

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 name	short	paper	reference
ACOR		An ACO Algorithm Benchmarked on the BBOB Noiseless Function Testbed (Page 159)	[5]
BIPOPacCMA		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]
NBIPOPacCMA		Black-box Optimization Benchmarking of NIPOP-aCMA-ES and NBIPOP-aCMA-ES on the BBOB-2012 Noiseless Testbed (Page 269)	[13]
NIPOPacCMA		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 $\text{ERT}/\text{ERT}_{\text{best 2009}}$ 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
<i>f1</i>	22	23	23	23	23	23	15/15
ACOR	11(2)	25(4)	37(5)	63(5)	88(6)	113(7)	15/15
BIPOPacCMA	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
NBIPOPacCMA	4.6(3)	11(2)	18(3)	31(4)	43(4)	55(4)	15/15
NIPOPacCMA	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 $ERT/ERT_{\text{best 2009}}$ 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
f_2	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 $\text{ERT}/\text{ERT}_{\text{best}} 2009$ 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
<i>f3</i>	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)	∞	∞	∞	∞ <i>5e5</i>	0/15
CMAa	4.4(3)	818(998)	∞	∞	∞	∞ <i>1e6</i>	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)	∞	∞	∞	∞ <i>1e6</i>	0/15
SNES	18(17)	5463(5262)	∞	∞	∞	∞ <i>3e6</i>	0/15
xNES	15(17)	4196(4767)	∞	∞	∞	∞ <i>2e6</i>	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 $\text{ERT}/\text{ERT}_{\text{best 2009}}$ 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
f_4	2234	3626	3660	3707	3744	28767	12/15
ACOR	31(60)	∞	∞	∞	∞	∞ <i>1e7</i>	0/15
BIPOPacCMA	5.6(5)	∞	∞	∞	∞	∞ <i>1e7</i>	0/15
BIPOPsaACM	5.3(4)	∞	∞	∞	∞	∞ <i>1e7</i>	0/5
CMA	6.6(4)	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAES	24(29)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
CMAa	7.5(4)	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAm	5.5(4)	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAMA	5.6(4)	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAmah	8.6(8)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
CMAmh	8.6(3)	∞	∞	∞	∞	∞ <i>2e6</i>	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)	∞	∞	∞	∞	∞ <i>1e7</i>	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
NBIPOPacCMA	8.4(10)	∞	∞	∞	∞	∞ <i>1e7</i>	0/15
NIPOPacCMA	4.9 (5)	∞	∞	∞	∞	∞ <i>1e7</i>	0/15
PSO-BFGS	156(93)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
SNES	25(27)	∞	∞	∞	∞	∞ <i>3e6</i>	0/15
xNES	17(20)	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
xNESas	7.8(9)	∞	∞	∞	∞	∞ <i>4e6</i>	0/15

Table 6: 10-D, running time excess $\text{ERT}/\text{ERT}_{\text{best 2009}}$ 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
f_5	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 $\text{ERT}/\text{ERT}_{\text{best 2009}}$ 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
<i>f6</i>	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
BIPOPacCMA	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
NBIPOPacCMA	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
NIPOPacCMA	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

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Table 8: 10-D, running time excess $\text{ERT}/\text{ERT}_{\text{best}} 2009$ 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
<i>f7</i>	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)	∞	∞	∞	∞	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) _{↓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) _{↓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
<i>f₈</i>	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
BIPOPacCMA	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
NBIPOPacCMA	2.6 (1)	4.9(4)	4.8(3)	4.7(3)	4.8(3)	4.9(3)	15/15
NIPOPacCMA	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
<i>f9</i>	200	648	857	1065	1138	1185	15/15
