Comparison tables: BBOB 2012 testbed in 10-D

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2012, see `http://coco.gforge.inria.fr/doku.php?id=bbob-2012`. More than 27 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 [4, 2]. The experimental set-up is described in [3].

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 [1]) if an algorithm from BBOB-2009 reached the given target function value. The ERT value is given otherwise (ERT_{best} is noted as infinite). See [3] 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 2012.

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

algorithm short name	paper	reference
ACOR	An ACO Algorithm Benchmarked on the BBOB Noiseless Function Testbed (Page 159)	[5]
BIPOPaCMA	Black-Box Optimization Benchmarking of IPOP-SaACM-ES and BIPOP-SaACM-ES on the BBOB-2012 Noiseless Testbed (Page 175)	[12]
BIPOPsaACM	Black-box Optimization Benchmarking of IPOP-SaACM-ES and BIPOP-SaACM-ES on the BBOB-2012 Noiseless Testbed (Page 175)	[12]
CMA	Comparing Mirrored Mutations and Active Covariance Matrix Adaptation in the IPOP-CMA-ES on the Noiseless BBOB Testbed (Page 297)	[14]
CMAES	Benchmarking the Differential Evolution with Adaptive Encoding on Noiseless Functions (Page 189)	[9]
CMAa	Comparing Mirrored Mutations and Active Covariance Matrix Adaptation in the IPOP-CMA-ES on the Noiseless BBOB Testbed (Page 297)	[14]
CMAm	Comparing Mirrored Mutations and Active Covariance Matrix Adaptation in the IPOP-CMA-ES on the Noiseless BBOB Testbed (Page 297)	[14]
CMAma	On the Impact of a Small Initial Population Size in the IPOP Active CMA-ES with Mirrored Mutations on the Noiseless BBOB Testbed (Page 285)	[19]
CMAmah	On the Impact of a Small Initial Population Size in the IPOP Active CMA-ES with Mirrored Mutations on the Noiseless BBOB Testbed (Page 285)	[19]
CMAmh	On the Impact of Active Covariance Matrix Adaptation in the CMA-ES With Mirrored Mutations and Small Initial Population Size on the Noiseless BBOB Testbed (Page 291)	[20]
DBRCGA	Black-Box Optimization Benchmarking for Noiseless Function Testbed Using A Direction-Based RCGA (Page 167)	[11]
DE	Benchmarking the Differential Evolution with Adaptive Encoding on Noiseless Functions (Page 189)	[9]
DE-AUTO	MEMPSODE: An Empirical Assessment of Local Search Algorithm Impact on a Memetic Algorithm Using Noiseless Testbed (Page 245)	[17]
DE-BFGS	MEMPSODE: Comparing Particle Swarm Optimization and Differential Evolution Within a Hybrid Memetic Global Optimization Framework (Page 253)	[18]
DE-ROLL	MEMPSODE: An Empirical Assessment of Local Search Algorithm Impact on a Memetic Algorithm Using Noiseless Testbed (Page 245)	[17]
DE-SIMPLEX	MEMPSODE: An Empirical Assessment of Local Search Algorithm Impact on a Memetic Algorithm Using Noiseless Testbed (Page 245)	[17]
DEctpb	JADE, an Adaptive Differential Evolution Algorithm, Benchmarked on the BBOB Noiseless Testbed (Page 197)	[16]
IPOPsaACM	Black-box Optimization Benchmarking of NIPOP-aCMA-ES and NBIPOP-aCMA-ES on the BBOB-2012 Noiseless Testbed (Page 269)	[14]
JADEctpb	JADE, an Adaptive Differential Evolution Algorithm, Benchmarked on the BBOB Noiseless Testbed (Page 197)	[16]
MVDE	Benchmarking the Multi-View Differential Evolution on the Noiseless BBOB-2012 Function Testbed (Page 183)	[10]
NBIPOPaCMA	Black-box Optimization Benchmarking of NIPOP-aCMA-ES and NBIPOP-aCMA-ES on the BBOB-2012 Noiseless Testbed (Page 269)	[13]
NIPOPaCMA	Black-box Optimization Benchmarking of NIPOP-aCMA-ES and NBIPOP-aCMA-ES on the BBOB-2012 Noiseless Testbed (Page 269)	[13]
PSO-BFGS	MEMPSODE: Comparing Particle Swarm Optimization and Differential Evolution Within a Hybrid Memetic Global Optimization Framework (Page 253)	[18]
SNES	Benchmarking Separable Natural Evolution Strategies on the Noiseless and Noisy Black-box Optimization Testbeds (Page 205)	[8]
xNES	Benchmarking Exponential Natural Evolution Strategies on the Noiseless and Noisy Black-Box Optimization Testbeds (Page 213)	[6]
xNESas	Benchmarking Natural Evolution Strategies with Adaptation Sampling on the Noiseless and Noisy Black-Box Optimization Testbeds (Page 229)	[7]
xNESas	Investigating the Impact of Adaptation Sampling in Natural Evolution Strategies on Black-Box Optimization Testbeds (Page 221)	[15]

Table 2: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_1, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-3	1e-5	1e-7	#succ
f1	22	23	23	23	23	23	15/15
ACOR	11(2)	25(4)	37(5)	63(5)	88(6)	113(7)	15/15
BIPOPaCMA	5.0(2)	13(3)	18(3)	31(2)	44(4)	57(5)	15/15
BIPOPsaACM	4.8(1)	6.3(0.5)	7.6(1.0)	11(0.8)	14(1)	17(1)	15/15
CMA	5.3(3)	12(3)	19(3)	31(4)	44(5)	57(5)	15/15
CMAES	5.8(2)	12(2)	18(2)	31(3)	44(4)	57(6)	15/15
CMAa	5.2(2)	11(3)	18(2)	30(3)	44(5)	57(6)	15/15
CMAm	4.4(2)	9.1(2)	14(2)	23(3)	32(2)	42(3)	15/15
CMAma	4.5(0.8)	8.7(2)	13(2)	23(3)	31(4)	41(4)	15/15
CMAmah	**3.2**(1)	6.5(2)	9.4(2)	16(3)	22(2)	29(3)	15/15
CMAmh	**3.4**(1)	6.6(1)	9.4(2)	16(2)	22(3)	29(3)	15/15
DBRCGA	77(18)	197(55)	336(58)	612(97)	910(116)	1201(85)	15/15
DE	28(10)	67(12)	107(19)	179(14)	252(17)	328(27)	15/15
DE-AUTO	3.7(0.4)	**4.1**(0.2)	**4.1**(0.2)	**4.1**(0.2)	**4.1**(0.2)	**4.1**(0.2)	15/15
DE-BFGS	**3.2**(0.2)	**3.3**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	15/15
DE-ROLL	7.6(8)	18(16)	19(20)	20(20)	20(21)	20(21)	15/15
DE-SIMPLEX	8.5(7)	22(12)	35(14)	46(15)	55(14)	67(11)	15/15
DEctpb	28(8)	69(10)	115(10)	201(15)	287(11)	368(17)	15/15
IPOPsaACM	4.6(1)	**6.2**(0.4)	**7.4**(0.7)	**11**(1)	**14**(0.8)	**17**(0.7)	15/15
JADEb	13(4)	32(5)	52(8)	98(9)	147(12)	201(13)	15/15
JADEctpb	18(4)	45(5)	78(8)	141(7)	211(7)	282(6)	15/15
MVDE	47(15)	139(13)	227(15)	409(17)	594(24)	781(21)	15/15
NBIPOPaCMA	4.6(3)	11(2)	18(3)	31(4)	43(4)	55(4)	15/15
NIPOPaCMA	5.9(2)	12(3)	19(3)	31(4)	44(4)	57(5)	15/15
PSO-BFGS	**3.1**(0.2)	**3.3**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	**3.2**(0)	15/15
SNES	4.3(2)	10(3)	19(4)	39(3)	57(4)	76(5)	15/15
xNES	3.8(1)	18(6)	52(3)	111(7)	176(6)	239(6)	15/15
xNESas	4.0(2)	16(4)	37(5)	64(15)	85(19)	103(31)	15/15

Table 3: 10-D, running time excess ERT/$\text{ERT}_{\text{best 2009}}$ 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-3	1e-5	1e-7	#succ
f2	187	190	191	193	194	195	15/15
ACOR	7.0(1)	8.2(0.8)	10(0.9)	12(1)	16(1)	18(2)	15/15
BIPOPaCMA	14(3)	17(2)	18(2)	20(1)	21(1)	22(2)	14/14
BIPOPsaACM	**3.9**(0.9)	**4.4**(0.8)	4.8(0.7)	5.4(0.6)	5.8(0.5)	6.2(0.6)	15/15
CMA	22(6)	24(3)	26(2)	28(2)	29(2)	30(2)	15/15
CMAES	21(4)	24(4)	26(2)	28(2)	29(2)	31(2)	15/15
CMAa	16(2)	17(2)	18(1)	20(1)	21(1)	23(1)	15/15
CMAm	21(5)	24(3)	25(3)	28(1)	29(1)	29(1)	15/15
CMAma	15(3)	17(2)	18(1)	19(1)	20(1)	21(1)	15/15
CMAmah	16(3)	18(3)	19(2)	21(2)	21(2)	22(2)	15/15
CMAmh	19(3)	24(3)	25(3)	27(1)	28(1)	28(1)	15/15
DBRCGA	61(8)	78(9)	96(9)	130(12)	161(12)	191(10)	15/15
DE	20(2)	24(3)	29(2)	38(2)	47(3)	56(3)	15/15
DE-AUTO	**1.7**(0.6)	**1.9**(0.7)	**2.0**(0.8)	**2.2**(0.9)	**2.4**(1.0)	**2.7**(1)	15/15
DE-BFGS	**2.0**(0.8)	**2.2**(0.9)	**2.4**(1)	**2.7**(1)	**2.9**(1)	**3.1**(1)	15/15
DE-ROLL	7.4(10)	7.5(10)	7.6(10)	7.8(9)	8.1(9)	8.3(9)	15/15
DE-SIMPLEX	91(33)	109(39)	119(41)	138(31)	144(27)	176(120)	15/15
DEctpb	22(2)	27(1)	32(2)	42(2)	52(2)	61(3)	15/15
IPOPsaACM	4.1(0.7)	4.4(0.7)	**4.7**(0.8)	**5.3**(0.7)	**5.7**(0.8)	**6.1**(0.7)	15/15
JADEb	11(1)	14(1)	17(1)	24(1)	31(2)	38(3)	15/15
JADEctpb	17(1)	21(2)	25(2)	34(1)	43(2)	51(3)	15/15
MVDE	44(2)	54(2)	65(3)	87(4)	109(1)	130(2)	15/15
NBIPOPaCMA	14(3)	17(2)	18(2)	20(1)	21(1)	23(1.0)	15/15
NIPOPaCMA	14(3)	16(3)	18(2)	19(2)	21(2)	23(2)	15/15
PSO-BFGS	**2.6**(1)	**2.6**(1)	**2.7**(1)	**3.0**(1)	**3.2**(1)	**3.6**(2)	15/15
SNES	4.8(0.9)	5.6(0.7)	6.7(0.5)	8.9(0.6)	11(0.7)	13(0.7)	15/15
xNES	15(1)	17(1.0)	21(0.9)	28(1)	35(0.8)	43(1)	15/15
xNESas	13(2)	16(2)	18(2)	22(2)	25(3)	27(4)	15/15

