Comparison tables: BBOB 2012 testbed in 5-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 ($\mathrm{ERT}_{\mathrm{best}}$ 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: 05-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	11	12	12	12	12	12	15/15
ACOR	4.7(5)	15(3)	26(4)	47(6)	67(4)	90(6)	15/15
BIPOPaCMA	3.1(2)	8.0(3)	15(3)	28(3)	40(5)	52(5)	15/15
BIPOPsaACM	**2.7**(2)	6.4(2)	8.8(0.7)	12(1)	16(1)	19(2)	15/15
CMA	**2.6**(3)	9.3(4)	15(4)	28(4)	40(5)	54(6)	15/15
CMAES	**2.3**(2)	8.6(3)	15(5)	27(5)	41(4)	53(6)	15/15
CMAa	**2.5**(2)	8.1(4)	15(4)	25(5)	38(4)	51(8)	15/15
CMAm	**2.8**(2)	7.6(2)	12(3)	22(4)	30(5)	41(5)	15/15
CMAma	**2.7**(3)	7.3(4)	11(4)	22(4)	31(5)	40(7)	15/15
CMAmah	**1.7**(1)	**4.9**(1)	**8.1**(2)	16(2)	23(2)	30(3)	15/15
CMAmh	**1.8**(1)	**5.1**(2)	9.2(3)	16(3)	24(4)	31(4)	15/15
DBRCGA	5.1(7)	49(33)	96(26)	197(20)	301(33)	416(43)	15/15
DE	5.0(4)	21(8)	39(8)	82(8)	122(9)	164(7)	15/15
DE-AUTO	3.3(2)	5.8(0.7)	**5.9**(0.3)	**6.0**(0.2)	**6.0**(0.2)	**6.0**(0.2)	15/15
DE-BFGS	3.3(2)	**4.9**(0.2)	**4.9**(0.2)	**4.9**(0.2)	**4.9**(0.2)	**4.9**(0.2)	15/15
DE-ROLL	3.3(2)	17(21)	18(21)	19(21)	19(21)	19(21)	15/15
DE-SIMPLEX	**2.8**(3)	6.7(2)	10(5)	15(3)	19(2)	23(3)	15/15
DEctpb	5.8(5)	26(9)	45(9)	92(10)	139(12)	183(13)	15/15
IPOPsaACM	3.0(2)	6.9(2)	8.7(0.9)	**12**(1)	**15**(2)	**18**(1)	15/15
JADEb	3.4(3)	14(6)	27(5)	50(6)	76(7)	104(9)	15/15
JADEctpb	4.1(3)	18(6)	36(7)	77(7)	115(10)	154(10)	15/15
MVDE	6.4(8)	45(20)	103(13)	220(20)	329(25)	451(21)	15/15
NBIPOPaCMA	**2.4**(2)	8.3(3)	14(2)	27(4)	39(3)	50(3)	15/15
NIPOPaCMA	**2.7**(2)	7.3(3)	14(3)	26(3)	37(2)	50(4)	15/15
PSO-BFGS	3.1(3)	**5.2**(0.2)	**5.2**(0.2)	**5.2**(0.2)	**5.2**(0.2)	**5.2**(0.2)	15/15
SNES	4.3(3)	7.9(3)	15(5)	33(5)	51(4)	68(5)	15/15
xNES	**3.0**(3)	6.3(4)	21(3)	50(6)	81(8)	110(7)	15/15
xNESas	**2.9**(2)	6.6(3)	16(5)	37(8)	60(12)	78(17)	15/15

Table 3: 05-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
f2	83	87	88	90	92	94	15/15
ACOR	6.0(0.6)	7.4(0.6)	8.7(0.8)	12(1)	14(0.8)	17(1)	15/15
BIPOPaCMA	10(4)	12(3)	14(1)	16(2)	17(2)	18(1)	14/15
BIPOPsaACM	**3.2**(0.7)	**3.4**(0.7)	**3.7**(0.5)	**4.2**(0.7)	**4.6**(0.6)	**4.9**(0.6)	15/15
CMA	14(4)	16(4)	17(4)	20(3)	22(3)	23(2)	15/15
CMAES	16(4)	17(3)	18(3)	20(2)	21(2)	22(2)	15/15
CMAa	10(3)	12(2)	13(2)	15(1)	16(2)	17(1)	15/15
CMAm	13(5)	16(4)	17(4)	19(2)	20(1)	21(1.0)	15/15
CMAma	11(3)	13(3)	14(2)	15(2)	16(2)	17(1)	15/15
CMAmah	13(3)	15(3)	15(2)	16(2)	17(2)	17(2)	15/15
CMAmh	16(5)	18(4)	21(3)	21(2)	22(2)	23(2)	15/15
DBRCGA	27(4)	33(4)	41(5)	54(6)	67(6)	81(6)	15/15
DE	11(1)	13(2)	16(2)	21(2)	27(2)	31(2)	15/15
DE-AUTO	**1.4**(0.2)	**1.4**(0.2)	**1.5**(0.4)	**1.8**(0.4)	**1.9**(0.5)	**2.1**(0.5)	15/15
DE-BFGS	**1.4**(0.3)	**1.4**(0.3)	**1.5**(0.3)	**1.7**(0.3)	**1.9**(0.3)	**2.0**(0.3)	15/15
DE-ROLL	5.1(6)	5.3(6)	5.4(6)	5.5(6)	5.8(6)	5.9(6)	15/15
DE-SIMPLEX	6.1(4)	10(7)	11(7)	12(7)	12(6)	12(6)	15/15
DEctpb	13(1.0)	16(1)	19(2)	24(2)	30(2)	35(2)	15/15
IPOPsaACM	3.5(1)	3.7(0.8)	4.1(0.8)	4.6(1.0)	5.0(0.9)	5.3(0.9)	15/15
JADEb	6.8(1)	8.5(2)	10(2)	14(2)	18(2)	22(3)	15/15
JADEctpb	10(1)	12(2)	15(2)	20(2)	26(2)	31(2)	15/15
MVDE	27(3)	33(4)	42(2)	56(4)	70(4)	83(3)	15/15
NBIPOPaCMA	11(3)	12(3)	14(2)	15(2)	17(2)	18(2)	15/15
NIPOPaCMA	10(3)	12(2)	13(2)	14(2)	16(2)	17(2)	15/15
PSO-BFGS	**1.7**(0.7)	**1.7**(0.7)	**1.8**(0.7)	**1.9**(0.7)	**2.1**(0.7)	**2.3**(0.8)	15/15
SNES	5.0(1)	5.9(0.9)	7.0(0.9)	9.3(0.6)	11(0.6)	13(0.6)	15/15
xNES	8.7(2)	10(2)	12(1)	16(1)	20(1)	23(1)	15/15
xNESas	11(5)	14(9)	19(18)	39(62)	43(63)	49(92)	15/15

Table 4: 05-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	716	1622	1637	1646	1650	1654	15/15
ACOR	**1.7**(0.8)	30(38)	241(167)	240(166)	239(165)	239(165)	15/15
BIPOPaCMA	**1.6**(2)	12(11)	190(397)	190(395)	190(394)	190(393)	15/15
BIPOPsaACM	**1.1**(1.0)	5.3(5)	264(474)	263(472)	262(470)	264(464)	15/15
CMA	**1.4**(2)	7.9(6)	718(956)	715(962)	713(950)	712(961)	6/15
CMAES	**1.7**(2)	23(26)	293(324)	292(311)	291(319)	290(321)	6/15
CMAa	**0.91**(0.6)	30(7)	1333(1513)	1326(1690)	1323(1681)	1321(1661)	4/15
CMAm	**1.1**(1)	7.0(10)	959(1381)	955(1217)	953(1283)	951(1152)	5/15
CMAma	**0.74**(1)	39(10)	556(738)	554(802)	553(718)	552(724)	7/15
CMAmah	**2.4**(2)	5.9(6)	3145(3852)	3129(3643)	3121(3740)	3114(3705)	2/15
CMAmh	**1.7**(2)	100(222)	1004(1261)	999(1333)	997(1257)	995(1431)	5/15
DBRCGA	**2.4**(1.0)	8.0(4)	11(6)	11(6)	12(6)	12(6)	15/15
DE	**1.1**(0.4)	**1.4**(0.2)	**2.5**(2)	**2.8**(2)	**3.1**(2)	**3.4**(2)	15/15
DE-AUTO	**1.3**(1)	11(5)	21(9)	20(9)	20(9)	20(9)	15/15
DE-BFGS	**2.0**(1)	3.7(3)	7.7(5)	7.6(5)	7.6(5)	7.6(5)	15/15
DE-ROLL	**2.2**(1)	4.4(2)	6.6(4)	6.6(4)	6.6(4)	6.6(4)	15/15
DE-SIMPLEX	4.1(3)	10(8)	19(13)	19(14)	19(14)	19(13)	15/15
DEctpb	**1.3**(0.5)	**2.1**(0.7)	**2.5**(0.5)	**3.2**(0.5)	**3.6**(0.5)	**3.9**(0.4)	15/15
IPOPsaACM	**1.1**(1)	30(90)	1790(2125)	1781(2319)	1776(2101)	1772(1934)	12/15
JADEb	**0.80**(0.2)	**1.9**(2)	6.6(7)	6.8(7)	7.1(7)	7.3(7)	15/15
JADEctpb	**1.1**(0.5)	**1.6**(0.3)	**2.2**(0.4)	**2.7**(0.3)	**3.0**(0.3)	**3.4**(0.3)	15/15
MVDE	**2.2**(0.6)	**2.4**(0.3)	**2.9**(0.2)	**3.8**(0.2)	**4.6**(0.2)	**5.5**(0.2)	15/15
NBIPOPaCMA	**0.87**(0.3)	13(18)	473(727)	471(723)	470(721)	470(720)	15/15
NIPOPaCMA	**1.4**(1)	29(12)	799(1357)	795(1349)	793(1345)	792(1342)	15/15
PSO-BFGS	9.4(10)	26(38)	121(155)	120(154)	120(155)	120(153)	13/15
SNES	4.4(7)	91(146)	785(889)	781(784)	779(752)	778(783)	8/15
xNES	3.0(1)	92(114)	414(447)	412(445)	412(441)	411(442)	9/15
xNESas	**1.5**(0.7)	69(80)	454(380)	452(373)	451(374)	450(430)	13/15