ACOR	9.1(6)	326(21)	303(27)	457(68)	664(125)	868(185)	15/15
BIPOPacCMA	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
NBIPOPacCMA	3.4(0.4)	7.3(6)	6.4(5)	5.8(4)	5.7(4)	5.8(3)	15/15
NIPOPacCMA	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)	∞	∞ <i>1e7</i>	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)	∞	∞	∞	∞ <i>1e6</i>	0/15
DE	∞	∞	∞	∞	∞	∞ <i>5e5</i>	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	∞	∞	∞	∞	∞	∞ <i>5e5</i>	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	∞	∞	∞	∞	∞	∞ <i>1e6</i>	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)	∞	∞	∞	∞	∞ <i>3e6</i>	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 $ERT/ERT_{\text{best 2009}}$ 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
BIPOPacCMA	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)	∞	∞ <i>5e5</i>	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)	∞ <i>1e6</i>	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)	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞	∞ <i>1e6</i>	0/15
NBIPOPacCMA	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
NIPOPacCMA	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)	∞	∞	∞	∞	∞ <i>3e6</i>	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)	∞	∞	∞ <i>1e7</i>	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)	∞	∞	∞ <i>1e6</i>	0/15
DE	337(494)	748(956)	1344(1481)	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞ <i>1e6</i>	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)	∞	∞ <i>3e6</i>	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
<i>f13</i>	387	596	797	4587	6208	7779	15/15
ACOR	1069(1012)	1.9e4(3e4)	3.6e4(5e4)	1.5e4(2e4)	∞	∞ <i>1e7</i>	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)	∞	∞ <i>1e6</i>	0/15
DE	21(7)	51(28)	189(74)	∞	∞	∞ <i>5e5</i>	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)	∞ <i>1e6</i>	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)	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞ <i>1e6</i>	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)	∞ <i>1e6</i>	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
BIPOPacCMA	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
NBIPOPacCMA	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
NIPOPacCMA	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
<i>f15</i>	4774	39246	73643	75790	77814	79834	12/15
ACOR	41(40)	220(255)	436(488)	424(462)	413(450)	402(438)	4/15
BIPOPacCMA	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)	∞	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
DE	108(73)	∞	∞	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
JADEctpb	3.9(1)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
MVDE	37(29)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
NBIPOPacCMA	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
NIPOPacCMA	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)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
SNES	5.0(6)	503(556)	∞	∞	∞	∞ <i>3e6</i>	0/15
xNES	2.4 (3)	190(216)	∞	∞	∞	∞ <i>2e6</i>	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
BIPOPacCMA	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)	∞	∞	∞ <i>1e6</i>	0/15
DE	106(76)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
DE-AUTO	18(22)	45(37)	90(94)	293(314)	∞	∞ <i>1e6</i>	0/15
DE-BFGS	26(24)	15(10)	39(41)	279(294)	∞	∞ <i>1e6</i>	0/15
DE-ROLL	13(10)	49(49)	148(160)	∞	∞	∞ <i>1e6</i>	0/15
DE-SIMPLEX	6.0(10)	13(9)	94(109)	134(141)	107(107)	∞ <i>1e6</i>	0/15
DEctpb	114(104)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
IPOPsaACM	2.5 (1)	0.67 (0.7)	0.72 (0.6)	0.44 (0.2)	0.36 (0.1) \downarrow	0.34 (0.1) \downarrow	15/15
JADEb	20(14)	112(132)	207(253)	∞	∞	∞ <i>5e5</i>	0/15
JADEctpb	17(9)	82(107)	∞	∞	∞	∞ <i>5e5</i>	0/15
MVDE	20(17)	193(214)	∞	∞	∞	∞ <i>1e6</i>	0/15