Table 4: 10-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-3	1e-5	1e-7	#succ
f3	1739	3600	3609	3642	3646	3651	15/15
ACOR	15(16)	2427(2749)	9807(1e4)	9718(9610)	9706(9599)	9693(1e4)	4/15
BIPOPaCMA	4.0(3)	307(440)	4151(4441)	4114(4399)	4110(4394)	4105(5310)	7/15
BIPOPsaACM	**2.2**(2)	231(319)	1682(2031)	1667(1737)	1665(2010)	1663(1981)	12/15
CMA	3.7(3)	632(823)	2700(3062)	2676(3274)	2674(3056)	2671(3034)	2/15
CMAES	8.4(11)	2030(2153)	∞	∞	∞	∞ *5e5*	0/15
CMAa	4.4(3)	818(998)	∞	∞	∞	∞ *1e6*	0/15
CMAm	3.0(3)	494(630)	5720(6455)	5670(6222)	5664(5865)	5657(6017)	1/15
CMAma	**2.0**(3)	366(512)	2640(3182)	2617(3003)	2614(2993)	2611(3036)	2/15
CMAmah	3.0(2)	358(586)	5586(6687)	5537(6174)	5531(6010)	5525(6498)	1/15
CMAmh	4.2(3)	608(794)	5512(6145)	5462(6555)	5456(6195)	5449(6121)	1/15
DBRCGA	13(5)	38(23)	56(38)	56(38)	57(39)	59(39)	15/15
DE	5.5(1)	**5.5**(4)	**16**(15)	**16**(15)	**17**(15)	17(15)	15/15
DE-AUTO	9.1(9)	24(7)	45(24)	45(24)	45(24)	45(24)	15/15
DE-BFGS	9.4(6)	16(7)	24(11)	24(11)	24(11)	24(11)	15/15
DE-ROLL	3.6(3)	13(6)	17(8)	17(8)	17(8)	**17**(8)	15/15
DE-SIMPLEX	37(20)	56(16)	80(37)	80(37)	80(37)	80(37)	15/15
DEctpb	7.6(2)	9.0(1)	**10**(1)	**11**(1)	**11**(1)	**12**(1)	15/15
IPOPsaACM	**2.3**(0.6)	174(325)	7895(9699)	7823(9037)	7814(9026)	7803(8219)	4/14
JADEb	3.5(0.8)	**6.3**(6)	19(24)	19(24)	20(24)	20(24)	15/15
JADEctpb	3.9(0.4)	**3.1**(0.2)	**3.5**(0.3)	**4.3**(0.2)	**5.0**(0.2)	**5.7**(0.2)	15/15
MVDE	5.8(1)	**5.6**(0.3)	**6.3**(0.4)	**7.4**(0.4)	**8.7**(0.4)	**10**(0.3)	15/15
NBIPOPaCMA	3.7(4)	1586(2779)	7793(9848)	7722(9612)	7714(9600)	7703(1e4)	4/15
NIPOPaCMA	**2.3**(1)	1021(1394)	6292(6934)	6235(7895)	6228(6864)	6220(7875)	5/15
PSO-BFGS	69(74)	1999(2191)	∞	∞	∞	∞ *1e6*	0/15
SNES	18(17)	5463(5262)	∞	∞	∞	∞ *3e6*	0/15
xNES	15(17)	4196(4767)	∞	∞	∞	∞ *2e6*	0/15
xNESas	16(17)	8179(8537)	1.7e4(2e4)	1.7e4(2e4)	1.7e4(2e4)	1.7e4(2e4)	1/15

Table 5: 10-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-3	1e-5	1e-7	#succ
f4	2234	3626	3660	3707	3744	28767	12/15
ACOR	31(60)	∞	∞	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	5.6(5)	∞	∞	∞	∞	∞ *1e7*	0/15
BIPOPsaACM	5.3(4)	∞	∞	∞	∞	∞ *1e7*	0/5
CMA	6.6(4)	∞	∞	∞	∞	∞ *2e6*	0/15
CMAES	24(29)	∞	∞	∞	∞	∞ *5e5*	0/15
CMAa	7.5(4)	∞	∞	∞	∞	∞ *2e6*	0/15
CMAm	5.5(4)	∞	∞	∞	∞	∞ *2e6*	0/15
CMAma	5.6(4)	∞	∞	∞	∞	∞ *2e6*	0/15
CMAmah	8.6(8)	∞	∞	∞	∞	∞ *1e6*	0/15
CMAmh	8.6(3)	∞	∞	∞	∞	∞ *2e6*	0/15
DBRCGA	25(15)	64(31)	166(148)	165(136)	164(134)	22(18)	13/15
DE	**4.1**(0.9)	**18**(16)	**48**(61)	**48**(60)	**48**(60)	**6.3**(8)	14/15
DE-AUTO	12(9)	49(33)	139(158)	137(136)	136(136)	18(18)	13/15
DE-BFGS	14(9)	52(39)	80(65)	79(64)	78(64)	10(8)	14/15
DE-ROLL	5.2(3)	**17**(9)	**44**(34)	**44**(34)	**43**(34)	**5.6**(4)	15/15
DE-SIMPLEX	37(14)	102(47)	239(227)	236(224)	259(260)	117(122)	2/15
DEctpb	6.9(1.0)	**11**(1)	**17**(9)	**18**(8)	**18**(8)	**2.5**(1)	15/15
IPOPsaACM	5.6(7)	∞	∞	∞	∞	∞ *1e7*	0/5
JADEb	**3.6**(5)	25(22)	125(157)	124(135)	123(134)	16(20)	10/15
JADEctpb	**3.6**(0.3)	**3.4**(0.3)	**3.9**(0.2)*	**4.8**(0.2)	**5.5**(0.2)	**0.82**(0.0)	15/15
MVDE	6.0(0.9)	26(1)	143(273)	143(270)	143(267)	19(35)	10/15
NBIPOPaCMA	8.4(10)	∞	∞	∞	∞	∞ *1e7*	0/15
NIPOPaCMA	**4.9**(5)	∞	∞	∞	∞	∞ *1e7*	0/15
PSO-BFGS	156(93)	∞	∞	∞	∞	∞ *1e6*	0/15
SNES	25(27)	∞	∞	∞	∞	∞ *3e6*	0/15
xNES	17(20)	∞	∞	∞	∞	∞ *2e6*	0/15
xNESas	7.8(9)	∞	∞	∞	∞	∞ *4e6*	0/15

Table 6: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_5, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-3	1e-5	1e-7	#succ
f5	20	20	20	20	20	20	15/15
ACOR	8.8(3)	11(3)	11(3)	11(3)	11(3)	11(3)	15/15
BIPOPaCMA	4.9(2)	6.0(2)	6.0(2)	6.0(2)	6.0(2)	6.0(2)	15/15
BIPOPsaACM	5.0(2)	6.1(2)	6.4(2)	6.4(2)	6.4(2)	6.4(2)	15/15
CMA	5.3(2)	6.2(1)	6.2(1)	6.3(1)	6.3(1)	6.3(1)	15/15
CMAES	5.3(0.9)	6.3(1)	6.5(1.0)	6.5(1.0)	6.5(1.0)	6.5(1.0)	15/15
CMAa	5.2(1)	6.5(1)	6.6(1)	6.7(1)	6.7(1)	6.7(1)	15/15
CMAm	4.5(0.8)	5.5(1)	5.7(1)	5.7(1)	5.7(1)	5.7(1)	15/15
CMAma	**4.0**(0.9)	**4.7**(0.9)	**4.8**(0.9)	**4.9**(1.0)	**4.9**(1.0)	**4.9**(1.0)	15/15
CMAmah	**3.1**(1)	**3.8**(1)	**4.0**(1)	**4.0**(1)	**4.0**(1)	**4.0**(1)	15/15
CMAmh	**3.1**(0.7)	**3.8**(1.0)	**4.0**(1.0)	**4.0**(1.0)	**4.0**(1.0)	**4.0**(1.0)	15/15
DBRCGA	115(74)	155(69)	156(72)	157(72)	157(72)	157(72)	15/15
DE	15(5)	21(5)	22(5)	22(5)	22(5)	22(5)	15/15
DE-AUTO	**3.9**(0.3)	**4.0**(0.3)	**4.0**(0.4)	**4.0**(0.4)	**4.0**(0.4)	**4.0**(0.4)	15/15
DE-BFGS	7.4(3)	9.3(4)	9.4(3)	9.4(3)	10(4)	11(6)	15/15
DE-ROLL	6.4(0.4)	6.7(0.7)	6.8(0.7)	7.2(2)	7.6(3)	8.0(5)	15/15
DE-SIMPLEX	351(92)	590(297)	823(362)	1130(356)	1307(386)	7174(1e4)	15/15
DEctpb	21(4)	28(4)	29(4)	29(4)	29(4)	29(4)	15/15
IPOPsaACM	5.0(1)	6.1(1.0)	6.2(0.9)	6.2(0.8)	6.2(0.8)	6.2(0.8)	15/15
JADEb	15(4)	21(5)	22(4)	22(4)	22(4)	22(4)	15/15
JADEctpb	25(9)	33(9)	36(6)	36(6)	36(6)	36(6)	15/15
MVDE	110(17)	163(16)	182(31)	197(41)	197(41)	197(41)	15/15
NBIPOPaCMA	4.9(1)	6.1(1)	6.1(1)	6.1(1)	6.1(1)	6.1(1)	15/15
NIPOPaCMA	5.7(0.8)	6.7(2)	7.0(2)	7.0(2)	7.0(2)	7.0(2)	15/15
PSO-BFGS	7.6(4)	11(6)	12(5)	12(5)	12(5)	12(5)	15/15
SNES	10(4)	13(4)	13(4)	13(4)	13(4)	13(4)	15/15
xNES	9.0(2)	12(4)	12(4)	12(4)	12(4)	12(4)	15/15
xNESas	9.0(3)	12(3)	12(3)	12(3)	12(3)	12(3)	15/15

Table 7: 10-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-3	1e-5	1e-7	#succ
f6	412	623	826	1292	1841	2370	15/15
ACOR	3.9(0.9)	4.3(0.9)	4.5(0.8)	4.5(0.9)	4.3(0.8)	4.3(0.8)	15/15
BIPOPaCMA	**2.0**(0.6)	**1.9**(0.5)	**1.9**(0.3)	**1.7**(0.2)	**1.6**(0.1)	**1.6**(0.1)	15/15
BIPOPsaACM	**1.8**(0.5)	**1.9**(0.5)	**1.9**(0.5)	**1.8**(0.3)	**1.8**(0.3)	**1.7**(0.3)	15/15
CMA	**1.8**(0.4)	**1.9**(0.2)	**1.9**(0.2)	**1.8**(0.3)	**1.7**(0.2)	**1.6**(0.2)	15/15
CMAES	**1.9**(0.7)	**1.9**(0.5)	**1.9**(0.4)	**1.8**(0.3)	**1.7**(0.2)	**1.7**(0.1)	15/15
CMAa	**1.8**(0.6)	**1.8**(0.5)	**1.8**(0.3)	**1.8**(0.3)	**1.7**(0.2)	**1.6**(0.2)	15/15
CMAm	**1.9**(0.6)	**2.0**(0.3)	**1.9**(0.3)	**1.8**(0.3)	**1.7**(0.2)	**1.7**(0.2)	15/15
CMAma	**1.9**(0.5)	**1.8**(0.4)	**1.8**(0.4)	**1.7**(0.4)	**1.5**(0.2)	**1.5**(0.2)	15/15
CMAmah	**1.3**(0.4)	**1.4**(0.5)	**1.5**(0.5)	**1.5**(0.3)	**1.4**(0.4)	**1.5**(0.4)	15/15
CMAmh	**1.4**(0.6)	**1.6**(0.5)	**1.6**(0.4)	**1.7**(0.7)	**1.6**(0.6)	**1.7**(0.4)	15/15
DBRCGA	18(5)	24(5)	28(5)	31(7)	30(5)	30(3)	15/15
DE	17(4)	20(3)	23(4)	24(5)	24(6)	24(6)	15/15
DE-AUTO	**2.4**(1)	**2.4**(1)	**2.3**(0.6)	**2.2**(0.6)	4.0(3)	6.3(8)	15/15
DE-BFGS	**2.2**(2)	**2.0**(1)	**2.1**(2)	5.3(6)	16(7)	84(61)	12/15
DE-ROLL	16(12)	22(19)	26(26)	41(41)	55(42)	185(239)	10/15
DE-SIMPLEX	25(17)	43(23)	55(19)	76(32)	145(79)	∞ *1e6*	0/15
DEctpb	12(2)	14(2)	15(2)	15(2)	14(2)	14(2)	15/15
IPOPsaACM	**1.7**(0.7)	**1.8**(0.5)	**1.9**(0.5)	**1.8**(0.5)	**1.8**(0.4)	**1.8**(0.2)	15/15
JADEb	5.7(3)	8.8(2)	12(3)	46(37)	382(517)	451(464)	2/15
JADEctpb	6.6(1)	7.5(1)	7.9(0.9)	8.3(1)	8.2(1)	8.1(1)	15/15
MVDE	19(6)	27(4)	33(7)	41(8)	48(15)	57(23)	15/15
NBIPOPaCMA	**1.8**(0.6)	**1.9**(0.5)	**1.9**(0.4)	**1.8**(0.2)	**1.6**(0.2)	**1.6**(0.2)	15/15
NIPOPaCMA	**1.8**(0.6)	**1.8**(0.4)	**1.8**(0.3)	**1.8**(0.3)	**1.6**(0.2)	**1.6**(0.2)	15/15
PSO-BFGS	4.0(3)	3.2(2)	**2.8**(2)	9.3(7)	23(9)	220(221)	4/15
SNES	**1.6**(0.3)	**1.7**(0.3)	**1.9**(0.4)	3.2(2)	155(257)	269(619)	13/15
xNES	**2.5**(0.4)	3.3(0.2)	3.9(0.2)	4.1(0.2)	4.1(0.1)	4.1(0.2)	15/15
xNESas	**2.2**(0.2)	3.1(0.3)	3.6(0.3)	3.9(0.3)	3.8(0.2)	3.8(0.1)	15/15

