid16 hol	**1.9**(2)	3.8(4)	18(30)	194(203)	1792(1769)	∞	∞ *1e5*	0/15
hill hol	4.1(8)	**1.9**(1)	15(26)	122(134)	659(666)	∞	∞ *1e5*	0/15
lmmCMA aug	**2.6**(2)	**0.88**(0.5)	**1.1**(1)	**0.83**(0.5)	**0.78**(0.4)	**1.7**(2)	**1.3**(1)	8/15
memPSODE v	**2.4**(2)	**2.4**(2)	5.7(12)	7.5(7)	7.1(8)	8.1(4)	6.4(6)	15/15
prcga saw	**1.6**(2)	**0.96**(1.0)	4.1(5)	11(17)	10(20)	7.9(10)	6.0(7)	15/15
ring100 ho	**3.0**(3)	4.9(5)	26(16)	77(47)	1175(1206)	∞	∞ *1e5*	0/15
ring16 hol	**2.5**(3)	**2.1**(2)	15(14)	115(148)	514(505)	∞	∞ *1e5*	0/15
simplex pa	18(18)	4.1(3)	13(10)	48(77)	50(63)	285(313)	186(192)	1/15

Table 19: 02-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	19	134	666	1249	1708	2438	2858	15/15
BIPOP-aCMA	**1.9**(2)	**3.3**(3)	**1.5**(2)	**1.2**(0.9)	**0.99**(0.6)	**1.1**(0.7)	**1.3**(1)	15/15
BIPOP-saAC	4.4(1)	4.6(4)	**1.6**(2)	**1.0**(1)	**1.0**(0.8)	**1.2**(0.6)	**1.2**(0.7)	15/15
CMAES hut	**1.4**(1)	**1.5**(1)	**1.5**(2)	∞	∞	∞	∞ *206*	0/15
DE pal	**1.9**(2)	**1.9**(1)	5.2(0.3)	3.2(0.2)	**2.6**(0.2)	**2.2**(0.2)	**2.2**(0.2)	14/15
HCMA los	**1.5**(1)	**3.1**(2)	**1.3**(1)	**1.2**(0.9)	**1.2**(0.9)	**1.8**(2)	**2.0**(1)	15/15
HMLSL pal	15(17)	29(37)	10(6)	7.2(6)	6.1(5)	8.2(9)	7.7(7)	13/15
IPOP-10DDr	**1.4**(1)	7.1(8)	3.3(1)	**1.9**(0.7)	**1.6**(0.5)	**1.3**(0.4)	**1.4**(0.7)	15/15
IPOP-500 l	**1.4**(1)	7.1(8)	3.1(1)	**1.8**(0.7)	**1.5**(0.5)	**1.3**(0.4)	**1.4**(0.5)	15/15
IPOP-tany	**1.7**(1)	6.7(8)	**2.9**(2)	**1.8**(1)	**1.5**(0.8)	**1.3**(0.7)	**1.3**(0.6)	15/15
IPOP-texp	7.8(19)	8.8(7)	**2.7**(1)	**1.9**(2)	**1.5**(2)	**1.4**(1)	**1.6**(1)	15/15
IPOP lia	**1.4**(1)	7.1(8)	3.1(1)	**1.8**(0.7)	**1.5**(0.5)	**1.3**(0.4)	**1.4**(0.5)	15/15
MLSL pal	16(23)	35(42)	53(51)	214(226)	∞	∞	∞ *4e4*	0/15
OQNLP pal	7.9(6)	4.0(3)	3.2(3)	22(25)	∞	∞	∞ *4065*	0/15
P-DCN tra	6.5(9)	228(134)	49(30)	32(16)	131(249)	3540(4354)	1.0e4(1e4)	1/15
P-zero tra	4.1(6)	2074(3989)	421(804)	250(447)	769(889)	∞	∞ *2e6*	0/15
SMAC hut	**1.2**(1)	3.7(4)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**2.3**(2)	24(13)	252(274)	3493(4071)	7798(8784)	∞	∞ *2e6*	0/15
U-zero tra	**2.8**(3)	29(25)	204(253)	7007(8013)	∞	∞	∞ *2e6*	0/15
fmincon pa	22(9)	33(34)	48(54)	406(455)	∞	∞	∞ *4e4*	0/15
fminunc pa	4.2(3)	13(9)	22(24)	∞	∞	∞	∞ *2e4*	0/15
ga100 hol	**2.1**(3)	8.7(9)	71(82)	250(282)	872(937)	∞	∞ *1e5*	0/15
grid100 ho	**2.9**(5)	17(19)	118(131)	569(640)	855(908)	∞	∞ *1e5*	0/15
grid16 hol	**2.2**(4)	16(24)	84(95)	∞	∞	∞	∞ *1e5*	0/15
hill hol	**2.2**(2)	17(24)	59(81)	1135(1201)	∞	∞	∞ *1e5*	0/15
lmmCMA aug	**1.8**(0.8)	**2.6**(4)	**1.1**(1.0)	**0.80**(0.7)	**0.87**(0.7)	**1.1**(0.8)	**0.97**(0.6)	8/15
memPSODE v	4.5(2)	18(19)	8.1(5)	6.8(3)	6.6(2)	6.3(3)	7.6(5)	15/15
prcga saw	**1.7**(1)	14(25)	7.6(8)	15(15)	19(23)	33(35)	31(28)	7/15
ring100 ho	4.1(6)	11(12)	31(22)	204(208)	∞	∞	∞ *1e5*	0/15
ring16 hol	**3.0**(3)	8.0(13)	96(149)	345(399)	∞	∞	∞ *1e5*	0/15
simplex pa	7.2(3)	4.7(2)	6.4(6)	34(36)	25(30)	65(69)	55(60)	2/15