Table 5: 05-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	809	1633	1688	1817	1886	1903	15/15
ACOR	**2.0**(1)	783(1075)	2.5e4(3e4)	2.3e4(3e4)	2.2e4(3e4)	2.2e4(3e4)	3/15
BIPOPaCMA	**1.6**(1)	1.4e4(2e4)	∞	∞	∞	∞ *5e6*	0/15
BIPOPsaACM	**1.3**(0.9)	6335(6377)	∞	∞	∞	∞ *5e6*	0/15
CMA	**2.7**(3)	∞	∞	∞	∞	∞ *9e5*	0/15
CMAES	**2.2**(1)	216(211)	∞	∞	∞	∞ *3e5*	0/15
CMAa	**1.7**(2)	∞	∞	∞	∞	∞ *9e5*	0/15
CMAm	**2.9**(3)	∞	∞	∞	∞	∞ *9e5*	0/15
CMAma	**1.7**(2)	∞	∞	∞	∞	∞ *9e5*	0/15
CMAmah	**2.5**(2)	∞	∞	∞	∞	∞ *9e5*	0/15
CMAmh	**1.8**(2)	∞	∞	∞	∞	∞ *9e5*	0/15
DBRCGA	**2.6**(1)	11(7)	17(10)	16(10)	16(9)	16(9)	15/15
DE	**1.2**(0.3)	**1.7**(0.3)	**9.4**(14)	**9.0**(13)	**9.0**(13)	**9.2**(13)	15/15
DE-AUTO	**1.8**(2)	16(9)	28(22)	26(21)	25(20)	25(20)	15/15
DE-BFGS	3.8(2)	9.0(6)	20(17)	19(15)	18(15)	18(15)	15/15
DE-ROLL	**1.6**(2)	4.7(3)	**11**(10)	**10**(9)	**10**(9)	**10**(8)	15/15
DE-SIMPLEX	6.8(3)	14(7)	24(16)	23(14)	22(14)	22(14)	15/15
DEctpb	**1.4**(0.4)	**2.6**(0.4)	**4.9**(3)	**5.2**(3)	**5.4**(3)	**5.7**(3)	15/15
IPOPsaACM	**1.0**(0.8)	4.3e4(5e4)	∞	∞	∞	∞ *5e6*	0/15
JADEb	**0.80**(0.4)	4.7(5)	25(28)	24(26)	23(25)	23(25)	15/15
JADEctpb	**1.4**(0.4)	**2.0**(0.5)	**3.9**(3)	**4.1**(3)	**4.4**(3)	**4.7**(3)	15/15
MVDE	**2.4**(0.4)	**3.0**(0.6)	95(296)	89(275)	86(265)	86(263)	13/15
NBIPOPaCMA	**1.7**(1)	738(708)	3819(3753)	3547(3233)	3418(3359)	3387(2721)	9/15
NIPOPaCMA	**2.8**(3)	2.2e4(2e4)	∞	∞	∞	∞ *5e6*	0/15
PSO-BFGS	14(12)	120(118)	410(479)	381(372)	367(414)	364(355)	7/15
SNES	3.2(6)	443(390)	3934(4054)	3654(4481)	3521(3838)	3489(3640)	2/15
xNES	4.5(6)	599(526)	5871(6210)	5453(6133)	5255(5742)	5208(5323)	1/15
xNESas	3.8(5)	381(428)	9998(1e4)	9287(1e4)	8949(9466)	8868(9618)	1/15

Table 6: 05-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	10	10	10	10	10	10	15/15
ACOR	8.5(1)	12(2)	13(3)	13(3)	13(3)	13(3)	15/15
BIPOPaCMA	5.7(3)	6.9(3)	6.9(3)	6.9(3)	6.9(3)	6.9(3)	15/15
BIPOPsaACM	4.7(2)	5.8(2)	6.2(3)	6.2(3)	6.2(3)	6.2(3)	15/15
CMA	4.4(2)	6.5(2)	6.7(2)	6.7(2)	6.7(2)	6.7(2)	15/15
CMAES	4.3(2)	5.8(2)	5.8(2)	5.9(2)	5.9(2)	5.9(2)	15/15
CMAa	4.2(2)	6.0(2)	6.3(2)	6.4(2)	6.4(2)	6.4(2)	15/15
CMAm	**3.9**(2)	**5.1**(2)	**5.3**(1)	**5.4**(1)	**5.4**(1)	**5.4**(1)	15/15
CMAma	**3.4**(0.8)	**4.7**(1)	**4.8**(2)	**4.8**(2)	**4.8**(2)	**4.8**(2)	15/15
CMAmah	**3.3**(2)	**4.2**(2)	**4.7**(2)	**4.8**(2)	**4.8**(2)	**4.8**(2)	15/15
CMAmh	**2.9**(1)	**3.9**(0.9)	**4.0**(1)	**4.1**(1)	**4.1**(1)	**4.1**(1)	15/15
DBRCGA	31(33)	50(38)	54(40)	54(40)	54(40)	54(40)	15/15
DE	8.3(3)	12(4)	12(3)	13(3)	13(3)	13(3)	15/15
DE-AUTO	5.8(0.4)	6.3(0.4)	6.4(0.3)	6.4(0.3)	6.4(0.3)	6.4(0.3)	15/15
DE-BFGS	6.5(2)	8.8(3)	9.0(2)	9.0(2)	9.0(2)	9.0(2)	15/15
DE-ROLL	5.9(0.3)	6.4(0.4)	6.5(0.4)	6.7(0.5)	6.9(0.5)	7.1(0.5)	15/15
DE-SIMPLEX	29(13)	122(119)	266(171)	324(99)	336(123)	369(138)	15/15
DEctpb	11(5)	16(4)	17(4)	18(2)	18(2)	18(2)	15/15
IPOPsaACM	4.3(3)	6.1(3)	6.2(3)	6.3(2)	6.3(2)	6.3(2)	15/15
JADEb	8.4(4)	14(4)	15(4)	15(4)	15(4)	15(4)	15/15
JADEctpb	11(6)	20(8)	21(7)	21(7)	21(7)	21(7)	15/15
MVDE	48(10)	90(16)	99(20)	101(20)	101(20)	101(20)	15/15
NBIPOPaCMA	4.2(2)	5.6(2)	5.9(2)	5.9(2)	5.9(2)	5.9(2)	15/15
NIPOPaCMA	4.1(2)	5.9(3)	6.1(3)	6.1(3)	6.1(3)	6.1(3)	15/15
PSO-BFGS	6.8(0.3)	8.8(0.3)	8.8(0.6)	8.9(0.6)	8.9(0.6)	8.9(0.6)	15/15
SNES	7.8(3)	12(4)	12(4)	12(4)	12(4)	12(4)	15/15
xNES	9.5(4)	15(6)	15(6)	16(6)	16(6)	16(6)	15/15
xNESas	10(4)	15(9)	16(9)	16(8)	16(8)	16(8)	15/15

Table 7: 05-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	114	214	281	580	1038	1332	15/15
ACOR	3.4(1)	3.6(0.8)	4.1(0.9)	3.4(0.4)	**2.6**(0.4)	**2.7**(0.3)	15/15
BIPOPaCMA	**2.0**(1)	**1.9**(0.8)	**2.2**(0.5)	**1.6**(0.3)	**1.2**(0.2)	**1.2**(0.1)	15/15
BIPOPsaACM	**1.9**(0.7)	**1.8**(0.6)	**2.1**(0.9)	**1.8**(0.9)	**1.3**(0.5)	**1.4**(0.5)	15/15
CMA	**2.5**(0.9)	**2.2**(0.4)	**2.2**(0.3)	**1.7**(0.2)	**1.3**(0.1)	**1.2**(0.1)	15/15
CMAES	**2.4**(0.7)	**2.0**(0.5)	**2.2**(0.5)	**1.7**(0.4)	**1.3**(0.3)	**1.3**(0.2)	15/15
CMAa	**2.0**(0.6)	**1.9**(0.4)	**2.0**(0.3)	**1.5**(0.2)	**1.2**(0.1)	**1.1**(0.1)	15/15
CMAm	**2.2**(1)	**2.0**(0.8)	**2.1**(0.6)	**1.7**(0.5)	**1.3**(0.2)	**1.3**(0.2)	15/15
CMAma	**2.4**(1)	**2.1**(0.9)	**2.2**(0.9)	**1.6**(0.4)	**1.2**(0.2)	**1.2**(0.2)	15/15
CMAmah	**1.7**(1.0)	**1.5**(0.5)	**1.7**(0.5)	**1.3**(0.4)	**0.94**(0.3)	**0.92**(0.2)	15/15
CMAmh	**1.8**(0.9)	**1.7**(0.8)	**1.8**(0.9)	**1.5**(0.4)	**1.1**(0.2)	**1.1**(0.2)	15/15
DBRCGA	7.4(3)	10(3)	12(4)	10(2)	8.0(2)	8.2(1)	15/15
DE	5.4(1)	6.6(2)	8.4(2)	8.0(2)	6.3(1)	6.7(2)	15/15
DE-AUTO	**1.3**(0.7)	**1.0**(0.4)	**1.00**(0.3)	**0.79**(0.4)	**0.73**(0.4)	**0.79**(0.2)	15/15
DE-BFGS	5.1(2)	3.1(1)	**2.5**(0.9)	**1.5**(0.6)	**1.3**(2)	**2.8**(3)	15/15
DE-ROLL	13(19)	13(19)	19(27)	18(23)	13(20)	53(66)	14/15
DE-SIMPLEX	5.5(9)	5.6(5)	6.2(4)	5.6(5)	5.9(6)	12(12)	15/15
DEctpb	6.0(3)	6.6(1)	8.2(2)	6.9(1)	5.6(1)	5.8(1.0)	15/15
IPOPsaACM	**2.3**(1)	**2.1**(0.9)	**2.6**(1)	**1.9**(0.8)	**1.5**(0.5)	**1.7**(0.7)	15/15
JADEb	**2.6**(1)	3.4(1)	4.5(1)	4.4(0.9)	3.7(0.9)	4.0(2)	15/15
JADEctpb	4.1(2)	4.5(1.0)	5.4(0.9)	4.4(0.5)	3.6(0.4)	3.7(0.5)	15/15
MVDE	6.5(3)	13(4)	18(4)	21(4)	21(8)	25(9)	15/15
NBIPOPaCMA	**2.1**(1)	**1.9**(0.6)	**2.0**(0.6)	**1.5**(0.3)	**1.1**(0.2)	**1.1**(0.2)	15/15
NIPOPaCMA	**2.0**(0.8)	**1.7**(0.5)	**1.9**(0.3)	**1.5**(0.2)	**1.2**(0.1)	**1.2**(0.1)	15/15
PSO-BFGS	6.4(9)	3.8(5)	3.1(4)	**1.9**(2)	**1.5**(2)	54(98)	11/15
SNES	**1.5**(1)	**1.7**(0.6)	**2.2**(0.5)	**2.0**(0.6)	10(15)	23(51)	15/15
xNES	**1.6**(1)	**2.0**(0.5)	**2.5**(0.3)	**2.2**(0.3)	**1.8**(0.1)	**1.8**(0.1)	15/15
xNESas	**1.5**(1)	**2.1**(0.6)	**2.4**(0.6)	**2.0**(0.2)	**1.5**(0.2)	**1.6**(0.2)	15/15