Table 8: 10-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-3	1e-5	1e-7	#succ
f7	172	1611	4195	5141	5141	5389	15/15
ACOR	5.7(3)	21(37)	275(279)	235(240)	235(240)	225(227)	15/15
BIPOPaCMA	**2.0**(0.3)	**1.1**(0.6)	**0.88**(0.4)	**0.85**(0.4)	**0.85**(0.4)	**0.82**(0.3)	15/15
BIPOPsaACM	**1.5**(0.3)	**0.81**(0.5)	**0.72**(0.4)	**0.69**(0.3)	**0.69**(0.3)	**0.70**(0.3)	15/15
CMA	**3.0**(1)	**1.5**(1)	**1.1**(0.7)	**1.4**(0.8)	**1.4**(0.8)	**1.3**(0.7)	15/15
CMAES	**2.9**(1)	**2.2**(3)	6.0(6)	27(37)	27(37)	36(36)	14/15
CMAa	**2.1**(0.5)	**1.2**(1)	**0.91**(0.6)	**0.93**(0.4)	**0.93**(0.4)	**0.90**(0.3)	15/15
CMAm	**2.4**(1)	**2.0**(1)	**1.3**(0.9)	**1.2**(0.8)	**1.2**(0.8)	**1.1**(0.8)	15/15
CMAma	**2.2**(1)	**1.3**(1)	**0.83**(0.4)	**0.79**(0.3)	**0.79**(0.3)	**0.80**(0.3)	15/15
CMAmah	**2.7**(2)	**2.1**(0.9)	**0.99**(0.3)	**0.90**(0.3)	**0.90**(0.3)	**0.87**(0.3)	15/15
CMAmh	4.8(5)	**2.2**(1)	**1.4**(0.4)	**1.3**(0.3)	**1.3**(0.3)	**1.2**(0.3)	15/15
DBRCGA	20(6)	15(16)	58(72)	152(175)	152(175)	146(170)	11/15
DE	19(9)	6.7(3)	22(60)	20(49)	20(49)	19(47)	13/15
DE-AUTO	38(20)	19(16)	62(106)	58(87)	58(87)	58(83)	14/15
DE-BFGS	22(18)	151(278)	385(409)	434(424)	434(407)	635(637)	2/15
DE-ROLL	15(11)	17(18)	26(40)	32(34)	32(34)	33(37)	15/15
DE-SIMPLEX	23(32)	19(18)	31(42)	30(34)	30(34)	30(32)	15/15
DEctpb	16(8)	6.2(2)	5.0(2)	6.3(2)	6.3(2)	6.3(2)	15/15
IPOPsaACM	**1.8**(0.5)	**1.00**(0.5)	**0.70**(0.4)	**0.69**(0.3)	**0.69**(0.3)	**0.72**(0.3)	15/15
JADEb	6.6(2)	157(310)	180(239)	269(341)	269(341)	256(325)	4/15
JADEctpb	8.1(1)	**2.3**(0.7)	20(60)	17(49)	17(49)	16(46)	13/15
MVDE	24(10)	11(3)	12(7)	31(20)	31(20)	33(31)	15/15
NBIPOPaCMA	**2.0**(0.5)	**1.4**(2)	**1.0**(0.7)	**1.3**(0.6)	**1.3**(0.6)	**1.2**(0.6)	15/15
NIPOPaCMA	**2.0**(0.6)	**1.2**(0.7)	**1.0**(0.4)	**0.96**(0.3)	**0.96**(0.3)	**0.93**(0.3)	15/15
PSO-BFGS	2448(3171)	8888(9762)	∞	∞	∞	∞ *1e6*	0/15
SNES	**1.9**(0.5)	87(80)	245(235)	1145(1017)	1145(1114)	1092(1016)	6/15
xNES	**2.4**(0.8)	**0.78**(0.1)$_{\downarrow 2}$	**0.48**(0.0)	**0.58**(0.1)	**0.58**(0.1)	**0.64**(0.1)	15/15
xNESas	**2.4**(1)	**0.76**(0.1)$_{\downarrow 3}$	**0.45**(0.1)	**0.58**(0.1)	**0.58**(0.1)	**0.59**(0.0)	15/15

Table 9: 10-D, running time excess ERT/ERT$_{\text{best 2009}}$ on f_8, in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension.

Δf_{opt}	1e1	1e0	1e-1	1e-3	1e-5	1e-7	#succ
f8	326	921	1114	1267	1315	1343	15/15
ACOR	4.3(0.9)	27(2)	41(2)	76(2)	112(3)	148(4)	15/15
BIPOPaCMA	**2.1**(0.7)	3.5(0.7)	3.6(0.6)	3.7(0.5)	3.8(0.5)	4.0(0.4)	15/15
BIPOPsaACM	**1.2**(0.4)	**1.8**(1)	**1.7**(1)	**1.7**(1)	**1.7**(1.0)	**1.7**(1.0)	15/15
CMA	**2.5**(1)	6.2(6)	6.0(5)	5.9(4)	6.0(4)	6.1(4)	15/15
CMAES	**2.2**(1.0)	4.6(0.9)	4.6(0.7)	4.6(0.6)	4.8(0.5)	4.9(0.5)	15/15
CMAa	**2.1**(0.4)	3.6(0.7)	3.7(0.6)	3.8(0.5)	3.9(0.5)	4.0(0.5)	15/15
CMAm	3.7(5)	4.6(2)	4.7(2)	4.7(2)	4.8(1)	4.9(1)	15/15
CMAma	**2.1**(0.8)	3.7(0.6)	3.8(0.5)	3.8(0.4)	3.9(0.4)	4.0(0.4)	15/15
CMAmah	**1.5**(1)	3.8(4)	3.7(3)	3.7(3)	3.7(3)	3.8(3)	15/15
CMAmh	**1.9**(2)	4.6(3)	4.6(3)	4.5(2)	4.6(2)	4.7(2)	15/15
DBRCGA	29(5)	107(98)	109(73)	127(43)	148(39)	180(40)	15/15
DE	14(4)	64(92)	70(78)	77(67)	88(64)	98(61)	15/15
DE-AUTO	**0.94**(0.2)	**2.0**(0.7)	**1.8**(0.6)	**1.7**(0.2)	**1.6**(0.2)	**1.6**(0.2)	15/15
DE-BFGS	**1.2**(0.2)	**1.4**(1)	**1.3**(0.9)	**1.2**(0.8)	**1.2**(0.8)	**1.1**(0.7)	15/15
DE-ROLL	4.2(3)	8.7(9)	20(17)	35(24)	55(17)	257(373)	8/15
DE-SIMPLEX	5.5(4)	11(12)	11(10)	13(8)	14(8)	17(11)	15/15
DEctpb	15(2)	41(3)	49(2)	60(4)	73(5)	87(5)	15/15
IPOPsaACM	**1.3**(0.8)	**2.0**(2)	**1.9**(1)	**1.8**(1)	**1.8**(1)	**1.9**(1)	15/15
JADEb	6.6(2)	15(13)	16(12)	34(11)	42(10)	42(10)	14/15
JADEctpb	10(2)	16(2)	15(2)	15(2)	16(2)	16(2)	15/15
MVDE	29(6)	631(370)	6125(7522)	1.1e4(1e4)	1.1e4(1e4)	1.1e4(1e4)	0/15
NBIPOPaCMA	**2.6**(1)	4.9(4)	4.8(3)	4.7(3)	4.8(3)	4.9(3)	15/15
NIPOPaCMA	**2.1**(0.7)	5.0(4)	4.9(4)	4.8(3)	4.9(3)	5.0(3)	15/15
PSO-BFGS	**1.4**(0.4)	**1.1**(0.3)	**1.0**(0.2)	**0.94**(0.2)	**0.93**(0.2)	**0.92**(0.2)	15/15
SNES	**1.9**(0.3)	90(26)	286(232)	961(693)	3799(3883)	∞ *3e6*	0/15
xNES	5.3(0.6)	5.7(0.5)	6.1(0.7)	6.2(0.8)	6.7(0.6)	7.5(0.7)	15/15
xNESas	4.5(0.6)	8.0(2)	8.3(2)	8.2(2)	8.4(2)	8.8(2)	15/15

Table 10: 10-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-3	1e-5	1e-7	#succ
f9	200	648	857	1065	1138	1185	15/15
ACOR	9.1(6)	326(21)	303(27)	457(68)	664(125)	868(185)	15/15
BIPOPaCMA	3.4(1)	5.1(1)	4.8(1)	4.4(0.9)	4.5(0.8)	4.5(0.8)	15/15
BIPOPsaACM	**1.6**(0.5)	**2.2**(0.5)	**2.0**(0.4)	**1.8**(0.3)	**1.7**(0.3)	**1.7**(0.3)	15/15
CMA	5.0(5)	6.7(2)	6.2(2)	5.7(1)	5.6(1)	5.7(1)	15/15
CMAES	3.6(2)	8.1(5)	7.3(4)	6.6(3)	6.5(3)	6.5(3)	15/15
CMAa	3.0(0.5)	5.3(1.0)	4.9(0.7)	4.6(0.6)	4.5(0.6)	4.6(0.5)	15/15
CMAm	3.5(2)	6.5(3)	6.0(2)	5.5(2)	5.4(2)	5.5(2)	15/15
CMAma	3.1(2)	7.7(6)	6.8(5)	6.0(4)	5.9(4)	5.9(4)	15/15
CMAmah	**1.9**(0.9)	3.9(1)	3.9(0.9)	3.6(0.7)	3.5(0.7)	3.6(0.7)	15/15
CMAmh	3.1(0.5)	5.9(5)	5.5(4)	5.0(3)	4.9(3)	4.9(3)	15/15
DBRCGA	38(9)	693(802)	627(616)	881(546)	4259(4281)	1.3e4(1e4)	0/15
DE	23(6)	130(70)	186(62)	272(50)	584(439)	3085(3374)	1/15
DE-AUTO	**1.7**(0.4)	4.1(3)	3.3(2)	**2.8**(2)	**2.6**(2)	**2.6**(2)	15/15
DE-BFGS	**2.0**(1.0)	**2.3**(2)	**1.9**(1)	**1.6**(1)	**1.5**(1)	**1.4**(1)	15/15
DE-ROLL	5.1(5)	63(15)	86(18)	106(23)	129(25)	418(436)	6/15
DE-SIMPLEX	10(10)	28(41)	26(29)	22(24)	22(23)	22(22)	15/15
DEctpb	25(4)	133(28)	193(58)	292(56)	677(482)	3117(3259)	1/15
IPOPsaACM	**1.6**(0.4)	**2.0**(0.4)	**1.8**(0.3)	**1.6**(0.2)	**1.6**(0.2)	**1.6**(0.2)	15/15
JADEb	15(20)	24(8)	21(5)	19(4)	19(4)	19(4)	15/15
JADEctpb	15(3)	25(3)	22(2)	20(2)	20(2)	20(2)	15/15
MVDE	48(13)	2.2e4(2e4)	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	3.4(0.4)	7.3(6)	6.4(5)	5.8(4)	5.7(4)	5.8(3)	15/15
NIPOPaCMA	3.1(0.5)	5.7(0.8)	5.3(0.6)	4.9(0.5)	4.9(0.5)	4.9(0.5)	15/15
PSO-BFGS	**1.6**(0.4)	**1.1**(0.3)*	**0.98**(0.2)*	**0.86**(0.2)*	**0.83**(0.2)*	**0.81**(0.2)*	15/15
SNES	3.6(1)	289(307)	619(359)	4.0e4(4e4)	∞	∞ *3e6*	0/15
xNES	8.8(1)	8.0(1)	7.7(1)	7.1(1)	7.5(1)	8.4(0.9)	15/15
xNESas	7.0(1)	8.6(4)	9.1(3)	8.5(3)	8.6(3)	8.8(3)	15/15