Table 20: 02-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	26	216	227	252	276	15/15
BIPOP-aCMA	5.8(5)	26(22)	8.9(11)	18(27)	22(27)	31(30)	29(28)	15/15
BIPOP-saAC	4.1(4)	21(20)	4.6(8)	13(18)	16(21)	17(19)	15(17)	15/15
CMAES hut	4.3(4)	53(94)	11(13)	14(15)	13(15)	∞	∞ *206*	0/15
DE pal	5.5(5)	47(48)	8.4(7)	71(95)	70(92)	67(85)	62(77)	11/15
HCMA los	5.5(3)	45(42)	10(13)	17(24)	22(22)	22(20)	21(18)	15/15
HMLSL pal	**1**(0)	**1**(0)	**0.64**(0)	**0.15**(0)	**0.18**(0)	**0.23**(0)	**0.28**(0.0)	15/15
IPOP-10DDr	4.1(4)	24(26)	13(31)	15(25)	16(24)	26(26)	24(24)	15/15
IPOP-500 l	4.1(4)	24(26)	13(31)	16(21)	17(19)	18(26)	17(27)	15/15
IPOP-tany	**2.8**(2)	19(15)	28(26)	26(35)	30(41)	28(36)	26(33)	15/15
IPOP-texp	3.6(4)	15(13)	21(25)	12(12)	15(18)	15(16)	14(15)	15/15
IPOP lia	4.1(4)	24(26)	13(31)	16(21)	17(19)	18(26)	17(27)	15/15
MLSL pal	**1**(0)	**1**(0)	**0.64**(0)	**0.15**(0)	**0.18**(0)	**0.23**(0)	**0.28**(0.0)	15/15
OQNLP pal	**1**(0)	**1**(0)	**0.45**(0)	8.7(9)	**8.3**(8)	**7.5**(7)	**7.0**(7)	13/15
P-DCN tra	4.5(2)	42(28)	11(10)	6.0e4(7e4)	5.7e4(7e4)	5.2e4(6e4)	4.7e4(6e4)	2/15
P-zero tra	4.5(2)	27(29)	10(17)	1.3e5(1e5)	1.2e5(1e5)	1.1e5(1e5)	1.0e5(1e5)	1/15
SMAC hut	**1**(0)	**1**(0)	6.5(6)	**6.5**(7)	∞	∞	∞ *200*	0/15
U-DCN tra	4.6(2)	33(39)	12(14)	53(69)	156(196)	559(766)	1.0e4(1e4)	7/15
U-zero tra	4.5(2)	36(42)	11(12)	117(134)	213(238)	2212(2740)	1.0e5(1e5)	1/15
fmincon pa	**1**(0)	**1**(0)	**0.64**(0)	**0.15**(0)	**0.18**(0)	**0.23**(0)	**0.28**(0.0)	15/15
fminunc pa	**1**(0)	**1**(0)	**0.55**(0.1)	8.9(10)	8.6(10)	7.8(9)	7.2(8)	15/15
ga100 hol	6.5(8)	40(38)	15(13)	20(15)	56(58)	357(380)	∞ *1e5*	0/15
grid100 ho	3.9(4)	67(129)	22(21)	22(17)	49(95)	580(668)	5174(5443)	1/15
grid16 hol	3.7(5)	42(38)	10(12)	24(53)	61(54)	360(394)	5133(5624)	1/15
hill hol	12(10)	36(18)	10(8)	32(40)	50(66)	387(411)	1720(1847)	3/15
lmmCMA aug	**1**(0)	**1**(0)	5.1(10)	**6.1**(7)	**6.7**(7)	**6.9**(8)	**7.2**(8)	8/15
memPSODE v	7.6(5)	40(33)	14(11)	47(106)	46(101)	50(90)	49(81)	15/15
prcga saw	3.2(4)	30(34)	**2.9**(3)	11(14)	13(19)	23(22)	37(33)	15/15
ring100 ho	4.1(4)	28(38)	18(21)	19(18)	38(40)	439(503)	1180(1423)	4/15
ring16 hol	6.7(6)	51(36)	12(11)	20(24)	33(36)	427(477)	1647(1690)	3/15
simplex pa	**1**(0)	**1**(0)	**0.33**(0.0)*	9.2(9)	8.8(9)	8.1(8)	7.4(7)	15/15