Table 8: 05-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	24	324	1171	1572	1572	1597	15/15
ACOR	6.5(3)	**2.1**(1)	32(25)	25(18)	25(18)	25(18)	15/15
BIPOPaCMA	6.9(4)	**1.3**(1)	**1.0**(0.9)	**0.93**(0.7)	**0.93**(0.7)	**0.95**(0.7)	15/15
BIPOPsaACM	4.5(3)	**1.4**(1)	**0.83**(0.5)	**0.91**(0.7)	**0.91**(0.7)	**0.93**(0.7)	15/15
CMA	4.7(3)	**1.5**(1)	**0.88**(0.4)	**0.92**(0.7)	**0.92**(0.7)	**0.94**(0.7)	15/15
CMAES	5.1(3)	**1.1**(0.9)	**2.0**(2)	**2.6**(3)	**2.6**(3)	**2.6**(3)	15/15
CMAa	7.3(3)	**1.1**(1)	**0.88**(0.6)	**0.77**(0.5)	**0.77**(0.5)	**0.79**(0.5)	15/15
CMAm	**3.9**(2)	**1.1**(1.0)	**1.3**(1)	**1.3**(1)	**1.3**(1)	**1.4**(1)	15/15
CMAma	5.1(3)	**1.4**(1)	**0.84**(0.6)	**0.76**(0.5)	**0.76**(0.5)	**0.82**(0.5)	15/15
CMAmah	**3.9**(3)	**1.6**(1)	**1.4**(0.7)	**1.2**(0.6)	**1.2**(0.6)	**1.2**(0.6)	15/15
CMAmh	4.5(5)	**2.1**(2)	**1.4**(0.9)	**1.4**(0.6)	**1.4**(0.6)	**1.4**(0.7)	15/15
DBRCGA	16(14)	4.1(2)	4.9(6)	7.9(7)	7.9(7)	8.0(8)	15/15
DE	13(11)	3.4(2)	**1.9**(0.6)	**2.5**(0.7)	**2.5**(0.7)	**2.7**(0.8)	15/15
DE-AUTO	40(64)	13(10)	6.9(3)	9.1(3)	9.1(3)	14(9)	15/15
DE-BFGS	8.9(6)	3.4(5)	10(22)	9.2(17)	9.2(17)	41(64)	10/15
DE-ROLL	29(39)	11(11)	8.4(7)	8.3(5)	8.3(5)	8.5(5)	15/15
DE-SIMPLEX	11(11)	8.0(7)	5.1(7)	4.7(5)	4.7(5)	4.9(5)	15/15
DEctpb	10(8)	3.3(1)	**2.1**(0.9)	**2.7**(0.8)	**2.7**(0.8)	3.0(0.9)	15/15
IPOPsaACM	**3.7**(2)	**1.2**(1)	**0.68**(0.5)	**0.77**(0.9)	**0.77**(0.9)	**0.90**(0.9)	15/15
JADEb	6.1(3)	57(0.7)	54(107)	81(159)	81(159)	80(157)	10/15
JADEctpb	8.4(5)	**2.0**(0.7)	**1.3**(0.4)	**1.4**(0.3)	**1.4**(0.3)	**1.6**(0.3)	15/15
MVDE	18(7)	7.0(4)	5.0(2)	8.7(4)	8.7(4)	9.4(4)	15/15
NBIPOPaCMA	4.8(2)	**1.3**(1)	**0.86**(0.9)	**0.86**(0.6)	**0.86**(0.6)	**0.88**(0.6)	15/15
NIPOPaCMA	6.0(3)	**1.3**(1)	**0.93**(0.9)	**0.99**(0.7)	**0.99**(0.7)	**1.1**(0.7)	15/15
PSO-BFGS	589(940)	458(446)	930(922)	2363(2591)	2363(2429)	2326(2392)	1/15
SNES	**3.5**(3)	37(76)	51(56)	212(256)	212(256)	237(253)	14/15
xNES	4.5(2)	**2.9**(0.5)	**2.7**(4)	3.0(6)	3.0(6)	3.0(6)	15/15
xNESas	4.4(3)	**0.81**(0.3)	3.2(4)	**2.6**(3)	**2.6**(3)	**2.6**(3)	15/15

Table 9: 05-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	73	273	336	391	410	422	15/15
ACOR	5.5(0.9)	11(2)	43(4)	120(11)	199(10)	278(10)	15/15
BIPOPaCMA	**3.0**(1)	5.9(5)	6.2(4)	6.2(4)	6.4(4)	6.7(4)	15/15
BIPOPsaACM	**2.2**(0.6)	**2.5**(2)	**2.5**(2)	**2.5**(2)	**2.5**(1)	**2.5**(1)	15/15
CMA	3.4(1.0)	5.1(5)	5.7(4)	5.8(4)	6.0(4)	6.3(4)	15/15
CMAES	4.3(4)	3.6(1)	4.4(1)	4.7(1)	5.0(1)	5.2(1)	15/15
CMAa	**2.7**(1.0)	4.5(5)	4.9(5)	5.1(4)	5.3(4)	5.5(4)	15/15
CMAm	**2.6**(0.8)	4.2(5)	4.9(4)	5.2(3)	5.4(3)	5.6(3)	15/15
CMAma	**2.7**(1)	3.2(2)	3.7(2)	4.0(1)	4.2(1)	4.4(1)	15/15
CMAmah	**1.8**(0.6)	3.5(3)	4.0(3)	4.3(2)	4.4(2)	4.5(2)	15/15
CMAmh	**2.5**(1)	4.5(4)	5.1(4)	5.3(3)	5.5(3)	5.6(3)	15/15
DBRCGA	18(5)	16(7)	24(16)	43(16)	56(22)	75(30)	15/15
DE	9.3(4)	14(5)	21(8)	30(8)	40(7)	49(8)	15/15
DE-AUTO	**1.6**(0.4)	**2.4**(4)	**2.1**(4)	**1.9**(3)	**1.9**(3)	**1.8**(3)	15/15
DE-BFGS	**2.8**(2)	**1.2**(0.6)	**1.1**(0.5)	**1.1**(0.4)	**1.1**(0.4)	**1.1**(0.4)	15/15
DE-ROLL	4.6(6)	13(10)	40(33)	83(51)	120(38)	1134(1188)	5/15
DE-SIMPLEX	**1.9**(0.8)	**2.2**(3)	**2.2**(2)	**2.1**(2)	**2.2**(2)	**2.2**(2)	15/15
DEctpb	11(2)	10(4)	22(9)	32(8)	43(7)	54(8)	15/15
IPOPsaACM	**2.3**(1)	**1.9**(0.7)	**2.0**(0.6)	**2.0**(0.5)	**2.0**(0.5)	**2.1**(0.5)	15/15
JADEb	5.0(1)	11(12)	12(10)	12(9)	13(8)	14(8)	15/15
JADEctpb	7.5(3)	7.3(3)	10(3)	12(2)	13(1)	14(1)	15/15
MVDE	21(8)	20(16)	64(69)	196(117)	388(152)	589(194)	15/15
NBIPOPaCMA	**2.9**(0.9)	4.1(4)	4.6(4)	4.8(3)	5.1(3)	5.3(3)	15/15
NIPOPaCMA	4.1(3)	4.4(5)	4.8(4)	5.0(4)	5.2(4)	5.5(4)	15/15
PSO-BFGS	**3.0**(2)	**1.8**(1)	**1.6**(0.8)	**1.5**(0.7)	**1.5**(0.7)	**1.4**(0.7)	15/15
SNES	3.7(1)	87(92)	219(164)	667(328)	1770(1554)	4064(3841)	4/15
xNES	4.1(2)	3.9(1)	5.8(3)	7.3(4)	7.7(4)	8.3(4)	15/15
xNESas	3.4(2)	6.8(3)	8.7(4)	16(13)	16(13)	16(12)	15/15

Table 10: 05-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	35	127	214	300	335	369	15/15
ACOR	12(3)	21(8)	59(26)	251(139)	467(266)	655(376)	15/15
BIPOPaCMA	7.9(4)	10(10)	7.7(6)	6.6(5)	6.4(4)	6.3(4)	15/15
BIPOPsaACM	**4.2**(1)	**4.1**(4)	**3.1**(2)	**2.6**(2)	**2.5**(2)	**2.3**(1)	15/15
CMA	7.0(3)	9.0(11)	7.7(7)	6.7(5)	6.7(5)	6.5(4)	15/15
CMAES	5.5(1)	7.1(3)	6.5(2)	5.8(1)	5.8(1.0)	5.7(0.9)	15/15
CMAa	6.1(2)	6.5(2)	5.9(1)	5.2(1)	5.2(1.0)	5.2(0.9)	15/15
CMAm	5.4(4)	6.5(2)	6.2(1)	5.6(1.0)	5.5(0.8)	5.3(0.8)	15/15
CMAma	5.9(2)	6.9(4)	6.0(2)	5.4(2)	5.3(1)	5.1(1)	15/15
CMAmah	4.4(1)	9.4(8)	7.5(5)	6.3(3)	6.1(3)	5.8(3)	15/15
CMAmh	5.0(2)	11(9)	9.0(5)	7.6(4)	7.4(3)	7.0(3)	15/15
DBRCGA	34(10)	37(26)	42(30)	72(51)	109(77)	129(74)	15/15
DE	22(8)	37(7)	36(10)	40(11)	50(14)	58(17)	15/15
DE-AUTO	**3.7**(1)	7.1(6)	4.5(4)	3.3(2)	3.0(2)	**2.8**(2)	15/15
DE-BFGS	**4.2**(0.7)	**2.7**(2)	**1.9**(0.9)	**1.5**(0.7)	**1.3**(0.6)	**1.2**(0.5)	15/15
DE-ROLL	8.1(6)	17(10)	71(43)	124(58)	165(67)	361(334)	13/15
DE-SIMPLEX	5.8(4)	4.4(4)	3.2(2)	**2.6**(2)	**2.5**(1)	**2.4**(1)	15/15
DEctpb	23(11)	29(7)	37(9)	43(11)	53(16)	62(19)	15/15
IPOPsaACM	5.0(2)	**3.1**(1)	**2.5**(0.6)	**2.1**(0.5)	**2.0**(0.5)	**2.0**(0.4)	15/15
JADEb	12(2)	20(33)	16(20)	15(13)	15(12)	15(11)	15/15
JADEctpb	14(2)	24(7)	22(5)	19(5)	19(4)	18(4)	15/15
MVDE	49(13)	79(49)	197(94)	304(85)	453(164)	614(232)	15/15
NBIPOPaCMA	5.2(1)	6.2(3)	5.6(2)	5.0(0.9)	5.0(1.0)	5.0(0.9)	15/15
NIPOPaCMA	5.6(1)	5.4(2)	5.0(1)	4.6(0.8)	4.6(0.8)	4.6(0.8)	15/15
PSO-BFGS	**4.1**(1)	**2.2**(1)	**1.6**(0.9)	**1.3**(0.6)	**1.2**(0.5)	**1.1**(0.5)	15/15
SNES	5.3(2)	69(48)	211(80)	1480(1829)	2065(1866)	5488(6053)	4/15
xNES	7.1(2)	8.2(3)	8.7(4)	8.4(5)	8.3(4)	8.4(4)	15/15
xNESas	6.4(2)	13(4)	12(3)	11(6)	11(6)	11(6)	15/15