Table 11: 10-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-3	1e-5	1e-7	#succ
f10	1835	2172	2455	2802	4543	4739	15/15
ACOR	1180(1005)	3561(3370)	8764(8712)	5.3e4(5e4)	∞	∞ *1e7*	0/15
BIPOPaCMA	**1.4**(0.3)	**1.5**(0.2)	**1.4**(0.1)	**1.3**(0.1)	**0.90**(0.0)$_{\downarrow 2}$	**0.92**(0.1)$_{\downarrow}$	15/15
BIPOPsaACM	**0.41**(0.1)$_{\downarrow 3}$	**0.39**(0.1)$_{\downarrow 4}$	**0.37**(0.1)$_{\downarrow 4}$	**0.36**(0.0)$_{\downarrow 4}$	**0.24**(0.0)$_{\downarrow 4}$	**0.25**(0.0)$_{\downarrow 4}$	15/15
CMA	**2.3**(0.3)	**2.3**(0.2)	**2.1**(0.1)	**2.0**(0.1)	**1.3**(0.1)	**1.3**(0.1)	15/15
CMAES	**2.2**(0.3)	**2.1**(0.3)	**2.0**(0.3)	**1.9**(0.2)	**1.2**(0.1)	**1.2**(0.1)	15/15
CMAa	**1.4**(0.2)	**1.5**(0.2)	**1.4**(0.2)	**1.3**(0.1)	**0.89**(0.1)$_{\downarrow 2}$	**0.92**(0.1)$_{\downarrow}$	15/15
CMAm	**2.1**(0.6)	**2.1**(0.3)	**2.0**(0.3)	**1.9**(0.1)	**1.2**(0.1)	**1.2**(0.1)	15/15
CMAma	**1.3**(0.4)	**1.4**(0.2)	**1.3**(0.1)	**1.3**(0.1)	**0.83**(0.1)$_{\downarrow 4}$	**0.84**(0.0)$_{\downarrow 4}$	15/15
CMAmah	**1.8**(0.3)	**1.7**(0.2)	**1.6**(0.1)	**1.4**(0.1)	**0.92**(0.1)$_{\downarrow 2}$	**0.92**(0.0)$_{\downarrow 2}$	15/15
CMAmh	**2.3**(0.4)	**2.2**(0.3)	**2.0**(0.1)	**1.9**(0.1)	**1.2**(0.1)	**1.2**(0.1)	15/15
DBRCGA	437(415)	3292(3575)	∞	∞	∞	∞ *1e6*	0/15
DE	∞	∞	∞	∞	∞	∞ *5e5*	0/15
DE-AUTO	**2.4**(3)	**2.0**(3)	**1.8**(2)	**1.6**(2)	**1.0**(1)	**0.99**(1)	15/15
DE-BFGS	**1.7**(2)	**1.5**(2)	**1.3**(1)	**1.2**(1)	**0.73**(0.7)	**0.72**(0.7)	15/15
DE-ROLL	111(34)	142(73)	165(64)	197(71)	148(44)	1524(1585)	0/15
DE-SIMPLEX	20(12)	25(8)	33(8)	46(9)	42(9)	221(214)	3/15
DEctpb	∞	∞	∞	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**0.41**(0.1)$_{\downarrow 3}$	**0.40**(0.1)$_{\downarrow 4}$	**0.38**(0.1)$_{\downarrow 4}$	**0.36**(0.1)$_{\downarrow 4}$	**0.25**(0.0)$_{\downarrow 4}$	**0.25**(0.0)$_{\downarrow 4}$	15/15
JADEb	13(8)	15(7)	16(5)	19(9)	14(5)	16(6)	15/15
JADEctpb	4.4(1)	4.4(1)	4.6(1)	4.7(1)	3.4(0.7)	3.6(0.7)	15/15
MVDE	∞	∞	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**1.3**(0.4)	**1.4**(0.3)	**1.3**(0.2)	**1.3**(0.1)	**0.89**(0.1)$_{\downarrow 3}$	**0.92**(0.1)$_{\downarrow 2}$	15/15
NIPOPaCMA	**1.4**(0.3)	**1.4**(0.3)	**1.4**(0.2)	**1.3**(0.1)	**0.89**(0.1)$_{\downarrow 2}$	**0.92**(0.1)$_{\downarrow}$	15/15
PSO-BFGS	3.9(5)	3.3(4)	**2.9**(4)	**2.6**(3)	**1.6**(2)	**1.6**(2)	15/15
SNES	2.3e4(2e4)	∞	∞	∞	∞	∞ *3e6*	0/15
xNES	**1.5**(0.1)	**1.5**(0.1)	**1.6**(0.1)	**1.9**(0.1)	**1.5**(0.0)	**1.8**(0.0)	15/15
xNESas	**1.4**(0.2)	**1.4**(0.3)	**1.4**(0.2)	**1.5**(0.2)	**1.0**(0.1)	**1.1**(0.2)	15/15

Table 12: 10-D, running time excess ERT/$\text{ERT}_{\text{best 2009}}$ 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-3	1e-5	1e-7	#succ
f11	266	1041	2602	3338	4092	4843	15/15
ACOR	356(147)	160(33)	92(18)	115(22)	132(23)	140(23)	14/15
BIPOPaCMA	6.6(0.9)	**2.0**(0.2)	**0.87**(0.1)	**0.78**(0.0)$_{\downarrow 4}$	**0.72**(0.0)$_{\downarrow 4}$	**0.67**(0.0)$_{\downarrow 4}$	15/15
BIPOPsaACM	**2.9**(0.2)	**0.79**(0.1)	**0.33**(0.0)$_{\downarrow 4}$	**0.29**(0.0)$_{\downarrow 4}$	**0.25**(0.0)$_{\downarrow 4}$	**0.23**(0.0)$_{\downarrow 4}$	15/15
CMA	14(1)	4.2(0.6)	**1.8**(0.3)	**1.6**(0.2)	**1.4**(0.1)	**1.2**(0.1)	15/15
CMAES	14(2)	4.1(0.4)	**1.8**(0.2)	**1.5**(0.1)	**1.3**(0.1)	**1.2**(0.1)	15/15
CMAa	6.9(0.7)	**2.1**(0.2)	**0.90**(0.1)	**0.80**(0.0)$_{\downarrow 4}$	**0.73**(0.0)$_{\downarrow 4}$	**0.67**(0.0)$_{\downarrow 4}$	15/15
CMAm	14(2)	4.1(0.4)	**1.8**(0.1)	**1.5**(0.1)	**1.3**(0.1)	**1.2**(0.1)	15/15
CMAma	6.8(0.8)	**2.0**(0.2)	**0.88**(0.1)	**0.77**(0.1)$_{\downarrow 4}$	**0.69**(0.0)$_{\downarrow 4}$	**0.63**(0.0)$_{\downarrow 4}$	15/15
CMAmah	9.1(0.8)	**2.6**(0.3)	**1.1**(0.1)	**0.97**(0.1)	**0.84**(0.1)$_{\downarrow 3}$	**0.75**(0.1)$_{\downarrow 4}$	15/15
CMAmh	17(3)	5.1(0.6)	**2.2**(0.2)	**1.9**(0.2)	**1.6**(0.1)	**1.4**(0.1)	15/15
DBRCGA	153(183)	233(152)	149(50)	216(28)	235(18)	1542(1651)	0/15
DE	516(175)	284(74)	210(119)	2234(2471)	∞	∞ *5e5*	0/15
DE-AUTO	**0.43**(0.1)$_{\downarrow 4}$	**0.20**(0.0)$_{\downarrow 3}$	**0.09**(0.0)$_{\downarrow 4}$	**0.08**(0.0)$_{\downarrow 4}$	**0.08**(0.0)$_{\downarrow 4}$	**0.37**(0.5)	15/15
DE-BFGS	**0.52**(0.3)$_{\downarrow 3}$	**0.16**(0.1)$_{\downarrow 4}$	**0.07**(0.0)$_{\downarrow 4}$	**0.07**(0.0)$_{\downarrow 4}$	**0.07**(0.0)$_{\downarrow 4}$	**0.07**(0.0)$_{\downarrow 4}$	15/15
DE-ROLL	293(157)	170(89)	106(64)	138(65)	156(54)	∞ *1e6*	0/15
DE-SIMPLEX	49(33)	42(17)	28(9)	41(7)	49(7)	966(944)	0/15
DEctpb	667(172)	327(67)	392(310)	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**2.8**(0.3)	**0.76**(0.1)	**0.33**(0.0)$_{\downarrow 4}$	**0.28**(0.0)$_{\downarrow 4}$	**0.25**(0.0)$_{\downarrow 4}$	**0.23**(0.0)$_{\downarrow 4}$	15/15
JADEb	22(10)	11(8)	7.3(3)	11(3)	13(3)	13(3)	15/15
JADEctpb	21(8)	6.5(2)	3.1(0.9)	3.0(0.8)	**2.9**(0.8)	**2.9**(0.8)	15/15
MVDE	507(351)	7039(7640)	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	6.8(0.7)	**2.0**(0.2)	**0.90**(0.1)	**0.81**(0.1)$_{\downarrow 4}$	**0.73**(0.1)$_{\downarrow 4}$	**0.68**(0.0)$_{\downarrow 4}$	15/15
NIPOPaCMA	7.1(0.6)	**2.1**(0.2)	**0.92**(0.1)	**0.83**(0.1)$_{\downarrow 3}$	**0.75**(0.1)$_{\downarrow 4}$	**0.70**(0.0)$_{\downarrow 4}$	15/15
PSO-BFGS	**0.44**(0.1)$_{\downarrow 4}$	**0.14**(0.0)$_{\downarrow 4}$	**0.06**(0.0)$_{\downarrow 4}$	**0.06**(0.0)$_{\downarrow 4}$	**0.06**(0.0)$_{\downarrow 4}$	**0.99**(3)	15/15
SNES	5.1e4(5e4)	∞	∞	∞	∞	∞ *3e6*	0/15
xNES	6.5(0.8)	**2.1**(0.2)	**1.1**(0.1)	**1.2**(0.1)	**1.4**(0.1)	**1.5**(0.1)	15/15
xNESas	6.7(1)	**2.1**(0.3)	**1.0**(0.1)	**1.0**(0.1)	**0.94**(0.1)	**0.88**(0.1)$_{\downarrow}$	15/15