Table 21: 02-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	3.7	61	365	366	366	370	375	15/15
BIPOP-aCMA	4.2(4)	11(24)	10(10)	10(11)	12(10)	12(10)	12(10)	15/15
BIPOP-saAC	**2.3**(3)	6.1(5)	5.5(6)	6.2(6)	8.0(10)	8.0(10)	7.9(9)	15/15
CMAES hut	**2.2**(3)	**4.6**(4)	3.9(4)	4.0(5)	4.1(4)	8.3(9)	∞ *206*	0/15
DE pal	**2.9**(3)	51(4)	74(110)	75(110)	75(109)	75(108)	74(107)	9/15
HCMA los	**1.7**(1)	6.1(4)	8.9(8)	10(8)	12(24)	12(24)	13(23)	15/15
HMLSL pal	**2.1**(0)	**5.5**(3)	**1.7**(2)	**2.0**(2)	**2.0**(2)	**2.0**(2)	**2.0**(2)	15/15
IPOP-10DDr	3.1(3)	17(46)	21(15)	21(15)	21(14)	21(14)	21(14)	15/15
IPOP-500 l	3.1(3)	13(30)	14(6)	15(6)	20(8)	22(9)	22(9)	15/15
IPOP-tany	**1.2**(1)	19(28)	15(14)	16(14)	16(14)	17(14)	17(14)	15/15
IPOP-texp	**2.4**(2)	20(29)	11(15)	18(33)	23(33)	23(33)	23(32)	15/15
IPOP lia	3.1(3)	13(30)	14(6)	15(6)	20(8)	22(9)	22(9)	15/15
MLSL pal	**2.1**(0)	6.5(3)	**2.8**(3)	**2.8**(3)	**2.8**(3)	**2.8**(3)	**2.8**(3)	15/15
OQNLP pal	3.5(0)	12(8)	4.0(2)	4.0(2)	4.0(2)	4.0(2)	**4.0**(2)	15/15
P-DCN tra	4.6(5)	2.0e4(3e4)	6884(9191)	6858(8444)	6859(8274)	6784(8239)	6703(8131)	7/15
P-zero tra	5.0(5)	5.0e4(7e4)	8245(1e4)	8214(1e4)	8214(1e4)	8136(1e4)	8106(1e4)	6/15
SMAC hut	**1.1**(0.8)	**2.8**(3)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**1.9**(1)	5.9(6)	3.6(3)	5.8(7)	13(14)	44(70)	1085(901)	15/15
U-zero tra	**2.7**(3)	13(21)	14(16)	23(34)	44(20)	282(111)	1.2e4(1e4)	5/15
fmincon pa	**2.1**(0)	**4.7**(3)	**2.5**(3)	**2.5**(3)	**2.5**(3)	**2.5**(3)	**2.5**(2)	15/15
fminunc pa	**1.9**(0)	7.8(7)	**2.7**(2)	**2.7**(2)	**2.7**(2)	**2.7**(2)	**2.7**(2)	15/15
ga100 hol	**2.1**(2)	8.2(6)	5.5(3)	14(11)	63(46)	1252(1364)	∞ *1e5*	0/15
grid100 ho	**2.9**(2)	19(17)	37(68)	161(181)	565(546)	∞	∞ *1e5*	0/15
grid16 hol	**2.1**(2)	7.3(5)	34(48)	81(137)	105(141)	950(975)	∞ *1e5*	0/15
hill hol	5.4(6)	6.3(6)	33(55)	37(57)	55(69)	309(315)	3954(4131)	1/15
lmmCMA aug	**2.0**(2)	14(17)	14(16)	15(15)	15(16)	15(15)	15(16)	4/15
memPSODE v	3.9(2)	8.6(15)	**2.8**(3)	**2.9**(3)	**3.1**(3)	**3.3**(3)	4.7(4)	15/15
prcga saw	**1.8**(2)	17(16)	23(39)	24(39)	25(39)	28(42)	31(39)	15/15
ring100 ho	**2.1**(2)	16(11)	7.6(7)	21(18)	67(26)	463(413)	∞ *1e5*	0/15
ring16 hol	4.3(5)	**5.3**(4)	3.7(2)	8.2(6)	26(21)	245(230)	3991(4264)	1/15
simplex pa	8.9(0.1)	14(11)	4.7(5)	4.7(5)	4.8(5)	4.7(5)	4.7(4)	15/15