Table 11: 05-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	349	500	574	626	829	880	15/15
ACOR	662(773)	1848(1729)	3067(1662)	5253(2231)	5798(2317)	9645(7046)	1/15
BIPOPaCMA	**2.6**(0.9)	**2.2**(0.6)	**2.1**(0.3)	**2.2**(0.3)	**1.9**(0.1)	**2.0**(0.1)	15/15
BIPOPsaACM	**0.76**(0.1)	**0.59**(0.1)	**0.58**(0.1)$_{\downarrow 3}$	**0.60**(0.1)$_{\downarrow 3}$	**0.51**(0.1)$_{\downarrow 3}$	**0.53**(0.1)$_{\downarrow 4}$	15/15
CMA	**2.8**(1)	**2.7**(0.8)	**2.6**(0.6)	**2.8**(0.4)	**2.3**(0.3)	**2.3**(0.3)	15/15
CMAES	3.5(0.7)	**2.9**(0.5)	**2.7**(0.4)	**2.8**(0.3)	**2.3**(0.2)	**2.3**(0.2)	15/15
CMAa	**2.6**(0.8)	**2.2**(0.4)	**2.1**(0.2)	**2.2**(0.2)	**1.8**(0.2)	**1.9**(0.2)	15/15
CMAm	3.9(0.9)	3.2(0.7)	3.0(0.3)	3.0(0.3)	**2.4**(0.2)	**2.4**(0.2)	15/15
CMAma	**2.5**(0.8)	**2.2**(0.5)	**2.1**(0.3)	**2.2**(0.2)	**1.8**(0.2)	**1.8**(0.2)	15/15
CMAmah	**2.9**(1)	**2.5**(0.5)	**2.4**(0.3)	**2.3**(0.3)	**1.9**(0.2)	**1.9**(0.2)	15/15
CMAmh	4.1(1)	3.4(0.9)	3.3(0.3)	3.2(0.3)	**2.5**(0.2)	**2.5**(0.2)	15/15
DBRCGA	59(45)	194(275)	407(299)	1184(1040)	1630(1560)	4070(4546)	2/15
DE	27(8)	28(6)	32(6)	43(8)	42(6)	49(7)	15/15
DE-AUTO	**2.6**(4)	**1.9**(3)	**1.6**(3)	**1.5**(2)	**1.2**(2)	**1.1**(2)	15/15
DE-BFGS	**0.75**(0.7)	**0.54**(0.4)	**0.49**(0.4)	**0.48**(0.4)	**0.39**(0.3)	**0.50**(0.9)	15/15
DE-ROLL	93(102)	121(86)	129(82)	176(66)	178(43)	1865(1957)	1/15
DE-SIMPLEX	**2.9**(3)	**2.7**(2)	**2.5**(1)	**2.4**(1)	**1.9**(1.0)	**2.0**(2)	15/15
DEctpb	32(7)	32(6)	37(8)	52(6)	51(5)	61(6)	15/15
IPOPsaACM	**0.77**(0.2)	**0.61**(0.1)	**0.57**(0.1)$_{\downarrow 3}$	**0.60**(0.1)$_{\downarrow 3}$	**0.51**(0.1)$_{\downarrow 3}$	**0.53**(0.1)$_{\downarrow 3}$	15/15
JADEb	6.7(2)	5.7(2)	6.0(1)	6.7(2)	5.8(2)	6.1(1)	15/15
JADEctpb	6.1(1)	5.1(0.8)	5.0(0.8)	5.4(0.7)	4.8(0.5)	5.1(0.5)	15/15
MVDE	137(86)	198(73)	331(134)	780(257)	996(230)	2756(2274)	1/15
NBIPOPaCMA	**2.8**(0.8)	**2.2**(0.5)	**2.1**(0.2)	**2.2**(0.2)	**1.8**(0.2)	**1.9**(0.2)	15/15
NIPOPaCMA	**2.7**(0.7)	**2.3**(0.3)	**2.1**(0.3)	**2.2**(0.3)	**1.8**(0.2)	**1.9**(0.2)	15/15
PSO-BFGS	**1.3**(1)	**0.94**(1)	**0.84**(0.9)	**0.79**(0.8)	**0.62**(0.6)	**1.7**(0.6)	15/15
SNES	3419(3283)	5375(5422)	∞	∞	∞	∞ *1e6*	0/15
xNES	**2.1**(0.6)	**1.9**(0.3)	**1.9**(0.2)	**2.3**(0.2)	**2.2**(0.2)	**2.5**(0.2)	15/15
xNESas	**2.0**(0.8)	**1.8**(0.7)	**1.8**(0.6)	**2.0**(0.5)	**1.9**(0.4)	**2.0**(0.3)	15/15

Table 12: 05-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	143	202	763	1177	1467	1673	15/15
ACOR	130(102)	258(72)	118(34)	130(26)	153(30)	177(34)	15/15
BIPOPaCMA	5.1(2)	4.6(1)	**1.4**(0.2)	**1.1**(0.2)	**0.94**(0.1)	**0.91**(0.1)	15/15
BIPOPsaACM	**2.1**(0.3)	**1.6**(0.2)	**0.47**(0.1)$_{\downarrow 4}$	**0.34**(0.0)$_{\downarrow 4}$	**0.30**(0.0)$_{\downarrow 4}$	**0.29**(0.0)$_{\downarrow 4}$	15/15
CMA	8.7(2)	7.6(1)	**2.2**(0.4)	**1.6**(0.2)	**1.4**(0.2)	**1.3**(0.2)	15/15
CMAES	9.1(1)	7.7(1)	**2.3**(0.3)	**1.6**(0.2)	**1.4**(0.2)	**1.3**(0.1)	15/15
CMAa	5.2(1.0)	4.6(0.7)	**1.4**(0.2)	**1.1**(0.1)	**0.95**(0.1)	**0.93**(0.1)	15/15
CMAm	8.4(3)	7.8(1)	**2.3**(0.3)	**1.7**(0.2)	**1.4**(0.2)	**1.3**(0.1)	15/15
CMAma	5.1(1)	4.4(0.8)	**1.3**(0.2)	**1.0**(0.1)	**0.89**(0.1)	**0.84**(0.1)	15/15
CMAmah	6.5(2)	6.2(1)	**1.8**(0.3)	**1.3**(0.2)	**1.1**(0.1)	**1.0**(0.1)	15/15
CMAmh	12(4)	10(2)	**3.0**(0.3)	**2.1**(0.2)	**1.7**(0.1)	**1.6**(0.1)	15/15
DBRCGA	18(9)	106(111)	77(75)	100(79)	140(85)	177(152)	11/15
DE	32(23)	42(19)	16(5)	17(4)	19(4)	23(4)	15/15
DE-AUTO	**2.6**(0.1)	**1.9**(0.1)	**0.51**(0.0)	**0.35**(0.0)	**0.29**(0.0)	**0.61**(1)	15/15
DE-BFGS	**0.70**(0.2)$_{\downarrow 2}$	**0.53**(0.1)$_{\downarrow 3}$	**0.15**(0.0)$_{\downarrow 4}$	**0.11**(0.0)$_{\downarrow 4}$	**0.11**(0.0)$_{\downarrow 4}$	**0.12**(0.1)$_{\downarrow 4}$	15/15
DE-ROLL	76(76)	163(111)	63(26)	81(14)	92(14)	2107(2398)	0/15
DE-SIMPLEX	4.5(4)	5.3(3)	**1.7**(0.5)	**1.3**(0.6)	**1.1**(0.5)	**0.97**(0.4)	15/15
DEctpb	26(18)	44(17)	18(5)	21(5)	24(6)	27(6)	15/15
IPOPsaACM	**2.0**(0.4)	**1.6**(0.3)	**0.46**(0.1)$_{\downarrow 4}$	**0.34**(0.1)$_{\downarrow 4}$	**0.30**(0.1)$_{\downarrow 4}$	**0.29**(0.0)$_{\downarrow 4}$	15/15
JADEb	9.0(4)	12(6)	4.0(1)	3.0(0.9)	**2.8**(0.8)	**2.7**(0.7)	15/15
JADEctpb	8.1(3)	9.0(1)	**2.8**(0.4)	**2.3**(0.3)	**2.2**(0.2)	**2.3**(0.2)	15/15
MVDE	43(32)	195(125)	123(53)	267(143)	383(201)	795(741)	6/15
NBIPOPaCMA	6.1(1)	5.0(0.8)	**1.5**(0.2)	**1.1**(0.1)	**0.97**(0.1)	**0.94**(0.1)	15/15
NIPOPaCMA	5.2(1)	4.4(0.7)	**1.3**(0.1)	**1.0**(0.1)	**0.93**(0.1)	**0.90**(0.1)	15/15
PSO-BFGS	**0.60**(0.1)$_{\downarrow 4}$	**0.45**(0.1)$_{\downarrow 4}$	**0.13**(0.0)$_{\downarrow 4}$	**0.10**(0.0)$_{\downarrow 4}$	**0.09**(0.0)$_{\downarrow 4}$	**0.11**(0.0)$_{\downarrow 4}$	15/15
SNES	3907(2964)	∞	∞	∞	∞	∞ *1e6*	0/15
xNES	4.4(1)	3.9(1)	**1.2**(0.3)	**1.1**(0.2)	**1.1**(0.1)	**1.2**(0.1)	15/15
xNESas	4.2(3)	4.3(1)	**1.3**(0.3)	**1.1**(0.2)	**1.0**(0.1)	**1.1**(0.1)	15/15