Table 13: 10-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-3	1e-5	1e-7	#succ
f12	515	896	1240	1569	3660	5154	15/15
ACOR	1391(0.7)	6346(1e4)	2.2e4(3e4)	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	3.2(3)	4.4(3)	4.8(2)	4.9(2)	**2.6**(0.9)	**2.1**(0.7)	15/15
BIPOPsaACM	**1.0**(0.6)	**1.1**(1)	**1.1**(1)	**1.4**(0.9)	**0.94**(0.8)	**0.91**(0.7)	15/15
CMA	3.7(2)	4.3(3)	5.1(3)	5.7(3)	3.1(1)	**2.5**(1)	15/15
CMAES	4.0(4)	4.4(4)	4.8(4)	5.3(3)	**2.9**(1)	**2.4**(0.8)	15/15
CMAa	**2.8**(2)	3.1(2)	3.7(2)	4.1(2)	**2.3**(0.7)	**1.8**(0.5)	15/15
CMAm	**2.6**(2)	4.2(3)	5.1(2)	5.6(2)	3.0(0.9)	**2.5**(0.7)	15/15
CMAma	**2.6**(2)	3.3(2)	3.9(2)	4.4(2)	**2.4**(0.9)	**2.0**(0.7)	15/15
CMAmah	4.1(5)	5.0(5)	5.3(4)	5.5(3)	**2.9**(1)	**2.3**(1)	15/15
CMAmh	**2.5**(4)	3.3(5)	3.8(4)	4.6(3)	**2.6**(2)	**2.2**(1)	15/15
DBRCGA	334(972)	1000(1117)	3244(3629)	∞	∞	∞ *1e6*	0/15
DE	337(494)	748(956)	1344(1481)	∞	∞	∞ *5e5*	0/15
DE-AUTO	**2.7**(4)	**2.1**(3)	**2.0**(2)	**1.8**(2)	**0.96**(0.9)	**1.6**(1.0)	15/15
DE-BFGS	**1.3**(2)	**0.98**(1)	**0.97**(1.0)	**0.94**(0.7)	**0.53**(0.3)	**0.59**(0.3)	15/15
DE-ROLL	41(71)	40(68)	47(67)	59(61)	59(40)	344(343)	4/15
DE-SIMPLEX	10(13)	13(11)	16(10)	22(9)	15(8)	55(88)	7/15
DEctpb	224(161)	435(411)	1344(1401)	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**0.97**(0.7)	**1.0**(0.9)	**1.1**(0.9)	**1.4**(0.8)	**0.82**(0.3)	**0.69**(0.3)	15/15
JADEb	10(3)	17(13)	20(15)	24(11)	13(5)	11(4)	15/15
JADEctpb	18(3)	13(2)	13(8)	15(8)	9.0(3)	7.8(3)	15/15
MVDE	416(544)	1081(1230)	5736(6228)	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	3.2(3)	4.6(4)	5.1(4)	5.4(3)	**2.9**(1)	**2.3**(0.8)	15/15
NIPOPaCMA	**2.6**(2)	3.5(3)	3.9(3)	4.4(2)	**2.5**(0.9)	**2.0**(0.7)	15/15
PSO-BFGS	**1.9**(1)	**1.8**(1)	**1.7**(1.0)	**1.5**(0.8)	**1.0**(0.9)	3.5(5)	15/15
SNES	14(29)	64(50)	411(654)	3005(3689)	∞	∞ *3e6*	0/15
xNES	7.9(0.8)	7.0(3)	9.2(3)	10(6)	5.6(3)	5.5(2)	15/15
xNESas	4.1(0.8)	3.5(0.9)	5.8(4)	14(17)	8.0(9)	6.4(7)	15/15

Table 14: 10-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-3	1e-5	1e-7	#succ
f13	387	596	797	4587	6208	7779	15/15
ACOR	1069(1012)	1.9e4(3e4)	3.6e4(5e4)	1.5e4(2e4)	∞	∞ *1e7*	0/15
BIPOPaCMA	**2.5**(2)	3.6(2)	3.3(1)	**0.97**(0.2)	**0.97**(0.2)	**1.2**(0.7)	15/15
BIPOPsaACM	**0.75**(0.1)	**1.0**(0.5)	**1.2**(0.5)	**0.27**(0.1)$_{\downarrow 4}$	**0.30**(0.2)$_{\downarrow 4}$	**0.32**(0.1)$_{\downarrow 4}$	15/15
CMA	**2.7**(2)	5.9(4)	6.1(3)	**1.5**(0.6)	**1.4**(0.5)	**1.4**(0.5)	15/15
CMAES	**2.9**(2)	4.2(3)	4.7(2)	**1.4**(0.7)	**1.9**(1)	**2.6**(2)	15/15
CMAa	**2.3**(1)	3.7(2)	3.6(1)	**0.98**(0.2)	**1.0**(0.3)	**0.99**(0.4)	15/15
CMAm	**1.9**(0.6)	5.0(5)	6.1(4)	**1.7**(0.5)	**1.7**(0.6)	**1.8**(0.7)	15/15
CMAma	**1.7**(0.4)	3.7(2)	5.0(3)	**1.1**(0.4)	**1.3**(0.5)	**1.4**(0.6)	15/15
CMAmah	**2.4**(3)	5.4(4)	5.6(2)	**1.4**(0.5)	**1.6**(0.6)	**1.6**(0.6)	15/15
CMAmh	**2.9**(3)	6.1(6)	8.9(4)	**2.0**(0.4)	**2.1**(1)	**2.2**(1)	15/15
DBRCGA	201(175)	551(841)	2133(2733)	1487(1635)	∞	∞ *1e6*	0/15
DE	21(7)	51(28)	189(74)	∞	∞	∞ *5e5*	0/15
DE-AUTO	**1.5**(0.1)	**1.1**(0.1)	**1.00**(0.1)	**0.52**(0.4)	**1.6**(1)	32(27)	10/15
DE-BFGS	**0.84**(0.1)	**0.74**(0.1)	**0.70**(0.0)	**0.17**(0.0)$_{\downarrow 4}$	**2.5**(0.3)	∞ *1e6*	0/15
DE-ROLL	16(16)	17(13)	31(25)	10(8)	13(5)	65(81)	8/15
DE-SIMPLEX	11(11)	13(10)	16(12)	4.7(1)	4.6(1)	14(12)	7/15
DEctpb	25(8)	78(29)	225(86)	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**0.96**(0.4)	**1.4**(1)	**1.3**(0.7)	**0.32**(0.1)$_{\downarrow 4}$	**0.31**(0.1)$_{\downarrow 4}$	**0.31**(0.1)$_{\downarrow 4}$	15/15
JADEb	11(10)	19(14)	25(17)	6.7(3)	8.7(4)	14(5)	15/15
JADEctpb	11(2)	14(2)	13(2)	3.1(0.4)	3.2(0.9)	3.1(0.8)	15/15
MVDE	42(11)	141(83)	3337(3573)	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**2.8**(2)	3.6(2)	3.9(1)	**0.90**(0.3)	**1.0**(0.4)	**1.4**(1)	15/15
NIPOPaCMA	**2.4**(2)	3.7(2)	3.6(2)	**1.1**(0.4)	**1.1**(0.5)	**1.2**(0.5)	15/15
PSO-BFGS	**0.92**(0.4)	**0.80**(0.3)	**0.75**(0.2)	**0.18**(0.0)$_{\downarrow 4}$	357(404)	∞ *1e6*	0/15
SNES	23(39)	97(99)	370(274)	492(436)	1652(1587)	5379(5383)	0/15
xNES	5.5(0.3)	6.0(0.1)	6.1(0.1)	**1.7**(0.0)	**1.7**(0.0)	**1.7**(0.0)	15/15
xNESas	3.6(0.8)	3.5(1.0)	16(27)	8.0(11)	9.5(14)	10(12)	15/15

Table 15: 10-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-3	1e-5	1e-7	#succ
f14	37	98	133	392	687	4305	15/15
ACOR	4.3(3)	6.4(1)	7.6(1)	13(4)	662(245)	∞ *1e7*	0/15
BIPOPaCMA	**2.2**(1)	3.0(0.6)	3.7(0.6)	3.3(0.4)	3.5(0.3)	**0.86**(0.1)$\downarrow_2$	15/15
BIPOPsaACM	**2.7**(1)	**2.2**(0.5)	**2.4**(0.3)	**1.6**(0.1)	**1.4**(0.1)	**0.31**(0.0)$\downarrow_4$	15/15
CMA	**2.5**(2)	3.1(0.7)	3.8(0.5)	3.9(0.7)	5.3(0.6)	**1.4**(0.2)	15/15
CMAES	**2.3**(2)	3.1(0.9)	3.9(0.7)	4.0(0.4)	5.2(0.5)	**1.3**(0.1)	15/15
CMAa	**3.0**(2)	3.3(0.6)	4.1(0.8)	3.2(0.5)	3.5(0.4)	**0.84**(0.1)$\downarrow_3$	15/15
CMAm	**2.5**(2)	**2.9**(0.8)	3.2(0.7)	3.8(0.8)	5.2(0.5)	**1.5**(0.2)	15/15
CMAma	**1.9**(1)	**2.5**(0.6)	3.1(0.6)	**2.8**(0.3)	3.5(0.3)	**0.86**(0.1)$\downarrow_2$	15/15
CMAmah	**1.6**(1)	**1.9**(0.6)	**2.2**(0.7)	**2.3**(0.4)	3.4(0.5)	**0.97**(0.1)	15/15
CMAmh	**1.4**(1)	**1.8**(0.6)	**2.1**(0.4)	**2.9**(0.6)	5.3(0.8)	**1.5**(0.3)	15/15
DBRCGA	18(14)	38(8)	54(9)	60(18)	375(161)	∞ *1e6*	0/15
DE	8.8(7)	19(4)	23(5)	46(12)	1102(799)	∞ *5e5*	0/15
DE-AUTO	**1.9**(1.0)	**1.2**(0.2)	**1.1**(0.2)	**0.63**(0.1)$\downarrow_4$	**0.53**(0.0)$\downarrow_4$	11(11)	2/15
DE-BFGS	**1.9**(0.3)	**1.1**(0.2)	**1.1**(0.1)	**0.64**(0.1)$\downarrow_4$	**0.55**(0.1)$\downarrow_4$	19(29)	0/15
DE-ROLL	**2.1**(0.6)	19(21)	21(18)	16(14)	111(46)	∞ *1e6*	0/15
DE-SIMPLEX	4.5(4)	16(10)	34(24)	20(10)	24(13)	19(21)	8/15
DEctpb	7.1(7)	20(6)	25(4)	46(11)	2049(2183)	∞ *5e5*	0/15
IPOPsaACM	**2.2**(2)	**2.3**(0.5)	**2.4**(0.5)	**1.6**(0.2)	**1.5**(0.2)	**0.31**(0.0)$\downarrow_4$	15/15
JADEb	3.8(2)	7.8(2)	11(1)	14(3)	20(9)	20(20)	7/15
JADEctpb	4.8(3)	11(2)	15(2)	16(2)	16(3)	3.4(0.6)	15/15
MVDE	13(10)	35(4)	47(4)	87(25)	∞	∞ *1e6*	0/15
NBIPOPaCMA	**2.1**(2)	3.0(1)	3.7(0.6)	3.3(0.6)	3.7(0.4)	**0.88**(0.1)$\downarrow$	15/15
NIPOPaCMA	3.0(2)	3.2(0.8)	4.0(0.6)	3.3(0.4)	3.7(0.3)	**0.87**(0.1)$\downarrow_2$	15/15
PSO-BFGS	**1.9**(0.8)	**1.2**(0.2)	**1.1**(0.2)	**0.66**(0.1)$\downarrow_4$	**0.55**(0.1)$\downarrow_4$	259(346)	0/15
SNES	**1.8**(1.0)	**2.1**(0.6)	3.4(0.6)	6.2(2)	∞	∞ *3e6*	0/15
xNES	**2.0**(0.9)	3.1(1)	8.9(1)	7.7(0.3)	7.1(0.3)	**1.5**(0.1)	15/15
xNESas	**2.0**(2)	3.3(0.9)	7.1(2)	5.9(0.9)	5.5(0.7)	**1.2**(0.1)	15/15