Table 22: 02-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	1.7	51	174	276	290	324	330	15/15
BIPOP-aCMA	**1.5**(0.9)	4.8(6)	6.4(11)	4.1(7)	6.3(7)	5.8(7)	5.9(6)	15/15
BIPOP-saAC	**1.5**(2)	7.7(11)	5.1(8)	3.5(5)	3.4(5)	3.2(4)	3.2(4)	15/15
CMAES hut	**1.2**(1)	**2.0**(3)	**0.99**(1)	**1.4**(2)	**1.4**(1)	**2.1**(2)	**2.9**(3)	3/15
DE pal	**2.0**(2)	**1.6**(2)	58(115)	37(73)	36(69)	32(62)	32(61)	12/15
HCMA los	**2.1**(2)	3.7(4)	5.8(9)	3.8(6)	6.1(10)	7.4(10)	7.4(9)	15/15
HMLSL pal	**2.3**(3)	**2.2**(3)	**1.4**(2)	**0.94**(1.0)	**1.0**(0.9)	**0.97**(0.8)	**1.0**(0.8)	15/15
IPOP-10DDr	**2.6**(2)	7.3(8)	12(16)	13(17)	14(15)	17(15)	16(14)	15/15
IPOP-500 l	**2.6**(2)	7.3(7)	13(25)	13(18)	41(58)	126(176)	557(632)	14/15
IPOP-tany	**2.2**(2)	10(11)	10(11)	12(16)	13(18)	12(16)	12(16)	15/15
IPOP-texp	**2.7**(2)	15(30)	18(25)	12(16)	11(15)	10(13)	10(13)	15/15
IPOP lia	**2.6**(2)	7.3(8)	13(25)	13(18)	74(99)	126(371)	570(524)	14/15
MLSL pal	**2.3**(3)	**1.4**(1)	**1.0**(1)	**0.68**(0.9)	**0.69**(0.9)	**0.68**(0.8)	**0.75**(0.8)	15/15
OQNLP pal	4.4(6)	**2.0**(2)	**0.96**(0.8)	**0.70**(0.5)	**0.76**(0.5)	**0.74**(0.5)	**0.85**(0.7)	15/15
P-DCN tra	**1.4**(1)	3.5e4(4e4)	1.3e4(2e4)	8282(1e4)	7882(1e4)	7064(9271)	6925(9088)	7/15
P-zero tra	**1.4**(1)	4.5e4(6e4)	1.3e4(2e4)	8360(1e4)	7956(1e4)	7131(9271)	6990(9088)	7/15
SMAC hut	**0.92**(0.9)	**1.2**(0.9)	**0.48**(0.4)	**0.49**(0.4)	**0.79**(0.7)	8.9(10)	∞ *200*	0/15
U-DCN tra	**1.4**(1)	**0.56**(0.5)	**0.49**(0.6)	**1.4**(2)	**2.6**(4)	12(16)	35(39)	15/15
U-zero tra	**1.4**(1)	**0.73**(2)	**1.5**(2)	3.6(5)	8.3(9)	24(24)	132(199)	15/15
fmincon pa	**2.3**(3)	**1.4**(2)	**0.78**(0.7)	**0.60**(0.5)	**0.59**(0.4)	**0.58**(0.3)	**0.65**(0.4)	15/15
fminunc pa	**3.0**(3)	**1.4**(0.8)	**0.62**(0.3)	**0.44**(0.2)	**0.53**(0.2)	**0.54**(0.2)	**0.59**(0.2)	15/15
ga100 hol	**1**(0.6)	**1.8**(3)	**1.6**(2)	**2.0**(2)	3.5(4)	14(11)	32(20)	15/15
grid100 ho	**1.1**(0.9)	**1.2**(1)	**1.9**(2)	4.4(5)	7.1(6)	46(54)	173(205)	12/15
grid16 hol	**1.1**(0.6)	**1.4**(1)	13(15)	10(21)	14(33)	38(54)	90(119)	14/15
hill hol	**1.7**(2)	11(15)	97(288)	62(182)	59(174)	60(155)	107(156)	13/15
lmmCMA aug	**1**(0.9)	**1.5**(2)	**2.7**(5)	**1.8**(3)	**1.7**(3)	**1.8**(3)	**1.8**(3)	12/15
memPSODE v	**1.9**(2)	**1.7**(2)	**1.8**(3)	**1.3**(2)	**1.4**(2)	**1.4**(1)	**2.1**(3)	15/15
prcga saw	**1.6**(1)	7.0(3)	9.0(12)	6.0(7)	6.5(7)	7.1(12)	9.3(13)	15/15
ring100 ho	**1.8**(0.9)	**1.3**(1)	**1.7**(2)	**2.2**(3)	3.9(4)	15(12)	80(62)	14/15
ring16 hol	**1.1**(0.9)	3.1(5)	**1.8**(2)	**2.1**(2)	3.2(4)	14(17)	55(79)	15/15
simplex pa	15(22)	3.3(2)	**1.3**(0.8)	**0.84**(0.5)	**0.82**(0.5)	**0.77**(0.4)	**0.78**(0.4)	15/15