Table 13: 05-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	108	268	371	461	1303	1494	15/15
ACOR	4129(7120)	3.3e4(6e4)	7.8e4(1e5)	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	12(9)	8.4(6)	7.7(6)	7.3(6)	3.0(3)	3.2(3)	15/15
BIPOPsaACM	**2.6**(0.8)	**2.1**(2)	**2.1**(2)	**2.5**(3)	**1.4**(1)	**1.7**(2)	15/15
CMA	10(8)	8.3(5)	8.4(5)	8.6(5)	3.7(2)	3.7(3)	15/15
CMAES	8.4(9)	5.9(7)	7.1(7)	7.9(5)	3.5(2)	3.8(2)	15/15
CMAa	8.7(6)	7.2(6)	7.9(6)	8.5(6)	3.7(2)	3.7(2)	15/15
CMAm	7.4(8)	7.5(6)	8.2(6)	8.7(6)	3.9(3)	3.9(3)	15/15
CMAma	6.1(3)	4.9(5)	5.4(5)	5.9(4)	**2.6**(2)	**2.6**(2)	15/15
CMAmah	6.5(8)	7.3(7)	8.1(6)	8.8(5)	3.9(2)	3.8(2)	15/15
CMAmh	8.3(10)	8.9(10)	10(9)	10(9)	4.5(4)	4.5(4)	15/15
DBRCGA	615(1690)	1328(1871)	9445(1e4)	∞	∞	∞ *5e5*	0/15
DE	103(94)	107(85)	117(116)	135(129)	63(51)	66(52)	15/15
DE-AUTO	**2.8**(3)	**2.2**(2)	**2.2**(2)	**2.2**(2)	**0.93**(0.8)	**1.2**(1)	15/15
DE-BFGS	**2.8**(1)	**2.0**(1)	**1.9**(1)	**1.9**(1)	**0.80**(0.5)	**1.1**(0.7)	15/15
DE-ROLL	21(19)	112(37)	148(105)	211(256)	118(148)	485(546)	1/15
DE-SIMPLEX	4.1(4)	3.1(2)	3.4(2)	3.4(2)	**1.6**(1)	**2.0**(2)	15/15
DEctpb	89(41)	77(46)	104(117)	138(134)	70(57)	80(56)	14/15
IPOPsaACM	3.8(3)	**2.9**(2)	**2.8**(2)	**2.8**(2)	**1.2**(0.9)	**1.2**(0.9)	15/15
JADEb	18(13)	15(8)	15(10)	15(11)	6.7(4)	6.7(4)	15/15
JADEctpb	24(3)	13(4)	12(7)	14(7)	6.1(3)	6.2(4)	15/15
MVDE	207(116)	342(277)	715(673)	1416(755)	1221(1148)	3256(3348)	2/15
NBIPOPaCMA	10(6)	6.9(6)	6.5(6)	6.5(5)	**2.7**(2)	**2.8**(2)	15/15
NIPOPaCMA	11(16)	8.2(11)	8.0(9)	7.9(8)	3.4(3)	3.4(3)	15/15
PSO-BFGS	**2.8**(2)	**1.7**(1)	**1.5**(1)	**1.7**(1)	**0.73**(0.5)	**0.86**(0.9)	15/15
SNES	43(92)	220(274)	296(610)	5016(4651)	∞	∞ *1e6*	0/15
xNES	11(3)	24(38)	32(42)	50(106)	22(39)	25(35)	15/15
xNESas	16(28)	36(66)	36(58)	51(97)	21(35)	31(34)	15/15

Table 14: 05-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	132	195	250	1310	1752	2255	15/15
ACOR	99(221)	475(603)	2137(2399)	5448(7733)	8.1e4(9e4)	∞ *1e7*	0/15
BIPOPaCMA	3.2(2)	3.8(1)	4.3(0.9)	**1.2**(0.1)	**1.2**(0.1)	**1.1**(0.2)	15/15
BIPOPsaACM	**1.2**(0.3)	**1.3**(0.4)	**1.3**(0.4)	**0.37**(0.1)$_{\downarrow 4}$	**0.34**(0.1)$_{\downarrow 4}$	**0.32**(0.1)$_{\downarrow 4}$	15/15
CMA	3.3(2)	5.3(2)	5.5(2)	**1.4**(0.3)	**1.6**(0.3)	**1.5**(0.3)	15/15
CMAES	4.5(3)	4.8(3)	5.1(2)	**1.5**(0.4)	**1.5**(0.4)	**1.4**(0.4)	15/15
CMAa	**2.9**(0.7)	4.1(2)	4.5(1)	**1.2**(0.2)	**1.2**(0.1)	**1.2**(0.1)	15/15
CMAm	4.0(3)	5.0(2)	4.7(2)	**1.7**(0.7)	**1.8**(0.8)	**2.0**(0.8)	15/15
CMAma	3.1(2)	4.5(3)	4.6(2)	**1.2**(0.3)	**1.3**(0.2)	**1.2**(0.2)	15/15
CMAmah	4.0(4)	5.6(4)	5.6(3)	**1.7**(0.8)	**1.7**(0.6)	**1.6**(0.5)	15/15
CMAmh	4.7(5)	10(3)	8.9(2)	**2.2**(0.8)	**2.5**(1)	**2.8**(0.9)	15/15
DBRCGA	22(8)	138(161)	603(907)	1034(1035)	2061(2364)	∞ *5e5*	0/15
DE	14(4)	26(11)	39(11)	19(7)	28(9)	45(23)	6/15
DE-AUTO	**0.99**(0.1)	**0.87**(0.1)$_{\downarrow 2}$	**0.83**(0.1)$_{\downarrow 4}$	**0.22**(0.0)$_{\downarrow 4}$	**1.1**(0.5)	**0.96**(0.1)	15/15
DE-BFGS	**1.0**(0.2)	**0.91**(0.1)	**0.87**(0.1)	**0.23**(0.0)$_{\downarrow 4}$	**2.6**(1.0)	529(621)	0/15
DE-ROLL	20(18)	43(39)	53(29)	16(7)	16(4)	79(115)	12/15
DE-SIMPLEX	4.8(4)	6.2(5)	8.4(6)	**2.3**(1)	**2.2**(1)	**2.7**(2)	15/15
DEctpb	17(8)	30(10)	49(16)	23(6)	30(6)	34(4)	12/15
IPOPsaACM	**1.2**(0.4)	**1.1**(0.3)	**1.2**(0.3)	**0.33**(0.1)$_{\downarrow 4}$	**0.35**(0.1)$_{\downarrow 4}$	**0.33**(0.1)$_{\downarrow 4}$	15/15
JADEb	5.4(2)	8.9(3)	11(4)	3.5(1)	3.5(1)	3.3(0.8)	15/15
JADEctpb	8.2(1)	12(2)	12(2)	3.1(0.3)	**2.9**(0.2)	**2.6**(0.2)	15/15
MVDE	29(12)	92(44)	240(114)	280(188)	2645(2759)	∞ *1e6*	0/15
NBIPOPaCMA	**2.7**(1)	3.3(2)	3.9(1)	**1.1**(0.2)	**1.2**(0.2)	**1.2**(0.1)	15/15
NIPOPaCMA	**2.9**(2)	4.4(2)	4.7(1)	**1.2**(0.2)	**1.3**(0.3)	**1.2**(0.2)	15/15
PSO-BFGS	**0.99**(0.1)	**0.87**(0.1)$_{\downarrow 2}$	**0.84**(0.1)$_{\downarrow 4}$	**0.22**(0.0)$_{\downarrow 4}$	181(286)	∞ *5e5*	0/15
SNES	44(76)	157(175)	335(295)	860(764)	2575(2827)	6385(7295)	0/15
xNES	3.6(0.8)	4.3(0.3)	4.7(0.3)	**1.4**(0.1)	**1.5**(0.1)	**1.5**(0.1)	15/15
xNESas	3.3(0.6)	3.7(0.5)	4.0(0.5)	**1.3**(0.2)	**1.4**(0.2)	**1.5**(0.2)	15/15

Table 15: 05-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	10	41	58	139	251	476	15/15
ACOR	**1.7**(2)	4.7(2)	6.3(1)	9.3(3)	123(85)	4.8e4(6e4)	0/15
BIPOPaCMA	**2.3**(3)	**2.6**(1)	3.3(0.8)	3.9(0.7)	3.9(0.7)	3.2(0.3)	15/15
BIPOPsaACM	**1.5**(2)	**2.3**(0.6)	**2.4**(0.5)	**2.2**(0.3)	**1.8**(0.2)	**1.3**(0.1)	15/15
CMA	**2.3**(3)	**2.8**(0.9)	3.5(1)	4.2(1)	5.4(0.5)	4.4(0.6)	15/15
CMAES	**1.5**(1)	**2.9**(1)	3.8(0.8)	4.2(1)	5.4(1)	4.4(0.5)	15/15
CMAa	**2.5**(3)	**2.7**(1)	3.5(1)	4.0(0.7)	3.9(0.4)	3.1(0.4)	15/15
CMAm	**1.6**(2)	**2.8**(1)	3.2(2)	4.1(1.0)	5.4(1)	4.4(0.6)	15/15
CMAma	**1.8**(3)	**2.8**(0.9)	3.3(0.6)	3.7(0.7)	4.0(0.8)	**3.0**(0.4)	15/15
CMAmah	**1.4**(1)	**2.1**(0.8)	**2.4**(0.6)	3.4(0.9)	4.1(1)	3.5(0.4)	15/15
CMAmh	**1.4**(2)	**2.1**(1)	**2.5**(0.9)	4.1(2)	6.4(0.8)	5.1(0.6)	15/15
DBRCGA	**1.5**(1)	15(7)	25(3)	26(9)	110(97)	1315(1232)	1/15
DE	**1.8**(3)	7.2(3)	12(2)	15(4)	37(8)	47(12)	15/15
DE-AUTO	**1.7**(1)	**2.0**(0.3)	**1.7**(0.2)	**0.99**(0.1)	**0.73**(0.1)	5.1(5)	15/15
DE-BFGS	**1.0**(1)	**1.8**(0.2)	**1.5**(0.3)	**0.95**(0.1)	**0.71**(0.1)	6.4(10)	13/15
DE-ROLL	**1.4**(2)	4.7(6)	4.9(4)	10(10)	112(33)	1824(2231)	0/15
DE-SIMPLEX	**0.95**(2)	5.3(4)	4.9(3)	3.1(0.9)	**2.2**(0.5)	**1.5**(0.3)	15/15
DEctpb	**1.1**(1)	6.3(4)	12(2)	16(3)	40(12)	52(10)	15/15
IPOPsaACM	**2.8**(2)	**2.5**(0.6)	**2.5**(0.6)	**2.1**(0.3)	**1.8**(0.2)	**1.3**(0.1)	15/15
JADEb	**1.3**(1)	4.0(1.0)	6.1(1)	7.8(1)	10(2)	8.2(3)	15/15
JADEctpb	**0.95**(0.8)	5.3(2)	8.9(1)	10(2)	12(1)	8.2(0.5)	15/15
MVDE	**0.91**(1.0)	15(6)	26(7)	38(9)	173(39)	591(272)	15/15
NBIPOPaCMA	**1.7**(2)	**2.5**(1)	3.6(0.8)	4.1(0.5)	4.2(0.5)	3.2(0.4)	15/15
NIPOPaCMA	**2.1**(2)	3.1(1)	3.9(1)	4.3(0.7)	4.0(0.5)	3.2(0.4)	15/15
PSO-BFGS	**2.3**(3)	**1.9**(0.3)	**1.6**(0.2)	**0.98**(0.1)	**0.76**(0.1)	134(203)	4/15
SNES	**2.6**(3)	**2.4**(1)	3.3(1)	8.3(10)	1.2e4(1e4)	∞ *1e6*	0/15
xNES	**2.3**(2)	**2.1**(1)	4.2(1)	5.5(0.7)	5.1(0.7)	3.9(0.2)	15/15
xNESas	**2.0**(2)	**1.9**(0.9)	3.9(1)	4.9(1)	4.6(0.5)	3.3(0.3)	15/15