NBIPOPacCMA	3.3(2)	0.67 (0.5)	1.1 (0.6)	0.48 (0.4)	0.40 (0.3) \downarrow	0.38 (0.3) \downarrow	15/15
NIPOPacCMA	2.8 (2)	0.63 (0.5)	0.68 (0.7)	0.44 (0.2) \downarrow	0.37 (0.2) \downarrow	0.36 (0.2) \downarrow	15/15
PSO-BFGS	41(26)	245(322)	∞	∞	∞	∞ <i>1e6</i>	0/15
SNES	2.6 (2)	1.4 (2)	14(12)	65(67)	322(357)	∞ <i>3e6</i>	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 $ERT/ERT_{\text{best } 2009}$ 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
<i>f17</i>	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
BIPOP _a CMA	2.1 (1)	1.1 (0.5)	0.81 (1)	1.3 (1.0)	0.90 (0.3)	1.2 (0.8)	15/15
BIPOP _{sa} ACM	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) _↓	2.6 (4)	∞	∞ <i>5e5</i>	0/15
CMA _a	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
CMA _m	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
CMA _a	1.5 (1)	3.0(0.4)	1.2 (1)	0.84 (0.5)	0.75 (0.2)	0.79 (0.4)	15/15
CMA _m ah	1.3 (0.7)	4.2(7)	1.6 (1)	1.3 (0.6)	1.1 (0.6)	1.1 (0.4)	15/15
CMA _m h	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)	∞	∞ <i>1e6</i>	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)	∞ <i>1e6</i>	0/15
DE-ROLL	13(12)	99(62)	118(229)	454(504)	∞	∞ <i>1e6</i>	0/15
DE-SIMPLEX	18(39)	114(35)	467(683)	∞	∞	∞ <i>1e6</i>	0/15
DEctpb	4.0(5)	8.2(2)	4.6(0.7)	3.4(0.5)	5.1(2)	14(12)	13/15
IPOP _{sa} ACM	2.4 (2)	1.1 (0.3)	1.1 (1)	1.2 (0.7)	1.2 (0.5)	1.4 (0.6)	15/15
JADE _b	2.7 (3)	4.1(2)	2.7 (1)	14(23)	75(90)	∞ <i>5e5</i>	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
NBIPOP _a CMA	3.0(3)	3.2(7)	1.5 (2)	1.3 (0.9)	1.0 (0.5)	1.3 (0.4)	15/15
NIPOP _a CMA	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)	∞ <i>1e6</i>	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
xNES _{as}	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
<i>f18</i>	238	836	7012	27536	37234	42708	15/15
ACOR	2.8 (1)	2.9 (1)	118(35)	747(913)	∞	∞ <i>1e7</i>	0/15
BIPOPacCMA	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)	∞	∞ <i>5e5</i>	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)	∞	∞	∞ <i>1e6</i>	0/15
DE	5.9(2)	12(7)	10(4)	19(20)	96(94)	∞ <i>5e5</i>	0/15
DE-AUTO	106(99)	250(359)	108(144)	82(73)	399(417)	∞ <i>1e6</i>	0/15
DE-BFGS	25(15)	51(31)	71(76)	115(127)	191(202)	∞ <i>1e6</i>	0/15
DE-ROLL	79(39)	315(611)	421(504)	∞	∞	∞ <i>1e6</i>	0/15
DE-SIMPLEX	135(112)	1304(1799)	973(1262)	532(528)	∞	∞ <i>1e6</i>	0/15
DEctpb	6.1(2)	13(5)	6.0(3)	18(13)	197(248)	∞ <i>5e5</i>	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)	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞ <i>1e6</i>	0/15
NBIPOPacCMA	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
NIPOPacCMA	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)	∞	∞ <i>1e6</i>	0/15
SNES	1.3 (0.9)	6.2(18)	5.9(6)	35(26)	∞	∞ <i>3e6</i>	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)	∞	∞	∞	∞ <i>1e7</i>	0/15
BIPOPacCMA	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)	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞ <i>1e6</i>	0/15
DE	387(218)	7.5e6(8e6)	∞	∞	∞	∞ <i>5e5</i>	0/15
DE-AUTO	1579(2240)	4.7e4(4e4)	96(99)	∞	∞	∞ <i>1e6</i>	0/15
DE-BFGS	665(492)	6773 (6367)	10 (12)	∞	∞	∞ <i>1e6</i>	0/15
DE-ROLL	801(1046)	2.7e4(2e4)	105(87)	∞	∞	∞ <i>1e6</i>	0/15
DE-SIMPLEX	1048(1127)	2.6e4(2e4)	42(53)	∞	∞	∞ <i>1e6</i>	0/15
Dectpb	305(222)	3.5e6(4e6)	∞	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞	∞ <i>5e5</i>	0/15
JADEctpb	165(106)	7.8e4(6e4)	679(742)	∞	∞	∞ <i>5e5</i>	0/15
MVDE	473(308)	4.8e5(4e5)	∞	∞	∞	∞ <i>1e6</i>	0/15
NBIPOPacCMA	73(34)	8153 (7547)	13(13)	0.82 (0.5)	0.82 (0.5)	0.82 (0.5)	15/15
NIPOPacCMA	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)	∞	∞	∞ <i>1e6</i>	0/15
SNES	47(20)	3.5e4(7e4)	4148(4384)	∞	∞	∞ <i>3e6</i>	0/15
xNES	40 (23)	2.6e5(3e5)	3158(3435)	∞	∞	∞ <i>2e6</i>	0/15