Table 23: 02-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	5.1	27	168	218	249	289	306	15/15
BIPOP-aCMA	**2.2**(2)	5.8(10)	4.3(4)	3.5(3)	3.3(3)	3.3(2)	3.3(2)	15/15
BIPOP-saAC	**1.9**(3)	9.2(22)	5.9(9)	5.6(7)	5.4(6)	5.5(5)	5.2(5)	15/15
CMAES hut	**1.5**(2)	7.9(11)	3.6(4)	14(14)	12(13)	10(11)	10(11)	1/15
DE pal	**1.3**(2)	3.7(4)	18(2)	14(1)	13(1)	12(1)	12(1)	14/15
HCMA los	**2.2**(2)	4.4(6)	3.5(5)	3.2(4)	3.3(3)	3.0(3)	**2.9**(2)	15/15
HMLSL pal	**2.9**(1)	3.8(3)	**1.2**(0.8)	**1.00**(0.6)	**0.92**(0.5)	**0.91**(0.5)	**0.93**(0.4)	15/15
IPOP-10DDr	**1.2**(0.9)	11(13)	10(12)	23(14)	22(13)	33(93)	31(88)	15/15
IPOP-500 l	**1.2**(0.9)	11(13)	8.5(10)	10(14)	13(15)	402(83)	493(78)	14/15
IPOP-tany	**1.4**(2)	3.2(8)	5.9(7)	9.1(21)	36(22)	33(19)	32(18)	15/15
IPOP-texp	**2.3**(3)	21(33)	11(16)	9.2(13)	10(16)	8.9(14)	9.0(13)	15/15
IPOP lia	**1.2**(0.9)	11(13)	8.5(10)	10(14)	13(15)	265(701)	1022(3273)	13/15
MLSL pal	**2.8**(1)	**2.8**(3)	**0.96**(0.8)	**0.81**(0.6)	**0.76**(0.5)	**0.73**(0.5)	**0.78**(0.5)	15/15
OQNLP pal	3.4(2)	4.3(4)	**1.4**(0.8)	**1.2**(0.5)	**1.1**(0.4)	**1.0**(0.3)	**1.3**(0.5)	15/15
P-DCN tra	**2.0**(2)	1.2e4(4e4)	1.1e4(2e4)	8122(9431)	7099(1e4)	6122(7106)	5794(6723)	8/15
P-zero tra	**1.9**(1)	1.4e4(4e4)	1.1e4(2e4)	8629(1e4)	7543(1e4)	6505(1e4)	6154(8225)	8/15
SMAC hut	**1.5**(2)	**1.1**(1)	**0.91**(1.0)	**0.91**(0.7)	**1.3**(1)	10(12)	∞ *200*	0/15
U-DCN tra	**1.2**(2)	3.1(3)	**1.3**(2)	**2.3**(2)	8.1(11)	29(33)	272(228)	15/15
U-zero tra	**1.1**(2)	3.8(5)	**2.4**(2)	5.3(6)	13(22)	61(100)	696(1498)	15/15
fmincon pa	**2.9**(1)	3.8(3)	**0.87**(0.7)	**0.71**(0.5)	**0.67**(0.4)	**0.66**(0.4)	**0.71**(0.3)	15/15
fminunc pa	**2.3**(0.9)	**2.9**(3)	**0.88**(0.7)	**0.76**(0.5)	**0.77**(0.4)	**0.74**(0.3)	**0.77**(0.4)	15/15
ga100 hol	**1.3**(2)	3.1(4)	**2.3**(3)	7.6(8)	15(11)	74(126)	178(211)	12/15
grid100 ho	**0.91**(0.6)	**2.3**(2)	**2.8**(3)	8.8(13)	21(22)	77(68)	394(379)	9/15
grid16 hol	**1.1**(0.9)	3.7(4)	**2.0**(2)	4.5(5)	10(15)	33(41)	282(344)	10/15
hill hol	**1.6**(2)	273(11)	45(3)	36(3)	35(14)	66(73)	350(491)	8/15
lmmCMA aug	**1.5**(1)	3.8(5)	**2.5**(4)	3.3(4)	3.1(4)	**3.0**(4)	**2.9**(4)	12/15
memPSODE v	**1.8**(2)	**2.8**(2)	**2.3**(3)	**2.9**(3)	**2.9**(3)	5.2(6)	10(9)	15/15
prcga saw	**0.88**(1)	**1.9**(2)	4.3(8)	13(14)	20(16)	27(27)	41(73)	15/15
ring100 ho	**1.1**(0.9)	**2.9**(4)	**2.4**(3)	4.3(4)	8.4(7)	43(30)	105(69)	14/15
ring16 hol	**1.4**(0.8)	5.5(9)	3.3(3)	4.5(4)	6.9(5)	41(41)	281(319)	10/15
simplex pa	12(13)	7.0(4)	**1.5**(0.7)	**1.2**(0.5)	**1.1**(0.4)	**1.00**(0.4)	**0.98**(0.3)	15/15