Table 16: 05-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	511	9310	19369	20073	20769	21359	14/15
ACOR	5.3(4)	7.7(11)	17(27)	16(26)	16(25)	15(25)	15/15
BIPOPaCMA	**1.5**(2)	**1.1**(0.8)	**1.4**(1)	**1.3**(1)	**1.3**(1)	**1.3**(1)	15/15
BIPOPsaACM	**1.4**(1)	**0.59**(0.5)	**0.65**(0.5)	**0.64**(0.5)	**0.62**(0.5)	**0.61**(0.4)	15/15
CMA	**1.6**(2)	**0.74**(0.5)	**0.86**(0.6)	**0.86**(0.6)	**0.86**(0.6)	**0.87**(0.6)	15/15
CMAES	**2.1**(2)	5.0(5)	15(13)	15(14)	14(13)	14(14)	9/15
CMAa	**1.5**(2)	**1.1**(0.7)	**1.2**(0.6)	**1.2**(0.7)	**1.2**(0.6)	**1.2**(0.6)	15/15
CMAm	**1.8**(2)	**0.74**(0.6)	**0.66**(0.4)	**0.67**(0.4)	**0.67**(0.3)	**0.68**(0.3)	15/15
CMAma	**1.0**(0.5)	**0.86**(0.6)	**1.1**(0.8)	**1.1**(0.8)	**1.1**(0.8)	**1.1**(0.8)	15/15
CMAmah	**2.0**(2)	**0.98**(0.5)	**1.1**(0.7)	**1.1**(0.7)	**1.1**(0.7)	**1.1**(0.7)	15/15
CMAmh	3.2(3)	**0.95**(0.5)	**1.1**(0.6)	**1.1**(0.6)	**1.1**(0.6)	**1.1**(0.6)	15/15
DBRCGA	3.7(2)	26(24)	84(90)	81(96)	79(80)	77(93)	4/15
DE	6.1(5)	4.3(4)	6.0(7)	5.9(6)	5.7(6)	5.6(6)	13/15
DE-AUTO	15(9)	6.1(7)	11(14)	11(13)	11(13)	10(13)	13/15
DE-BFGS	3.8(3)	**1.1**(1)	**1.6**(1)	**1.6**(1)	**1.5**(1)	**1.5**(1)	15/15
DE-ROLL	24(14)	7.0(6)	12(13)	12(14)	12(14)	11(13)	13/15
DE-SIMPLEX	10(5)	3.1(3)	3.2(3)	3.0(3)	**2.9**(3)	**2.9**(3)	15/15
DEctpb	6.0(4)	4.9(4)	7.1(8)	7.2(7)	7.1(8)	7.1(8)	12/15
IPOPsaACM	**1.6**(1)	**0.42**(0.4)$_\downarrow$	**0.72**(0.6)	**0.71**(0.6)	**0.70**(0.6)	**0.69**(0.6)	15/15
JADEb	3.0(2)	14(15)	32(33)	39(44)	38(42)	37(41)	4/15
JADEctpb	3.7(1)	7.5(13)	39(51)	39(44)	59(60)	175(199)	1/15
MVDE	5.1(2)	12(12)	26(31)	31(30)	32(28)	32(29)	11/15
NBIPOPaCMA	**1.7**(2)	**0.99**(1)	**1.6**(0.9)	**1.6**(0.9)	**1.5**(0.9)	**1.5**(0.8)	15/15
NIPOPaCMA	**1.4**(2)	**1.1**(0.9)	**1.2**(0.7)	**1.2**(0.7)	**1.2**(0.7)	**1.2**(0.7)	15/15
PSO-BFGS	10(7)	6.6(5)	39(40)	37(38)	36(39)	35(36)	8/15
SNES	5.0(10)	14(14)	23(20)	22(19)	22(18)	21(18)	14/15
xNES	**1.8**(1)	5.3(6)	25(33)	24(32)	24(24)	23(24)	11/15
xNESas	3.6(6)	4.3(4)	18(20)	18(19)	17(19)	16(18)	14/15

Table 17: 05-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	120	612	2662	10449	11644	12095	15/15
ACOR	7.0(9)	325(232)	154(187)	66(77)	70(66)	75(83)	15/15
BIPOPaCMA	3.6(2)	3.5(3)	**1.8**(2)	**0.74**(1.0)	**0.71**(0.8)	**0.71**(0.8)	15/15
BIPOPsaACM	3.2(4)	4.3(2)	**1.6**(1)	**0.82**(0.7)	**0.77**(0.7)	**0.79**(0.7)	15/15
CMA	**2.3**(2)	**3.1**(3)	**1.9**(2)	**1.1**(1)	**1.00**(1)	**1.00**(1)	15/15
CMAES	**2.0**(2)	3.6(4)	**2.7**(4)	4.5(8)	5.8(7)	5.7(7)	15/15
CMAa	**1.7**(1)	**2.8**(3)	**2.2**(2)	**0.84**(0.6)	**0.80**(0.5)	**0.80**(0.5)	15/15
CMAm	**2.9**(4)	5.0(6)	**3.0**(2)	**1.0**(0.6)	**1.1**(0.7)	**1.1**(0.7)	15/15
CMAma	**2.3**(2)	3.3(5)	**1.7**(0.8)	**0.88**(0.6)	**0.83**(0.5)	**0.83**(0.5)	15/15
CMAmah	**2.3**(1)	3.8(4)	**2.4**(2)	**0.94**(0.7)	**0.90**(0.6)	**0.90**(0.6)	15/15
CMAmh	**2.9**(1)	3.8(3)	**2.5**(1)	**1.2**(1)	**1.1**(1.0)	**1.1**(1.0)	15/15
DBRCGA	**2.2**(1)	27(41)	38(51)	50(58)	86(96)	101(117)	5/15
DE	5.1(6)	31(13)	17(16)	11(10)	10(9)	10(8)	14/15
DE-AUTO	6.6(15)	115(105)	99(103)	93(97)	86(90)	605(644)	1/15
DE-BFGS	8.0(8)	17(12)	21(9)	33(48)	30(43)	585(643)	0/15
DE-ROLL	8.3(9)	69(41)	62(96)	73(81)	110(116)	616(632)	0/15
DE-SIMPLEX	**2.4**(2)	7.6(7)	19(25)	10(9)	10(8)	37(47)	7/15
DEctpb	3.9(5)	54(30)	52(30)	165(191)	149(161)	144(155)	2/15
IPOPsaACM	3.1(4)	**2.4**(2)	**1.0**(1)	**0.52**(0.6)$\downarrow$	**0.55**(0.6)$\downarrow$	**0.55**(0.5)$\downarrow$	15/15
JADEb	3.1(3)	4.5(2)	6.8(8)	7.6(12)	8.4(12)	8.7(12)	12/15
JADEctpb	**2.9**(5)	10(5)	36(48)	∞	∞	∞ *2e5*	0/15
MVDE	**1.8**(2)	24(11)	90(163)	1411(1627)	∞	∞ *1e6*	0/15
NBIPOPaCMA	**2.6**(2)	4.6(6)	**2.4**(2)	**0.99**(1)	**0.94**(1.0)	**0.93**(1.0)	15/15
NIPOPaCMA	**1.8**(2)	**2.7**(5)	**1.0**(1)	**0.56**(0.6)	**0.55**(0.5)	**0.57**(0.5)	15/15
PSO-BFGS	6.9(8)	41(37)	75(97)	111(141)	298(345)	593(643)	1/15
SNES	**3.0**(3)	7.8(16)	13(24)	11(22)	41(45)	61(83)	9/15
xNES	**2.0**(2)	3.6(2)	4.4(8)	**2.5**(3)	**2.3**(3)	**2.2**(3)	15/15
xNESas	**2.3**(2)	5.3(8)	**1.7**(3)	**1.8**(2)	**1.6**(2)	**1.6**(2)	15/15

Table 18: 05-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
f17	5.2	215	899	3669	6351	7934	15/15
ACOR	3.1(3)	**1.8**(0.4)	**0.95**(0.2)	**2.8**(8)	7.5(9)	11(14)	15/15
BIPOPaCMA	3.8(5)	**0.86**(0.3)	**1.1**(2)	**0.83**(0.5)	**0.94**(0.7)	**1.4**(0.4)	15/15
BIPOPsaACM	3.8(6)	**1.0**(1)	**1.2**(2)	**0.92**(0.5)	**1.1**(0.4)	**1.4**(1)	15/15
CMA	**1.8**(2)	**0.82**(0.3)	**0.93**(2)	**0.89**(0.6)	**1.1**(0.7)	**1.2**(0.4)	15/15
CMAES	4.1(4)	**0.96**(0.4)	**0.74**(0.2)	**1.2**(2)	8.5(11)	30(30)	9/15
CMAa	**2.6**(2)	**1.3**(0.4)	**0.77**(1.0)	**0.89**(0.5)	**0.81**(0.3)	**1.0**(0.4)	15/15
CMAm	3.4(3)	**0.85**(0.5)	**0.58**(0.1)	**0.73**(0.4)	**0.77**(0.5)	**0.91**(0.3)	15/15
CMAma	3.3(2)	**1.5**(0.4)	**1.1**(1)	**0.84**(0.9)	**0.82**(0.5)	**0.96**(0.4)	15/15
CMAmah	3.1(2)	**1.5**(3)	**2.1**(2)	**1.3**(0.8)	**1.1**(0.5)	**1.0**(0.4)	15/15
CMAmh	**2.5**(2)	**1.2**(0.6)	**2.6**(3)	**1.5**(1.0)	**1.4**(0.6)	**1.5**(0.6)	15/15
DBRCGA	3.7(5)	5.4(0.8)	7.7(1)	16(14)	38(37)	88(92)	4/15
DE	4.1(6)	3.2(1.0)	**2.2**(0.5)	**2.1**(0.5)	**2.8**(2)	3.3(3)	15/15
DE-AUTO	3.8(3)	163(53)	120(212)	47(57)	35(32)	41(36)	10/15
DE-BFGS	3.0(3)	7.1(7)	35(110)	10(27)	6.9(16)	145(164)	0/15
DE-ROLL	**2.7**(3)	47(41)	125(261)	54(71)	45(42)	898(979)	1/15
DE-SIMPLEX	**2.5**(2)	23(16)	55(35)	24(34)	15(20)	887(915)	0/15
DEctpb	4.1(5)	3.4(1)	**2.6**(0.9)	**2.1**(0.5)	**2.1**(0.5)	3.7(2)	15/15
IPOPsaACM	4.9(4)	**1.8**(0.4)	**1.1**(1)	**0.85**(0.5)	**1.2**(0.5)	**1.4**(0.8)	15/15
JADEb	3.1(2)	**1.4**(0.6)	3.3(7)	3.4(7)	5.3(5)	9.0(7)	13/15
JADEctpb	3.3(4)	**2.5**(0.7)	**1.9**(0.3)	**1.2**(0.2)	**1.2**(0.3)	**1.2**(0.2)	15/15
MVDE	**2.9**(4)	5.8(2)	5.8(2)	6.8(3)	10(6)	32(63)	13/15
NBIPOPaCMA	6.5(6)	5.7(7)	**2.1**(2)	**1.1**(1)	**1.0**(0.6)	**1.3**(0.7)	15/15
NIPOPaCMA	5.5(4)	**1.00**(0.4)	**0.88**(2)	**0.98**(0.9)	**0.90**(0.4)	**1.0**(0.4)	15/15
PSO-BFGS	**1.5**(1.0)	26(15)	21(19)	13(21)	9.2(12)	907(947)	0/15
SNES	5.3(4)	4.2(0.9)	3.6(6)	**2.7**(3)	8.1(9)	19(20)	14/15
xNES	4.5(6)	**1.1**(0.4)	**0.79**(0.2)	**0.47**(0.1)	**1.3**(1)	6.1(9)	15/15
xNESas	6.8(7)	**1.0**(0.7)	**1.1**(0.7)	**0.81**(0.7)	**1.4**(1)	**2.0**(3)	15/15