Table 16: 10-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-3	1e-5	1e-7	#succ
f15	4774	39246	73643	75790	77814	79834	12/15
ACOR	41(40)	220(255)	436(488)	424(462)	413(450)	402(438)	4/15
BIPOPaCMA	**1.1**(0.7)	**1.5**(1)	**1.2**(0.7)	**1.2**(0.7)	**1.2**(0.7)	**1.2**(0.7)	15/15
BIPOPsaACM	**1.0**(1.0)	**1.1**(0.8)	**0.89**(0.5)	**0.87**(0.5)	**0.92**(0.8)	**0.91**(0.8)	15/15
CMA	**0.89**(0.7)	**1.2**(0.7)	**0.79**(0.4)	**0.80**(0.4)	**0.81**(0.4)	**0.82**(0.4)	15/15
CMAES	**2.0**(2)	190(194)	∞	∞	∞	∞ *5e5*	0/15
CMAa	**1.1**(1)	**1.0**(0.6)	**0.76**(0.4)	**0.77**(0.4)	**0.78**(0.4)	**0.79**(0.4)	15/15
CMAm	**0.74**(0.5)	**1.0**(0.8)	**1.0**(0.6)	**1.0**(0.6)	**1.1**(0.6)	**1.1**(0.6)	15/15
CMAma	**0.91**(1.0)	**0.89**(0.4)	**0.93**(0.7)	**0.94**(0.7)	**0.95**(0.7)	**0.96**(0.7)	15/15
CMAmah	**1.4**(1)	**0.96**(0.3)	**0.78**(0.4)	**0.79**(0.4)	**0.80**(0.4)	**0.80**(0.4)	15/15
CMAmh	**1.3**(1)	**0.97**(0.8)	**0.95**(0.8)	**0.95**(0.8)	**0.96**(0.8)	**0.97**(0.8)	15/15
DBRCGA	126(143)	∞	∞	∞	∞	∞ *1e6*	0/15
DE	108(73)	∞	∞	∞	∞	∞ *5e5*	0/15
DE-AUTO	24(14)	68(65)	203(228)	197(198)	192(212)	187(201)	1/15
DE-BFGS	4.5(3)	6.5(4)	8.8(8)	8.5(8)	8.3(8)	8.1(8)	12/15
DE-ROLL	24(24)	38(34)	199(218)	194(195)	189(199)	184(194)	1/15
DE-SIMPLEX	18(10)	16(14)	29(28)	28(27)	28(26)	27(26)	6/15
DEctpb	84(59)	∞	∞	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**0.90**(0.9)	**0.72**(0.5)	**0.76**(0.4)	**0.74**(0.4)	**0.73**(0.4)	**0.73**(0.4)	15/15
JADEb	14(15)	∞	∞	∞	∞	∞ *5e5*	0/15
JADEctpb	3.9(1)	∞	∞	∞	∞	∞ *5e5*	0/15
MVDE	37(29)	∞	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**0.77**(0.6)	**1.9**(0.9)	**1.3**(0.8)	**1.3**(0.8)	**1.3**(0.8)	**1.3**(0.8)	15/15
NIPOPaCMA	**0.71**(0.6)	**0.78**(0.8)	**0.75**(0.4)	**0.76**(0.4)	**0.77**(0.4)	**0.78**(0.4)	15/15
PSO-BFGS	43(30)	∞	∞	∞	∞	∞ *1e6*	0/15
SNES	5.0(6)	503(556)	∞	∞	∞	∞ *3e6*	0/15
xNES	**2.4**(3)	190(216)	∞	∞	∞	∞ *2e6*	0/15
xNESas	3.7(4)	168(203)	407(524)	395(436)	385(443)	375(440)	2/15

Table 17: 10-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-3	1e-5	1e-7	#succ
f16	425	7029	15779	51151	65798	71570	15/15
ACOR	169(139)	981(1089)	489(491)	364(407)	683(694)	2005(2166)	1/15
BIPOPaCMA	**2.6**(2)	**0.71**(1)	**0.84**(1.0)	**0.75**(0.8)	**0.78**(0.8)	**0.76**(0.7)	15/15
BIPOPsaACM	**2.4**(2)	**0.67**(0.7)	**0.82**(0.5)	**0.69**(0.6)	**0.63**(0.5)	**0.61**(0.5)	15/15
CMA	**2.2**(1)	**1.2**(1)	**1.8**(2)	**1.0**(0.9)	**0.84**(0.7)	**0.80**(0.6)	15/15
CMAES	**2.7**(0.9)	**2.0**(2)	8.3(9)	41(45)	107(129)	98(108)	0/15
CMAa	**2.4**(2)	**0.78**(1)	**0.90**(0.9)	**1.0**(0.8)	**0.84**(0.6)	**0.80**(0.6)	15/15
CMAm	**1.6**(0.8)	**0.95**(1)	**1.3**(0.8)	**0.77**(0.6)	**0.76**(0.7)	**0.73**(0.6)	15/15
CMAma	**1.4**(0.7)	**1.2**(1)	**1.2**(0.7)	**0.67**(0.4)	**0.56**(0.4)	**0.53**(0.3)	15/15
CMAmah	3.2(4)	**0.85**(0.7)	**1.0**(0.6)	**0.62**(0.4)	**0.52**(0.4)	**0.49**(0.3)	15/15
CMAmh	**2.6**(4)	**1.1**(1)	**1.3**(0.9)	**0.88**(0.5)	**0.74**(0.4)	**0.70**(0.4)	15/15
DBRCGA	8.6(6)	56(66)	283(317)	∞	∞	∞ *1e6*	0/15
DE	106(76)	∞	∞	∞	∞	∞ *5e5*	0/15
DE-AUTO	18(22)	45(37)	90(94)	293(314)	∞	∞ *1e6*	0/15
DE-BFGS	26(24)	15(10)	39(41)	279(294)	∞	∞ *1e6*	0/15
DE-ROLL	13(10)	49(49)	148(160)	∞	∞	∞ *1e6*	0/15
DE-SIMPLEX	6.0(10)	13(9)	94(109)	134(141)	107(107)	∞ *1e6*	0/15
DEctpb	114(104)	∞	∞	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**2.5**(1)	**0.67**(0.7)	**0.72**(0.6)	**0.44**(0.2)	**0.36**(0.1)↓	**0.34**(0.1)↓	15/15
JADEb	20(14)	112(132)	207(253)	∞	∞	∞ *5e5*	0/15
JADEctpb	17(9)	82(107)	∞	∞	∞	∞ *5e5*	0/15
MVDE	20(17)	193(214)	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	3.3(2)	**0.67**(0.5)	**1.1**(0.6)	**0.48**(0.4)	**0.40**(0.3)↓	**0.38**(0.3)↓	15/15
NIPOPaCMA	**2.8**(2)	**0.63**(0.5)	**0.68**(0.7)	**0.44**(0.2)↓	**0.37**(0.2)↓	**0.36**(0.2)↓	15/15
PSO-BFGS	41(26)	245(322)	∞	∞	∞	∞ *1e6*	0/15
SNES	**2.6**(2)	**1.4**(2)	14(12)	65(67)	322(357)	∞ *3e6*	0/15
xNES	8.2(5)	**2.2**(3)	3.9(5)	3.2(3)	**2.6**(2)	**2.4**(2)	15/15
xNESas	7.1(5)	**1.8**(2)	3.2(6)	**2.2**(2)	**1.8**(2)	**1.7**(1)	15/15

Table 18: 10-D, running time excess ERT/$\text{ERT}_{\text{best 2009}}$ 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-3	1e-5	1e-7	#succ
f17	26	429	2203	9851	20190	26503	15/15
ACOR	5.4(3)	**2.6**(0.7)	**1.1**(0.4)	24(31)	239(338)	278(281)	11/15
BIPOPaCMA	**2.1**(1)	**1.1**(0.5)	**0.81**(1)	**1.3**(1.0)	**0.90**(0.3)	**1.2**(0.8)	15/15
BIPOPsaACM	**2.0**(2)	**2.6**(1)	**1.5**(2)	**1.1**(0.5)	**1.1**(0.6)	**2.1**(2)	15/15
CMA	**1.9**(2)	**1.1**(0.3)	**0.66**(0.2)	**1.1**(0.9)	**0.81**(0.3)	**1.1**(0.4)	15/15
CMAES	**2.0**(1)	**1.1**(0.6)	**0.43**(0.1)$_\downarrow$	**2.6**(4)	∞	∞ *5e5*	0/15
CMAa	**2.4**(2)	**1.0**(0.3)	**0.61**(0.1)	**0.80**(0.5)	**0.75**(0.3)	**0.86**(0.3)	15/15
CMAm	**1.8**(1.0)	**1.1**(0.6)	**1.1**(1)	**0.80**(0.5)	**0.80**(0.1)	**0.92**(0.4)	15/15
CMAma	**1.5**(1)	3.0(0.4)	**1.2**(1)	**0.84**(0.5)	**0.75**(0.2)	**0.79**(0.4)	15/15
CMAmah	**1.3**(0.7)	4.2(7)	**1.6**(1)	**1.3**(0.6)	**1.1**(0.6)	**1.1**(0.4)	15/15
CMAmh	**1.5**(2)	6.6(9)	**2.4**(2)	**1.1**(0.9)	**0.99**(0.3)	**1.1**(0.4)	15/15
DBRCGA	3.7(4)	16(6)	77(67)	1426(1777)	∞	∞ *1e6*	0/15
DE	3.5(4)	7.4(2)	3.8(0.9)	**2.6**(0.8)	12(13)	45(55)	5/15
DE-AUTO	36(98)	207(181)	150(239)	108(109)	69(75)	169(189)	1/15
DE-BFGS	6.9(8)	38(24)	144(230)	115(136)	83(101)	∞ *1e6*	0/15
DE-ROLL	13(12)	99(62)	118(229)	454(504)	∞	∞ *1e6*	0/15
DE-SIMPLEX	18(39)	114(35)	467(683)	∞	∞	∞ *1e6*	0/15
DEctpb	4.0(5)	8.2(2)	4.6(0.7)	3.4(0.5)	5.1(2)	14(12)	13/15
IPOPsaACM	**2.4**(2)	**1.1**(0.3)	**1.1**(1)	**1.2**(0.7)	**1.2**(0.5)	**1.4**(0.6)	15/15
JADEb	**2.7**(3)	4.1(2)	**2.7**(1)	14(23)	75(90)	∞ *5e5*	0/15
JADEctpb	3.2(4)	5.2(1.0)	**2.8**(0.6)	**1.9**(0.5)	5.2(12)	6.8(10)	12/15
MVDE	4.7(5)	16(3)	13(4)	42(51)	158(176)	566(585)	0/15
NBIPOPaCMA	3.0(3)	3.2(7)	**1.5**(2)	**1.3**(0.9)	**1.0**(0.5)	**1.3**(0.4)	15/15
NIPOPaCMA	**2.1**(1.0)	**1.1**(0.2)	**0.84**(1)	**1.1**(0.5)	**0.81**(0.3)	**0.94**(0.5)	15/15
PSO-BFGS	7.7(8)	108(99)	201(237)	125(118)	170(182)	∞ *1e6*	0/15
SNES	**1.6**(1)	**1.1**(0.7)	4.2(7)	6.4(6)	28(20)	517(526)	2/15
xNES	**2.6**(2)	**1.8**(0.7)	**1.2**(0.2)	**0.69**(0.0)	**1.5**(1)	6.1(7)	15/15
xNESas	**1.5**(1)	**1.7**(0.3)	**1.1**(0.1)	**0.63**(0.0)	**1.2**(1)	**2.8**(3)	15/15