Table 24: 02-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	7.8	193	234	263	299	348	379	15/15
BIPOP-aCMA	**1.8**(2)	7.1(9)	13(12)	20(17)	18(15)	17(13)	16(12)	15/15
BIPOP-saAC	**2.0**(2)	5.7(11)	11(11)	11(11)	11(10)	12(12)	12(17)	15/15
CMAES hut	**2.0**(2)	15(17)	∞	∞	∞	∞	∞ *206*	0/15
DE pal	**2.3**(2)	3.8(3)	11(4)	14(4)	15(3)	16(4)	16(4)	15/15
HCMA los	**2.4**(2)	7.0(6)	14(8)	13(7)	11(6)	**10**(5)	**10**(5)	15/15
HMLSL pal	4.6(8)	**1.7**(1)	**2.2**(1)	**2.2**(2)	**2.2**(1)	35(25)	49(11)	15/15
IPOP-10DDr	**1.8**(2)	6.7(11)	14(20)	13(18)	12(16)	**11**(14)	**10**(13)	15/15
IPOP-500 l	**1.8**(2)	6.7(11)	14(20)	13(18)	12(16)	**11**(14)	**10**(13)	15/15
IPOP-tany	**2.4**(2)	6.7(11)	13(15)	12(14)	11(12)	**10**(10)	11(13)	15/15
IPOP-texp	**2.1**(1)	5.2(6)	18(23)	17(21)	15(18)	14(16)	14(15)	15/15
IPOP lia	**1.8**(2)	6.7(11)	14(20)	13(18)	12(16)	**11**(14)	**10**(13)	15/15
MLSL pal	4.5(8)	**1.5**(1)	**1.9**(1)	**2.4**(1)	**2.6**(2)	90(111)	∞ *3e4*	0/15
OQNLP pal	9.1(11)	**2.7**(1)	5.1(5)	12(12)	87(94)	∞	∞ *6297*	0/15
P-DCN tra	**1.7**(2)	4.1(3)	53(51)	3385(3902)	7026(1e4)	7811(9529)	3.6e4(4e4)	2/15
P-zero tra	**1.1**(0.8)	6.9(11)	312(426)	5469(7612)	2.2e4(2e4)	∞	∞ *2e6*	0/15
SMAC hut	**2.0**(2)	15(16)	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**1.7**(2)	10(8)	920(1506)	2.4e4(3e4)	∞	∞	∞ *2e6*	0/15
U-zero tra	**1.7**(2)	13(22)	2383(2383)	3.4e4(4e4)	∞	∞	∞ *2e6*	0/15
fmincon pa	4.5(9)	**2.0**(3)	**3.3**(4)	**3.6**(4)	**4.0**(3)	85(116)	∞ *3e4*	0/15
fminunc pa	5.2(8)	3.9(5)	38(55)	287(328)	570(662)	∞	∞ *2e4*	0/15
ga100 hol	**1.7**(2)	17(29)	3049(3421)	∞	∞	∞	∞ *1e5*	0/15
grid100 ho	**2.5**(3)	10(13)	773(865)	∞	∞	∞	∞ *1e5*	0/15
grid16 hol	**1.7**(1)	13(14)	3016(3257)	∞	∞	∞	∞ *1e5*	0/15
hill hol	3.4(3)	13(24)	1045(1201)	∞	∞	∞	∞ *1e5*	0/15
lmmCMA aug	**2.1**(2)	**3.0**(2)	**4.0**(4)	**3.6**(3)	**3.3**(3)	**3.0**(2)	**2.8**(2)	13/15
memPSODE v	**1.6**(2)	4.7(8)	14(16)	14(14)	13(11)	18(25)	18(23)	15/15
prcga saw	**2.5**(3)	5.4(5)	30(32)	61(55)	65(66)	75(62)	100(86)	14/15
ring100 ho	**2.3**(2)	11(14)	3067(3421)	∞	∞	∞	∞ *1e5*	0/15
ring16 hol	**2.0**(2)	13(14)	1406(1497)	∞	∞	∞	∞ *1e5*	0/15
simplex pa	23(19)	**1.7**(1)	**1.5**(0.8)	**1.4**(0.7)	**1.3**(0.6)	**1.2**(0.5)	**1.2**(0.5)	15/15