Table 19: 05-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	103	378	3968	9280	10905	12469	15/15
ACOR	**1.9**(1)	**2.4**(1)	5.8(14)	36(38)	82(70)	80(60)	15/15
BIPOPaCMA	**1.2**(0.3)	**2.0**(3)	**0.62**(0.5)	**0.76**(0.3)	**0.86**(0.3)	**0.98**(0.3)	15/15
BIPOPsaACM	**2.5**(1)	3.1(4)	**0.82**(1.0)	**0.76**(0.7)	**1.2**(0.7)	**1.4**(0.7)	15/15
CMA	**1.2**(0.9)	**1.6**(0.8)	**1.6**(2)	**0.97**(0.8)	**1.0**(0.7)	**1.1**(0.5)	15/15
CMAES	**1.2**(0.7)	**2.2**(4)	**1.5**(2)	11(11)	76(80)	92(100)	3/15
CMAa	**0.82**(0.3)	**1.7**(0.3)	**0.44**(0.5)	**0.66**(0.3)$_{\downarrow}$	**0.76**(0.3)	**0.94**(0.6)	15/15
CMAm	**0.94**(0.7)	**0.77**(0.3)	**0.53**(0.6)	**0.79**(0.4)	**0.82**(0.3)	**0.85**(0.3)	15/15
CMAma	**0.89**(0.7)	**1.2**(0.8)	**0.63**(0.5)	**0.69**(0.6)	**0.67**(0.6)	**0.71**(0.5)	15/15
CMAmah	6.2(2)	7.2(11)	**1.5**(1)	**1.2**(0.6)	**1.1**(0.7)	**1.1**(0.6)	15/15
CMAmh	**0.51**(0.3)	**2.6**(3)	**1.1**(1)	**1.3**(0.6)	**1.3**(0.6)	**1.3**(0.6)	15/15
DBRCGA	5.0(3)	12(2)	5.4(9)	100(116)	∞	∞ *5e5*	0/15
DE	**2.4**(2)	4.4(2)	**1.4**(0.7)	**2.8**(3)	7.7(9)	40(43)	5/15
DE-AUTO	48(107)	162(60)	60(71)	54(56)	60(60)	84(83)	2/15
DE-BFGS	5.7(7)	18(10)	28(63)	19(27)	20(23)	587(685)	0/15
DE-ROLL	49(69)	112(57)	65(69)	88(91)	∞	∞ *5e5*	0/15
DE-SIMPLEX	23(23)	155(285)	62(77)	65(71)	74(83)	575(613)	0/15
DEctpb	**2.9**(2)	4.9(2)	**1.5**(0.7)	**2.3**(1.0)	6.7(7)	290(331)	1/15
IPOPsaACM	**2.8**(0.8)	**1.5**(0.5)	**0.64**(0.7)	**0.85**(0.7)	**1.0**(0.4)	**1.1**(0.4)	15/15
JADEb	**1.8**(1)	4.0(1)	**2.5**(3)	12(16)	72(83)	∞ *2e5*	0/15
JADEctpb	**1.9**(1)	3.3(0.7)	**0.72**(0.1)	**0.60**(0.1)$_{\downarrow 2}$	**1.1**(0.2)	**1.1**(0.2)	15/15
MVDE	4.2(1)	10(4)	4.3(2)	18(10)	39(24)	50(28)	12/15
NBIPOPaCMA	**1.0**(0.6)	3.1(7)	**0.68**(0.9)	**0.99**(0.4)	**1.0**(0.4)	**1.1**(0.4)	15/15
NIPOPaCMA	**1.1**(0.7)	**1.5**(1)	**0.49**(0.6)	**0.99**(0.7)	**1.1**(0.7)	**1.1**(0.4)	15/15
PSO-BFGS	24(18)	37(11)	16(10)	38(38)	53(55)	∞ *5e5*	0/15
SNES	**1.1**(0.9)	6.3(13)	**1.9**(3)	20(22)	647(734)	∞ *1e6*	0/15
xNES	**1.2**(1)	**1.4**(0.5)	**0.43**(0.1)	**0.51**(0.6)	**2.0**(2)	3.6(4)	15/15
xNESas	**0.80**(0.5)	**1.4**(0.3)	**0.25**(0.1)	**0.43**(0.5)	**1.4**(0.9)	**2.0**(3)	15/15

Table 20: 05-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	242	1.2e5	1.2e5	1.2e5	15/15
ACOR	28(28)	3135(4608)	626(611)	17(38)	17(38)	17(38)	14/15
BIPOPaCMA	22(14)	**1466**(1186)	186(177)	**2.0**(1)	**2.0**(1)	**2.0**(1)	15/15
BIPOPsaACM	16(14)	1834(1246)	**92**(142)	**0.85**(0.6)	**0.85**(0.6)	**0.85**(0.6)	15/15
CMA	**15**(14)	1796(1570)	572(827)	**2.1**(2)	**2.1**(2)	**2.1**(2)	15/15
CMAES	21(13)	2230(1651)	327(335)	∞	∞	∞ *3e5*	0/15
CMAa	24(10)	6888(1525)	462(416)	**3.0**(3)	**3.0**(3)	**3.0**(3)	14/15
CMAm	20(16)	**1379**(1430)	551(660)	**2.3**(2)	**2.3**(2)	**2.3**(2)	15/15
CMAma	18(13)	**1297**(924)	259(255)	**1.9**(2)	**1.9**(2)	**1.9**(2)	15/15
CMAmah	17(12)	**1167**(656)	518(491)	**2.4**(2)	**2.4**(2)	**2.3**(2)	15/15
CMAmh	**12**(15)	3.1e4(8e4)	421(494)	**2.5**(2)	**2.5**(2)	**2.5**(2)	15/15
DBRCGA	28(26)	3184(1818)	859(1122)	∞	∞	∞ *5e5*	0/15
DE	32(28)	4210(2571)	1106(1032)	15(17)	15(16)	15(16)	2/15
DE-AUTO	323(28)	1.3e4(1e4)	361(226)	19(21)	19(21)	19(19)	3/15
DE-BFGS	40(38)	2166(1133)	**71**(65)	4.3(4)	4.3(4)	11(11)	2/15
DE-ROLL	38(26)	5195(8159)	502(489)	61(62)	61(70)	∞ *5e5*	0/15
DE-SIMPLEX	62(16)	2807(2948)	**68**(95)	4.7(6)	4.7(5)	4.7(5)	9/15
DEctpb	34(41)	3526(3425)	1050(1038)	∞	∞	∞ *2e5*	0/15
IPOPsaACM	19(16)	1931(1477)	250(254)	**1.4**(1)	**1.4**(1)	**1.4**(1)	15/15
JADEb	30(24)	3020(2620)	586(682)	9.5(9)	9.4(10)	9.4(10)	3/15
JADEctpb	35(26)	2139(2314)	276(160)	∞	∞	∞ *2e5*	0/15
MVDE	34(26)	4483(4878)	756(722)	56(62)	120(124)	120(123)	1/15
NBIPOPaCMA	20(20)	2026(1762)	156(138)	**2.6**(4)	**2.6**(4)	**2.6**(4)	15/15
NIPOPaCMA	16(16)	1813(1877)	324(473)	**2.7**(3)	**2.7**(3)	**2.7**(3)	15/15
PSO-BFGS	69(94)	2559(2762)	**60**(51)	3.6(3)	3.6(3)	19(21)	1/15
SNES	**14**(12)	3327(5308)	1668(2065)	36(41)	36(41)	36(38)	3/15
xNES	**15**(16)	2009(1734)	386(502)	5.3(5)	5.3(5)	5.6(5)	10/15
xNESas	17(18)	3280(5087)	542(792)	11(10)	20(21)	21(22)	6/15

Table 21: 05-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	16	851	38111	54470	54861	55313	14/15
ACOR	6.0(2)	3.2(4)	3.3(4)	**2.3**(3)	**2.3**(3)	**2.3**(3)	15/15
BIPOPaCMA	3.4(3)	10(11)	**2.4**(1)	**1.7**(0.9)	**1.8**(0.9)	**1.8**(0.9)	15/15
BIPOPsaACM	3.1(2)	3.9(4)	**1.7**(1)	**1.2**(1.0)	**1.2**(1.0)	**1.2**(1.0)	15/15
CMA	3.7(2)	8.3(6)	**1.7**(0.8)	**1.3**(0.6)	**1.3**(0.6)	**1.3**(0.6)	15/15
CMAES	3.7(3)	27(28)	∞	∞	∞	∞ *3e5*	0/15
CMAa	**2.5**(2)	9.1(3)	**1.7**(1)	**1.4**(1)	**1.4**(1)	**1.4**(1)	15/15
CMAm	**3.0**(3)	9.0(4)	**1.7**(0.8)	**1.3**(0.6)	**1.3**(0.6)	**1.3**(0.6)	15/15
CMAma	**2.4**(2)	9.4(6)	**1.7**(2)	**1.3**(1)	**1.3**(1)	**1.4**(1)	15/15
CMAmah	**2.3**(2)	11(4)	**1.6**(2)	**1.2**(1)	**1.2**(1)	**1.2**(1)	15/15
CMAmh	**2.6**(1)	14(12)	**1.7**(2)	**1.3**(1)	**1.3**(1)	**1.3**(1)	15/15
DBRCGA	18(15)	4.4(6)	**2.4**(2)	**1.7**(1)	**1.7**(1)	**1.7**(1)	14/15
DE	8.8(6)	**1.9**(0.7)	**0.57**(0.8)	**0.41**(0.6)	**0.42**(0.6)	**0.42**(0.5)	15/15
DE-AUTO	4.0(1)	7.2(6)	14(16)	10(12)	10(12)	10(12)	9/15
DE-BFGS	4.1(2)	**2.8**(1)	10(14)	7.1(10)	7.0(8)	7.0(7)	10/15
DE-ROLL	15(19)	3.1(3)	4.0(6)	**2.8**(4)	**2.8**(4)	**2.8**(4)	14/15
DE-SIMPLEX	6.4(2)	4.7(5)	19(22)	13(15)	13(18)	13(15)	7/15
DEctpb	7.7(6)	**2.1**(1)	**0.14**(0.0)$_{\downarrow 4}$	**0.14**(0.0)	**0.16**(0.0)	**0.17**(0.0)	15/15
IPOPsaACM	**2.4**(2)	3.5(3)	**1.6**(1)	**1.2**(1)	**1.2**(1)	**1.2**(1)	15/15
JADEb	5.8(4)	**0.91**(0.3)	**1.7**(2)	**1.2**(2)	**1.2**(2)	**1.2**(2)	14/15
JADEctpb	4.9(3)	**2.3**(2)	**0.25**(0.2)$_{\downarrow 3}$	**0.25**(0.2)	**0.29**(0.2)	**0.33**(0.2)	15/15
MVDE	14(8)	**2.7**(2)	**0.23**(0.1)$_{\downarrow 4}$	**0.26**(0.1)	**0.32**(0.1)	**0.35**(0.1)	15/15
NBIPOPaCMA	3.6(3)	11(12)	**2.4**(1)	**1.8**(1)	**1.8**(1)	**1.8**(1)	15/15
NIPOPaCMA	3.2(2)	10(5)	**2.1**(2)	**1.6**(1)	**1.6**(1)	**1.7**(1)	15/15
PSO-BFGS	4.9(0.9)	5.4(7)	3.5(3)	**2.4**(2)	**2.4**(2)	**2.4**(2)	14/15
SNES	**2.3**(2)	29(29)	23(21)	16(13)	16(14)	16(13)	11/15
xNES	**2.3**(2)	10(12)	11(9)	8.0(6)	8.0(8)	7.9(8)	13/15
xNESas	3.2(3)	12(22)	21(25)	15(19)	15(17)	14(16)	12/15