Table 19: 10-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-3	1e-5	1e-7	#succ
f18	238	836	7012	27536	37234	42708	15/15
ACOR	**2.8**(1)	**2.9**(1)	118(35)	747(913)	∞	∞ *1e7*	0/15
BIPOPaCMA	**1.0**(0.4)	**2.2**(4)	**0.84**(0.9)	**0.72**(0.5)	**0.85**(0.4)	**0.96**(0.4)	15/15
BIPOPsaACM	**1.5**(0.6)	**2.2**(4)	**0.81**(0.6)	**0.63**(0.4)	**0.91**(0.6)	**0.91**(0.6)	15/15
CMA	**1.0**(0.4)	**1.7**(0.5)	**1.0**(0.7)	**0.83**(0.5)	**0.92**(0.3)	**0.93**(0.3)	15/15
CMAES	**1.2**(0.6)	**2.0**(4)	**1.4**(2)	45(49)	∞	∞ *5e5*	0/15
CMAa	**1.1**(0.4)	**2.9**(4)	**0.85**(1)	**0.74**(0.3)	**0.74**(0.3)$_{\downarrow}$	**0.84**(0.3)	15/15
CMAm	**0.94**(0.4)	**0.91**(0.4)	**0.66**(0.4)	**0.82**(0.4)	**0.82**(0.3)$_{\downarrow}$	**0.85**(0.3)$_{\downarrow 2}$	15/15
CMAma	**1.0**(0.4)	**1.6**(3)	**0.78**(0.4)	**0.63**(0.5)	**0.70**(0.3)$_{\downarrow 2}$	**0.69**(0.2)$_{\downarrow 3}$	15/15
CMAmah	**1.8**(0.8)	8.4(6)	**2.2**(3)	**0.97**(0.7)	**0.92**(0.6)	**0.88**(0.5)	15/15
CMAmh	**1.2**(1)	6.3(7)	**2.0**(2)	**1.1**(0.5)	**1.0**(0.4)	**1.0**(0.4)	15/15
DBRCGA	12(4)	25(7)	108(133)	∞	∞	∞ *1e6*	0/15
DE	5.9(2)	12(7)	10(4)	19(20)	96(94)	∞ *5e5*	0/15
DE-AUTO	106(99)	250(359)	108(144)	82(73)	399(417)	∞ *1e6*	0/15
DE-BFGS	25(15)	51(31)	71(76)	115(127)	191(202)	∞ *1e6*	0/15
DE-ROLL	79(39)	315(611)	421(504)	∞	∞	∞ *1e6*	0/15
DE-SIMPLEX	135(112)	1304(1799)	973(1262)	532(528)	∞	∞ *1e6*	0/15
DEctpb	6.1(2)	13(5)	6.0(3)	18(13)	197(248)	∞ *5e5*	0/15
IPOPsaACM	**1.3**(0.6)	**1.2**(0.5)	**1.6**(1)	**0.75**(0.5)	**1.0**(0.4)	**1.3**(0.6)	15/15
JADEb	3.2(2)	5.6(2)	4.6(7)	∞	∞	∞ *5e5*	0/15
JADEctpb	4.1(2)	6.4(2)	**1.6**(0.3)	**1.9**(3)	4.9(7)	16(20)	7/15
MVDE	10(4)	32(10)	53(74)	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**1.2**(0.5)	**2.1**(4)	**0.67**(0.7)	**0.81**(0.6)	**1.1**(0.7)	**1.1**(0.6)	15/15
NIPOPaCMA	**1.2**(0.4)	**1.0**(0.2)	**0.87**(0.9)	**0.81**(0.5)	**0.85**(0.3)	**0.86**(0.2)	15/15
PSO-BFGS	74(31)	188(213)	133(160)	538(600)	∞	∞ *1e6*	0/15
SNES	**1.3**(0.9)	6.2(18)	5.9(6)	35(26)	∞	∞ *3e6*	0/15
xNES	**1.1**(0.7)	**2.2**(0.2)	**0.54**(0.0)	**0.29**(0.0)$_{\downarrow 4}$	**1.1**(0.6)	4.1(4)	15/15
xNESas	**1.1**(0.5)	**2.2**(0.5)	**0.72**(0.1)	**0.32**(0.0)$_{\downarrow 4}$	**0.75**(0.5)	**1.3**(0.8)	15/15

Table 20: 10-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-3	1e-5	1e-7	#succ
f19	1	1	10609	1.4e6	1.4e6	1.4e6	15/15
ACOR	187(48)	1.8e6(2e6)	∞	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	63(48)	1.0e4(4478)	**11**(9)	**0.77**(0.3)	**0.77**(0.3)	**0.77**(0.3)	15/15
BIPOPsaACM	44(37)	1.1e4(8202)	**5.9**(5)	**0.78**(0.5)	**0.78**(0.5)	**0.78**(0.5)	15/15
CMA	56(28)	8548(2692)	37(38)	**1.1**(0.5)	**1.1**(0.5)	**1.2**(0.8)	13/15
CMAES	67(50)	1.3e4(9380)	144(165)	∞	∞	∞ *5e5*	0/15
CMAa	63(34)	**7971**(5628)	35(50)	**0.95**(0.8)	**0.95**(0.8)	**0.94**(0.8)	12/15
CMAm	52(45)	8856(7009)	32(56)	**0.80**(0.4)	**0.80**(0.4)	**0.80**(0.4)	14/15
CMAma	56(42)	5.7e4(2e4)	31(38)	**1.1**(0.9)	**1.1**(0.9)	**1.1**(0.9)	12/15
CMAmah	**43**(28)	6.3e4(8e4)	27(31)	**0.77**(0.4)	**0.77**(0.4)	**0.77**(0.4)	15/15
CMAmh	**42**(26)	**7109**(6223)	55(74)	**1.2**(1)	**1.2**(0.8)	**1.2**(0.9)	12/15
DBRCGA	379(265)	1.3e5(5e4)	1396(1461)	∞	∞	∞ *1e6*	0/15
DE	387(218)	7.5e6(8e6)	∞	∞	∞	∞ *5e5*	0/15
DE-AUTO	1579(2240)	4.7e4(4e4)	96(99)	∞	∞	∞ *1e6*	0/15
DE-BFGS	665(492)	**6773**(6367)	**10**(12)	∞	∞	∞ *1e6*	0/15
DE-ROLL	801(1046)	2.7e4(2e4)	105(87)	∞	∞	∞ *1e6*	0/15
DE-SIMPLEX	1048(1127)	2.6e4(2e4)	42(53)	∞	∞	∞ *1e6*	0/15
DEctpb	305(222)	3.5e6(4e6)	∞	∞	∞	∞ *5e5*	0/15
IPOPsaACM	60(42)	1.8e4(8701)	**9.3**(8)	**0.49**(0.3)$\downarrow_2$	**0.49**(0.3)$\downarrow_2$	**0.49**(0.3)$\downarrow_2$	15/15
JADEb	174(106)	2.0e5(1e5)	∞	∞	∞	∞ *5e5*	0/15
JADEctpb	165(106)	7.8e4(6e4)	679(742)	∞	∞	∞ *5e5*	0/15
MVDE	473(308)	4.8e5(4e5)	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	73(34)	**8153**(7547)	13(13)	**0.82**(0.5)	**0.82**(0.5)	**0.82**(0.5)	15/15
NIPOPaCMA	55(24)	8205(6590)	29(47)	**1.5**(1)	**1.5**(1)	**1.5**(1)	15/15
PSO-BFGS	766(800)	1.3e4(8284)	16(9)	∞	∞	∞ *1e6*	0/15
SNES	47(20)	3.5e4(7e4)	4148(4384)	∞	∞	∞ *3e6*	0/15
xNES	**40**(23)	2.6e5(3e5)	3158(3435)	∞	∞	∞ *2e6*	0/15
xNESas	**38**(24)	4.0e5(6e5)	1440(1650)	∞	∞	∞ *5e6*	0/15

Table 21: 10-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-3	1e-5	1e-7	#succ
f20	32	15426	5.5e5	5.7e5	5.8e5	5.9e5	15/15
ACOR	11(4)	**1.6**(2)	**1.3**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	15/15
BIPOPaCMA	4.6(1)	3.2(2)	**1.2**(0.4)	**1.2**(0.4)	**1.2**(0.3)	**1.2**(0.3)	15/15
BIPOPsaACM	4.4(0.6)	**1.4**(1)	**1.1**(0.5)	**1.1**(0.5)	**1.0**(0.5)	**1.0**(0.5)	15/15
CMA	4.9(2)	**2.8**(0.8)	**0.89**(0.4)	**0.90**(0.4)	**0.91**(0.4)	**0.92**(0.4)	15/15
CMAES	5.7(2)	22(20)	∞	∞	∞	∞ *5e5*	0/15
CMAa	4.8(2)	**1.8**(0.8)	**0.86**(0.4)	**0.88**(0.4)	**0.88**(0.4)	**0.89**(0.4)	15/15
CMAm	3.9(2)	3.2(2)	**0.88**(0.4)	**0.90**(0.4)	**0.90**(0.4)	**0.91**(0.4)	15/15
CMAma	4.2(1)	**2.1**(0.9)	**0.77**(0.4)	**0.78**(0.4)	**0.79**(0.4)	**0.79**(0.4)	15/15
CMAmah	**3.0**(0.8)	**2.5**(1)	**0.83**(0.4)	**0.85**(0.4)	**0.85**(0.4)	**0.86**(0.4)	15/15
CMAmh	**3.0**(0.7)	3.3(2)	**0.75**(0.4)	**0.77**(0.4)	**0.78**(0.4)	**0.78**(0.4)	15/15
DBRCGA	49(8)	5.8(6)	∞	∞	∞	∞ *1e6*	0/15
DE	27(11)	**0.77**(0.3)	**0.48**(0.5)$_{\downarrow}$	**0.47**(0.5)$_{\downarrow}$	**0.46**(0.5)$_{\downarrow}$	**0.46**(0.5)$_{\downarrow}$	13/15
DE-AUTO	**3.2**(0.5)	**1.6**(1)	13(14)	12(12)	12(14)	12(14)	2/15
DE-BFGS	4.6(2)	**0.43**(0.3)	∞	∞	∞	∞ *1e6*	0/15
DE-ROLL	49(78)	**0.57**(0.7)	**3.0**(3)	**2.9**(3)	**2.8**(3)	**2.8**(3)	7/15
DE-SIMPLEX	11(6)	3.1(2)	∞	∞	∞	∞ *1e6*	0/15
DEctpb	26(6)	**1.9**(0.5)	**0.14**(0.0)$_{\downarrow 4}$	**0.15**(0.0)$_{\downarrow 4}$	**0.15**(0.0)$_{\downarrow 4}$	**0.15**(0.0)$_{\downarrow 4}$	15/15
IPOPsaACM	4.3(0.7)	**0.86**(0.4)	**0.74**(0.4)	**0.75**(0.5)	**0.75**(0.4)	**0.74**(0.4)	15/15
JADEb	12(4)	**0.27**(0.1)	**3.0**(3)	**2.9**(3)	**2.9**(3)	**2.8**(3)	3/15
JADEctpb	14(6)	**0.73**(0.2)	**0.16**(0.2)$_{\downarrow 4}$	**0.21**(0.2)$_{\downarrow 4}$	**0.29**(0.2)$_{\downarrow 4}$	**0.34**(0.2)$_{\downarrow 4}$	15/15
MVDE	50(13)	**0.98**(0.4)	**0.22**(0.0)$_{\downarrow 3}$	**0.23**(0.0)$_{\downarrow 3}$	**0.24**(0.0)$_{\downarrow 3}$	**0.25**(0.0)$_{\downarrow 3}$	14/15
NBIPOPaCMA	4.9(2)	3.1(2)	**1.3**(0.5)	**1.3**(0.5)	**1.3**(0.5)	**1.3**(0.5)	15/15
NIPOPaCMA	4.5(1)	**2.6**(1)	**0.77**(0.4)	**0.78**(0.4)	**0.79**(0.4)	**0.80**(0.4)	15/15
PSO-BFGS	4.3(2)	**1.0**(0.8)	26(29)	25(28)	25(24)	24(27)	1/15
SNES	**3.1**(0.8)	7.2(6)	∞	∞	∞	∞ *3e6*	0/15
xNES	3.6(2)	**1.1**(1)	∞	∞	∞	∞ *2e6*	0/15
xNESas	3.4(2)	**2.1**(3)	106(119)	102(116)	100(104)	99(109)	1/15