Table 25: 02-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	18	857	8515	23399	24113	24721	24721	5/15
BIPOP-aCMA	**2.6**(2)	10(16)	12(11)	16(16)	24(33)	24(32)	24(32)	15/15
BIPOP-saAC	**1.8**(2)	10(7)	15(12)	14(15)	14(14)	14(14)	14(14)	15/15
CMAES hut	**2.7**(2)	**1.7**(2)	∞	∞	∞	∞	∞ *206*	0/15
DE pal	**1.2**(1)	71(93)	13(16)	6.9(9)	6.7(8)	6.6(8)	6.6(8)	3/15
HCMA los	**1.5**(2)	8.5(18)	25(40)	31(37)	35(39)	39(43)	39(43)	13/15
HMLSL pal	**2.6**(3)	**2.0**(2)	**1.3**(2)	**2.0**(2)	**2.0**(2)	**1.9**(2)	**1.9**(2)	7/15
IPOP-10DDr	**1.6**(2)	185(258)	338(382)	261(299)	362(398)	353(382)	353(382)	3/15
IPOP-500 l	**1.6**(2)	1588(2333)	∞	∞	∞	∞	∞ *2e6*	0/15
IPOP-tany	**1.7**(1)	85(88)	92(121)	117(131)	113(117)	110(105)	110(110)	8/15
IPOP-texp	**1.6**(1.0)	4.6(6)	**2.7**(5)	**3.5**(5)	3.9(4)	3.8(4)	3.8(4)	15/15
IPOP lia	**1.6**(2)	2034(2364)	∞	∞	∞	∞	∞ *2e6*	0/15
MLSL pal	**2.5**(3)	**2.4**(2)	3.5(4)	**2.4**(3)	**2.4**(3)	**2.3**(3)	**2.3**(2)	5/15
OQNLP pal	9.0(2)	3.7(4)	**2.0**(2)	**0.74**(0.7)	**0.72**(0.7)	**0.71**(0.7)	**0.75**(0.8)	4/15
P-DCN tra	**1.5**(1)	4667(5834)	470(587)	172(256)	167(207)	163(202)	171(205)	5/15
P-zero tra	12(1)	4669(5834)	472(704)	173(214)	170(207)	243(283)	568(566)	2/15
SMAC hut	**1.7**(2)	∞	∞	∞	∞	∞	∞ *200*	0/15
U-DCN tra	**1.5**(2)	13(25)	138(152)	286(277)	1165(1369)	∞	∞ *2e6*	0/15
U-zero tra	**1.4**(1)	11(14)	191(235)	557(684)	1167(1203)	∞	∞ *2e6*	0/15
fmincon pa	**2.2**(2)	**2.2**(2)	3.6(4)	4.4(5)	4.3(5)	4.2(4)	4.2(4)	3/15
fminunc pa	3.2(3)	**2.0**(2)	**3.1**(4)	6.5(7)	6.3(7)	6.1(7)	6.1(7)	2/15
ga100 hol	**1.5**(2)	232(278)	165(170)	∞	∞	∞	∞ *1e5*	0/15
grid100 ho	**2.2**(2)	37(61)	79(96)	∞	∞	∞	∞ *1e5*	0/15
grid16 hol	**1.8**(3)	172(213)	166(194)	62(71)	∞	∞	∞ *1e5*	0/15
hill hol	**2.1**(2)	189(241)	78(88)	61(68)	59(68)	∞	∞ *1e5*	0/15
lmmCMA aug	**1.5**(3)	**1.5**(2)	∞	∞	∞	∞	∞ *1611*	0/15
memPSODE v	**2.2**(2)	21(47)	**2.6**(5)	**1.3**(2)	**1.2**(2)	**1.2**(2)	**1.5**(2)	15/15
prcga saw	**1.2**(1)	11(17)	4.8(6)	3.8(4)	**3.7**(4)	**3.7**(4)	**3.8**(4)	11/15
ring100 ho	**2.2**(3)	12(9)	19(20)	∞	∞	∞	∞ *1e5*	0/15
ring16 hol	3.1(3)	70(117)	82(98)	∞	∞	∞	∞ *1e5*	0/15
simplex pa	8.4(4)	4.1(4)	3.2(3)	7.4(8)	7.2(8)	7.0(8)	7.0(8)	2/15