xNESas	38 (24)	4.0e5(6e5)	1440(1650)	∞	∞	∞ <i>5e6</i>	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)	∞	∞	∞	∞ <i>5e5</i>	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)	∞	∞	∞	∞ <i>1e6</i>	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)	∞	∞	∞	∞ <i>1e6</i>	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)	∞	∞	∞	∞ <i>1e6</i>	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)	∞	∞	∞	∞ <i>3e6</i>	0/15
xNES	3.6(2)	1.1 (1)	∞	∞	∞	∞ <i>2e6</i>	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
f_{21}	130	2236	4392	4618	5074	11329	15/15
ACOR	36(4)	1457(2351)	1746(2270)	1661(2166)	1512(1971)	677(880)	10/15
BIPOP _a CMA	2.7 (0.7)	5.9 (12)	14(15)	13(14)	12(13)	5.4(6)	15/15
BIPOP _{sa} ACM	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
IPOP _{sa} ACM	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
NBIPOP _a CMA	5.6(11)	11(16)	10(11)	9.3(10)	8.5(9)	3.8 (4)	15/15
NIPOP _a CMA	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
<i>f22</i>	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)	∞	∞	∞	∞ <i>6e5</i>	0/15
CMAma	26(53)	153(230)	1365(1531)	1276(1406)	1045(1088)	838(992)	1/15
CMAmah	6.8 (18)	246(323)	∞	∞	∞	∞ <i>6e5</i>	0/15
CMAmh	17(36)	194(314)	∞	∞	∞	∞ <i>6e5</i>	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)	∞ <i>1e6</i>	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)	∞	∞	∞	∞ <i>1e7</i>	0/15
BIPOPacCMA	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)	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAES	2.9 (2)	44(44)	22(28)	∞	∞	∞ <i>5e5</i>	0/15
CMAa	2.8 (2)	277(305)	727(835)	∞	∞	∞ <i>2e6</i>	0/15
CMAm	1.2 (0.7)	243(343)	734(926)	∞	∞	∞ <i>2e6</i>	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)	∞	∞	∞ <i>2e6</i>	0/15
DBRCGA	1.8 (2)	105(121)	∞	∞	∞	∞ <i>1e6</i>	0/15
DE	2.5 (1)	1384(1537)	∞	∞	∞	∞ <i>5e5</i>	0/15
DE-AUTO	1.2 (0.9)	2.4 (2)	12(13)	∞	∞	∞ <i>1e6</i>	0/15
DE-BFGS	1.8 (2)	3.6 (6)	52(65)	∞	∞	∞ <i>1e6</i>	0/15
DE-ROLL	1.5 (1)	5.7(7)	∞	∞	∞	∞ <i>1e6</i>	0/15
DE-SIMPLEX	1.9 (2)	0.57 (0.6)	7.0 (6)	∞	∞	∞ <i>1e6</i>	0/15
DEctpb	1.3 (1)	473(549)	∞	∞	∞	∞ <i>5e5</i>	0/15
IPOPsaACM	2.5 (3)	199(326)	429(609)	114(133)	111(129)	108(139)	5/15
JADEb	1.9 (2)	169(135)	∞	∞	∞	∞ <i>5e5</i>	0/15
JADEctpb	1.5 (1)	89(93)	137(154)	∞	∞	∞ <i>5e5</i>	0/15
MVDE	2.0 (2)	163(280)	∞	∞	∞	∞ <i>1e6</i>	0/15
NBIPOPacCMA	2.4 (2)	18(19)	2.9 (2)	1.5 (1)	1.5 (1.0)	1.5 (1.0)	15/15
NIPOPacCMA	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)	∞	∞	∞ <i>1e6</i>	0/15
SNES	1.3 (1)	60(59)	113(141)	∞	∞	∞ <i>3e6</i>	0/15
xNES	1.8 (2)	933(1037)	∞	∞	∞	∞ <i>2e6</i>	0/15
xNESas	1.4 (1)	594(669)	∞	∞	∞	∞ <i>5e6</i>	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	∞	∞	∞	∞	∞	∞ <i>1e7</i>	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)	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAES	0.95 (1)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
CMAa	18(30)	13(13)	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAm	18(21)	5.5(7)	∞	∞	∞	∞ <i>2e6</i>	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)	∞	∞	∞	∞ <i>2e6</i>	0/15
CMAmh	82(111)	13(14)	∞	∞	∞	∞ <i>2e6</i>	0/15
DBRCGA	32(38)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
DE	∞	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
DE-AUTO	143(172)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
DE-BFGS	142(157)	∞	∞	∞	∞	∞ <i>1e6</i>	0/15
DE-ROLL	41(46)	6.9(7)	∞	∞	∞	∞ <i>1e6</i>	0/15
DE-SIMPLEX	21(30)	6.8(7)	∞	∞	∞	∞ <i>1e6</i>	0/15
DEctpb	∞	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
IPOPsaACM	72(101)	17(19)	∞	∞	∞	∞ <i>1e7</i>	0/15
JADEb	21(25)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
JADEctpb	34(38)	∞	∞	∞	∞	∞ <i>5e5</i>	0/15
MVDE	∞	∞	∞	∞	∞	∞ <i>1e6</i>	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)	∞	∞	∞	∞ <i>1e6</i>	0/15
SNES	1.4 (2)	∞	∞	∞	∞	∞ <i>3e6</i>	0/15
xNES	336(364)	∞	∞	∞	∞	∞ <i>2e6</i>	0/15
xNESas	731(861)	∞	∞	∞	∞	∞ <i>5e6</i>	0/15

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