Table 22: 10-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-3	1e-5	1e-7	#succ
f21	130	2236	4392	4618	5074	11329	15/15
ACOR	36(4)	1457(2351)	1746(2270)	1661(2166)	1512(1971)	677(880)	10/15
BIPOPaCMA	**2.7**(0.7)	**5.9**(12)	14(15)	13(14)	12(13)	5.4(6)	15/15
BIPOPsaACM	**2.5**(4)	**2.3**(2)	**1.5**(2)	**1.5**(2)	**1.4**(2)	**0.61**(0.7)	15/15
CMA	6.8(12)	21(25)	11(13)	11(13)	11(12)	4.9(5)	15/15
CMAES	7.0(20)	6.4(6)	**6.0**(9)	**5.7**(8)	**5.2**(7)	**2.4**(3)	15/15
CMAa	**2.8**(0.7)	53(148)	30(78)	29(73)	26(66)	12(30)	13/15
CMAm	**2.5**(1)	50(134)	46(75)	44(71)	40(65)	18(29)	12/15
CMAma	5.7(9)	89(146)	47(74)	45(71)	41(65)	19(29)	12/15
CMAmah	**2.4**(5)	71(147)	63(96)	60(82)	55(74)	25(38)	11/15
CMAmh	**2.3**(5)	108(151)	67(83)	65(79)	59(73)	27(33)	11/15
DBRCGA	18(8)	40(68)	47(56)	46(53)	42(48)	20(21)	14/15
DE	24(15)	17(22)	10(11)	10(11)	10(10)	4.6(4)	15/15
DE-AUTO	4.4(7)	28(49)	32(36)	31(34)	28(31)	13(14)	15/15
DE-BFGS	**2.6**(2)	7.6(10)	8.8(18)	8.4(18)	7.7(16)	32(51)	4/15
DE-ROLL	22(31)	53(86)	48(92)	45(87)	41(80)	18(36)	15/15
DE-SIMPLEX	16(23)	83(156)	83(96)	79(92)	72(83)	32(37)	14/15
DEctpb	21(9)	43(112)	23(57)	22(54)	21(50)	10(22)	13/15
IPOPsaACM	**2.5**(4)	15(23)	48(109)	46(104)	42(95)	19(43)	15/15
JADEb	23(45)	25(31)	18(18)	18(18)	16(16)	7.4(7)	15/15
JADEctpb	7.7(3)	**6.0**(6)	**3.6**(3)	**5.0**(5)	**6.3**(7)	**3.7**(4)	15/15
MVDE	21(9)	8.9(8)	6.5(4)	13(9)	19(13)	12(7)	15/15
NBIPOPaCMA	5.6(11)	11(16)	10(11)	9.3(10)	8.5(9)	**3.8**(4)	15/15
NIPOPaCMA	6.1(10)	99(140)	71(75)	68(72)	62(65)	28(29)	15/15
PSO-BFGS	**2.6**(2)	**2.2**(3)	**2.1**(3)	**2.1**(3)	**1.9**(3)	26(44)	7/15
SNES	116(229)	82(94)	77(117)	73(111)	67(101)	30(45)	15/15
xNES	125(230)	66(58)	94(146)	89(139)	81(126)	37(57)	14/15
xNESas	84(155)	69(85)	58(59)	55(56)	50(51)	22(23)	15/15

Table 23: 10-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-3	1e-5	1e-7	#succ
f22	98	2839	6353	6798	8296	10351	15/15
ACOR	9762(3e4)	5191(5996)	1.1e4(1e4)	1.0e4(1e4)	8351(9534)	6694(7246)	2/15
BIPOPaCMA	29(34)	**6.4**(9)	143(202)	133(189)	109(155)	88(124)	15/15
BIPOPsaACM	13(13)	**3.7**(6)	**32**(18)	**30**(17)	**25**(14)	**20**(11)	15/15
CMA	**6.4**(15)	157(222)	1357(1439)	1268(1444)	1039(1157)	833(908)	1/15
CMAES	22(29)	12(12)	56(61)	53(57)	43(45)	**35**(38)	11/15
CMAa	10(15)	127(209)	1359(1543)	1270(1368)	1041(1111)	834(925)	1/15
CMAm	14(14)	210(327)	∞	∞	∞	∞ *6e5*	0/15
CMAma	26(53)	153(230)	1365(1531)	1276(1406)	1045(1088)	838(992)	1/15
CMAmah	**6.8**(18)	246(323)	∞	∞	∞	∞ *6e5*	0/15
CMAmh	17(36)	194(314)	∞	∞	∞	∞ *6e5*	0/15
DBRCGA	27(16)	38(41)	62(92)	60(87)	52(69)	43(53)	13/15
DE	68(19)	45(62)	50(50)	53(51)	46(44)	39(33)	11/15
DE-AUTO	144(286)	81(104)	206(275)	193(238)	158(238)	127(152)	5/15
DE-BFGS	**4.2**(6)	12(17)	**26**(28)	**24**(27)	**20**(22)	121(154)	0/15
DE-ROLL	34(84)	44(62)	140(158)	132(176)	109(138)	127(144)	5/15
DE-SIMPLEX	95(316)	65(137)	90(104)	85(83)	70(68)	69(78)	10/15
DEctpb	30(28)	128(175)	235(274)	225(257)	187(211)	152(185)	4/15
IPOPsaACM	120(46)	175(219)	1652(1871)	1544(1714)	1265(1434)	1014(1172)	9/15
JADEb	66(146)	**11**(13)	**33**(41)	32(38)	26(32)	**21**(25)	13/15
JADEctpb	22(4)	68(91)	111(118)	117(126)	144(163)	147(179)	4/15
MVDE	33(17)	141(183)	253(318)	270(304)	869(941)	∞ *1e6*	0/15
NBIPOPaCMA	38(35)	17(13)	34(16)	**31**(15)	**26**(12)	**21**(10)	15/15
NIPOPaCMA	81(201)	61(114)	131(147)	123(137)	101(112)	81(90)	15/15
PSO-BFGS	**5.2**(5)	**1.8**(2)	**3.0**(4)	**2.8**(4)	**2.3**(3)	93(116)	0/15
SNES	307(307)	87(108)	93(113)	89(103)	96(120)	105(89)	14/15
xNES	125(155)	105(190)	131(168)	123(147)	101(127)	81(102)	13/15
xNESas	70(204)	53(70)	84(124)	79(116)	65(95)	52(76)	15/15

Table 24: 10-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-3	1e-5	1e-7	#succ
f23	2.8	915	16425	2.0e5	2.1e5	2.1e5	15/15
ACOR	**2.5**(2)	1656(2613)	∞	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	**2.7**(3)	20(13)	**1.8**(2)	**1.4**(1)	**1.4**(1)	**1.4**(1)	15/15
BIPOPsaACM	4.9(4)	19(15)	**1.8**(1)	**0.55**(0.3)	**0.65**(0.4)	**0.92**(0.3)	15/15
CMA	**1.8**(2)	548(489)	∞	∞	∞	∞ *2e6*	0/15
CMAES	**2.9**(2)	44(44)	22(28)	∞	∞	∞ *5e5*	0/15
CMAa	**2.8**(2)	277(305)	727(835)	∞	∞	∞ *2e6*	0/15
CMAm	**1.2**(0.7)	243(343)	734(926)	∞	∞	∞ *2e6*	0/15
CMAma	**2.9**(2)	67(90)	224(277)	124(140)	120(131)	118(130)	1/15
CMAmah	3.9(5)	136(266)	459(566)	129(142)	125(145)	123(126)	1/15
CMAmh	3.2(2)	423(667)	1455(1627)	∞	∞	∞ *2e6*	0/15
DBRCGA	**1.8**(2)	105(121)	∞	∞	∞	∞ *1e6*	0/15
DE	**2.5**(1)	1384(1537)	∞	∞	∞	∞ *5e5*	0/15
DE-AUTO	**1.2**(0.9)	**2.4**(2)	12(13)	∞	∞	∞ *1e6*	0/15
DE-BFGS	**1.8**(2)	**3.6**(6)	52(65)	∞	∞	∞ *1e6*	0/15
DE-ROLL	**1.5**(1)	5.7(7)	∞	∞	∞	∞ *1e6*	0/15
DE-SIMPLEX	**1.9**(2)	**0.57**(0.6)	**7.0**(6)	∞	∞	∞ *1e6*	0/15
DEctpb	**1.3**(1)	473(549)	∞	∞	∞	∞ *5e5*	0/15
IPOPsaACM	**2.5**(3)	199(326)	429(609)	114(133)	111(129)	108(139)	5/15
JADEb	**1.9**(2)	169(135)	∞	∞	∞	∞ *5e5*	0/15
JADEctpb	**1.5**(1)	89(93)	137(154)	∞	∞	∞ *5e5*	0/15
MVDE	**2.0**(2)	163(280)	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**2.4**(2)	18(19)	**2.9**(2)	**1.5**(1)	**1.5**(1.0)	**1.5**(1.0)	15/15
NIPOPaCMA	**2.8**(2)	88(109)	8.4(8)	**1.1**(0.7)	**1.2**(0.7)	**1.2**(0.7)	15/15
PSO-BFGS	**1.8**(2)	**3.0**(4)	22(16)	∞	∞	∞ *1e6*	0/15
SNES	**1.3**(1)	60(59)	113(141)	∞	∞	∞ *3e6*	0/15
xNES	**1.8**(2)	933(1037)	∞	∞	∞	∞ *2e6*	0/15
xNESas	**1.4**(1)	594(669)	∞	∞	∞	∞ *5e6*	0/15

Table 25: 10-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-3	1e-5	1e-7	#succ
f24	98761	1.0e6	7.5e7	7.5e7	7.5e7	7.5e7	1/15
ACOR	∞	∞	∞	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	**0.98**(1)	**2.2**(2)	**0.93**(1)	**0.93**(1)	**0.93**(1)	**0.93**(1)	2/15
BIPOPsaACM	**1.3**(2)	**1.6**(2)	**0.61**(0.7)	**2.0**(2)	**2.0**(2)	**2.0**(2)	1/15
CMA	41(51)	27(32)	∞	∞	∞	∞ *2e6*	0/15
CMAES	**0.95**(1)	∞	∞	∞	∞	∞ *5e5*	0/15
CMAa	18(30)	13(13)	∞	∞	∞	∞ *2e6*	0/15
CMAm	18(21)	5.5(7)	∞	∞	∞	∞ *2e6*	0/15
CMAma	27(32)	5.8(7)	**0.39**(0.4)	**0.39**(0.4)	**0.39**(0.5)	**0.39**(0.5)	1/15
CMAmah	56(71)	27(31)	∞	∞	∞	∞ *2e6*	0/15
CMAmh	82(111)	13(14)	∞	∞	∞	∞ *2e6*	0/15
DBRCGA	32(38)	∞	∞	∞	∞	∞ *1e6*	0/15
DE	∞	∞	∞	∞	∞	∞ *5e5*	0/15
DE-AUTO	143(172)	∞	∞	∞	∞	∞ *1e6*	0/15
DE-BFGS	142(157)	∞	∞	∞	∞	∞ *1e6*	0/15
DE-ROLL	41(46)	6.9(7)	∞	∞	∞	∞ *1e6*	0/15
DE-SIMPLEX	21(30)	6.8(7)	∞	∞	∞	∞ *1e6*	0/15
DEctpb	∞	∞	∞	∞	∞	∞ *5e5*	0/15
IPOPsaACM	72(101)	17(19)	∞	∞	∞	∞ *1e7*	0/15
JADEb	21(25)	∞	∞	∞	∞	∞ *5e5*	0/15
JADEctpb	34(38)	∞	∞	∞	∞	∞ *5e5*	0/15
MVDE	∞	∞	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**0.90**(0.8)	**1.2**(2)	**0.58**(0.7)	**0.59**(0.6)	**0.59**(0.6)	**0.59**(0.7)	3/15
NIPOPaCMA	6.8(14)	**1.0**(2)	**0.23**(0.3)	**0.31**(0.3)	**0.31**(0.3)	**0.31**(0.3)	5/15
PSO-BFGS	8.4(10)	7.0(8)	∞	∞	∞	∞ *1e6*	0/15
SNES	**1.4**(2)	∞	∞	∞	∞	∞ *3e6*	0/15
xNES	336(364)	∞	∞	∞	∞	∞ *2e6*	0/15
xNESas	731(861)	∞	∞	∞	∞	∞ *5e6*	0/15

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