References

[1] Anne Auger, Dimo Brockhoff, and Nikolaus Hansen. Benchmarking the local metamodel CMA-ES on the noiseless BBOB'2013 test bed. In Blum and Alba [3], pages 1225–1232.

[2] Anne Auger, Steffen Finck, Nikolaus Hansen, and Raymond Ros. BBOB 2009: Comparison tables of all algorithms on all noiseless functions. Technical Report RT-0383, INRIA, April 2010.

[3] Christian Blum and Enrique Alba, editors. *Genetic and Evolutionary Computation Conference, GECCO '13, Amsterdam, The Netherlands, July 6-10, 2013, Companion Material Proceedings*. ACM, 2013.

[4] S. Finck, N. Hansen, R. Ros, and A. Auger. Real-parameter black-box optimization benchmarking 2009: Presentation of the noiseless functions. Technical Report 2009/20, Research Center PPE, 2009. Updated February 2010.

[5] N. Hansen, A. Auger, S. Finck, and R. Ros. Real-parameter black-box optimization benchmarking 2012: Experimental setup. Technical report, INRIA, 2012.

[6] N. Hansen, S. Finck, R. Ros, and A. Auger. Real-parameter black-box optimization benchmarking 2009: Noiseless functions definitions. Technical Report RR-6829, INRIA, 2009. Updated February 2010.

[7] Neal J. Holtschulte and Melanie Moses. Benchmarking cellular genetic algorithms on the BBOB noiseless testbed. In Blum and Alba [3], pages 1201–1208.

[8] Frank Hutter, Holger Hoos, and Kevin Leyton-Brown. An evaluation of sequential model-based optimization for expensive blackbox functions. In Blum and Alba [3], pages 1209–1216.

[9] Tianjun Liao and Thomas Stützle. Bounding the population size of IPOP-CMA-ES on the noiseless BBOB testbed. In Blum and Alba [3], pages 1161–1168.

[10] Tianjun Liao and Thomas Stützle. Testing the impact of parameter tuning on a variant of IPOP-CMA-ES with a bounded maximum population size on the noiseless BBOB testbed. In Blum and Alba [3], pages 1169–1176.

[11] Ilya Loshchilov, Marc Schoenauer, and Michèle Sebag. Bi-population CMA-ES agorithms with surrogate models and line searches. In Blum and Alba [3], pages 1177–1184.

[12] László Pál. Benchmarking a hybrid multi level single linkage algorithm on the BBOB noiseless testbed. In Blum and Alba [3], pages 1145–1152.

[13] László Pál. Comparison of multistart global optimization algorithms on the BBOB noiseless testbed. In Blum and Alba [3], pages 1153–1160.

[14] Babatunde A. Sawyerr, Aderemi Oluyinka Adewumi, and Montaz M. Ali. Benchmarking projection-based real coded genetic algorithm on BBOB-2013 noiseless function testbed. In Blum and Alba [3], pages 1193–1200.

[15] Thanh-Do Tran, Dimo Brockhoff, and Bilel Derbel. Multiobjectivization with NSGA-II on the noiseless BBOB testbed. In Blum and Alba [3], pages 1217–1224.

[16] Costas Voglis. Adapt-MEMPSODE: a memetic algorithm with adaptive selection of local searches. In Blum and Alba [3], pages 1137–1144.