Table 22: 05-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	41	1157	1674	1705	1729	1757	14/15
ACOR	3.8(4)	118(196)	299(212)	294(209)	290(206)	285(202)	15/15
BIPOPaCMA	**1.8**(0.9)	7.4(8)	49(23)	50(22)	50(22)	49(22)	15/15
BIPOPsaACM	**1.9**(1)	3.4(4)	4.9(8)	5.0(8)	4.9(8)	4.9(8)	15/15
CMA	6.6(16)	7.3(14)	43(108)	43(105)	43(103)	42(101)	13/15
CMAES	**1.8**(1)	3.1(3)	3.9(5)	3.9(5)	**3.9**(5)	**3.9**(5)	15/15
CMAa	**1.9**(1)	28(14)	23(20)	23(21)	23(21)	22(22)	14/15
CMAm	**1.4**(1)	26(8)	21(20)	21(21)	21(21)	21(21)	14/15
CMAma	**2.0**(2)	5.0(5)	22(18)	39(110)	39(107)	39(106)	13/15
CMAmah	3.6(4)	**2.7**(3)	5.7(10)	5.9(11)	6.0(11)	6.1(11)	15/15
CMAmh	3.3(1)	5.7(6)	40(62)	41(63)	42(70)	42(69)	14/15
DBRCGA	3.2(3)	**2.2**(5)	**2.1**(4)	**2.7**(3)	**3.3**(3)	**3.8**(3)	15/15
DE	**2.7**(3)	3.9(6)	3.7(4)	4.0(4)	4.3(4)	**4.5**(4)	15/15
DE-AUTO	10(24)	26(47)	36(72)	36(71)	35(70)	35(69)	15/15
DE-BFGS	**2.2**(2)	**1.6**(2)	**2.7**(3)	**2.7**(3)	**2.7**(3)	16(15)	12/15
DE-ROLL	10(21)	33(51)	31(39)	31(39)	30(38)	30(38)	15/15
DE-SIMPLEX	3.2(2)	19(23)	19(17)	19(17)	18(17)	18(17)	15/15
DEctpb	3.2(3)	5.5(5)	4.5(4)	5.3(4)	5.8(4)	6.2(4)	15/15
IPOPsaACM	**2.9**(2)	**1.6**(2)	28(23)	28(26)	28(26)	27(26)	15/15
JADEb	**2.3**(2)	4.4(5)	4.4(4)	4.4(4)	4.5(4)	**4.6**(4)	15/15
JADEctpb	**1.7**(2)	**1.1**(1)	**1.2**(1)	**2.8**(4)	5.0(9)	8.2(13)	15/15
MVDE	4.3(3)	**1.5**(0.8)	**2.8**(2)	5.9(3)	10(4)	13(4)	15/15
NBIPOPaCMA	**2.1**(2)	11(10)	31(62)	30(61)	30(60)	29(59)	15/15
NIPOPaCMA	4.1(1)	76(145)	272(620)	269(609)	266(601)	263(591)	15/15
PSO-BFGS	**1.8**(2)	**0.88**(1)	**1.6**(2)	**1.6**(2)	**1.6**(2)	29(55)	13/15
SNES	51(123)	46(74)	53(65)	52(63)	52(62)	51(62)	15/15
xNES	34(123)	29(37)	32(44)	32(44)	31(43)	31(42)	15/15
xNESas	12(1)	23(25)	36(57)	35(56)	35(55)	35(54)	15/15

Table 23: 05-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	71	386	938	1008	1040	1068	14/15
ACOR	**2.9**(3)	143(261)	855(1544)	797(1437)	774(1394)	756(1359)	15/15
BIPOPaCMA	14(13)	16(22)	38(92)	36(86)	35(84)	34(82)	15/15
BIPOPsaACM	**2.2**(4)	**3.2**(4)	14(27)	**13**(25)	**13**(24)	**13**(23)	15/15
CMA	10(11)	87(40)	292(414)	554(747)	537(710)	524(658)	6/15
CMAES	9.3(10)	21(28)	18(31)	17(28)	16(28)	**16**(27)	15/15
CMAa	15(24)	87(30)	379(552)	433(594)	421(637)	411(517)	7/15
CMAm	12(23)	17(26)	144(219)	444(563)	431(595)	421(541)	7/15
CMAma	**2.0**(0.8)	94(71)	250(367)	465(573)	452(570)	442(555)	7/15
CMAmah	6.3(14)	130(262)	289(387)	346(452)	336(397)	329(412)	8/15
CMAmh	5.3(8)	38(29)	288(406)	436(559)	424(547)	414(526)	7/15
DBRCGA	**2.6**(3)	6.7(5)	**11**(11)	**12**(10)	**15**(11)	**16**(11)	15/15
DE	5.0(4)	13(16)	17(25)	17(22)	18(22)	19(21)	15/15
DE-AUTO	8.1(15)	84(101)	102(128)	95(119)	92(115)	96(103)	15/15
DE-BFGS	6.7(15)	13(27)	23(24)	21(22)	21(22)	131(241)	8/15
DE-ROLL	16(24)	144(290)	150(233)	143(217)	144(215)	208(240)	8/15
DE-SIMPLEX	6.5(8)	29(74)	44(47)	41(44)	40(42)	39(41)	15/15
DEctpb	5.1(5)	7.9(13)	**11**(15)	13(14)	16(13)	17(13)	15/15
IPOPsaACM	3.4(5)	12(13)	85(258)	116(267)	113(258)	110(252)	15/15
JADEb	12(30)	16(19)	14(10)	14(10)	**14**(9)	**14**(9)	15/15
JADEctpb	**2.1**(1)	**3.4**(3)	**8.0**(11)	**12**(18)	16(27)	17(30)	15/15
MVDE	4.4(3)	**5.4**(3)	85(14)	98(52)	113(58)	124(58)	14/15
NBIPOPaCMA	8.9(11)	14(18)	18(19)	17(18)	17(18)	17(17)	15/15
NIPOPaCMA	4.0(10)	258(468)	338(715)	316(665)	307(644)	300(628)	15/15
PSO-BFGS	**1.6**(2)	**4.2**(6)	**3.4**(4)	**3.2**(4)	**3.3**(4)	170(238)	5/15
SNES	91(152)	191(260)	134(155)	129(144)	149(188)	161(189)	15/15
xNES	66(209)	100(193)	104(119)	97(110)	95(107)	92(104)	15/15
xNESas	46(61)	44(57)	39(42)	37(39)	36(37)	35(37)	15/15

Table 24: 05-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	3.0	518	14249	31654	33030	34256	15/15
ACOR	**2.6**(3)	86(79)	∞	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	3.2(3)	11(9)	**1.6**(1)	**0.86**(0.6)	**0.85**(0.6)	**0.84**(0.6)	15/15
BIPOPsaACM	4.2(4)	14(8)	**1.1**(1)	**0.91**(0.9)	**0.88**(0.8)	**0.97**(0.8)	15/15
CMA	**2.7**(3)	20(18)	107(141)	49(64)	47(61)	45(59)	6/15
CMAES	**2.9**(5)	13(15)	6.9(9)	4.9(5)	4.7(5)	4.5(4)	12/15
CMAa	**2.4**(3)	29(17)	39(71)	18(32)	17(30)	17(29)	10/15
CMAm	**2.2**(2)	16(17)	63(105)	37(48)	36(46)	35(44)	7/15
CMAma	**2.5**(2)	21(38)	37(70)	22(32)	21(31)	20(29)	9/15
CMAmah	**1.9**(2)	17(29)	52(73)	23(32)	22(30)	22(30)	9/15
CMAmh	4.5(10)	10(13)	38(70)	23(32)	22(31)	21(30)	9/15
DBRCGA	**0.91**(0.8)	19(19)	43(40)	222(237)	212(220)	205(223)	1/15
DE	**2.9**(4)	48(59)	57(62)	35(39)	53(60)	105(124)	1/15
DE-AUTO	**2.9**(3)	4.6(4)	3.5(2)	4.4(2)	4.8(2)	6.1(3)	14/15
DE-BFGS	**2.2**(2)	**2.5**(3)	**2.0**(2)	**1.3**(0.9)	**1.4**(0.9)	96(109)	0/15
DE-ROLL	**2.4**(2)	**4.4**(5)	18(21)	14(14)	16(13)	104(117)	0/15
DE-SIMPLEX	**2.3**(2)	**0.92**(0.9)	**0.88**(0.7)	**0.91**(0.8)	**1.1**(0.8)	99(110)	0/15
DEctpb	3.5(4)	57(60)	∞	∞	∞	∞ *2e5*	0/15
IPOPsaACM	**2.1**(2)	13(17)	8.8(2)	6.6(20)	6.4(19)	6.2(18)	15/15
JADEb	**2.3**(3)	35(40)	32(28)	17(17)	17(16)	16(15)	6/15
JADEctpb	**2.4**(3)	37(32)	8.3(6)	7.6(8)	7.3(7)	7.1(7)	10/15
MVDE	**1.8**(2)	32(40)	190(182)	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**1.6**(2)	8.2(8)	**1.4**(2)	**0.97**(1)	**0.95**(1)	**1.1**(0.9)	15/15
NIPOPaCMA	3.2(2)	15(21)	**1.8**(1)	**0.86**(0.7)	**0.86**(0.7)	**0.87**(0.7)	15/15
PSO-BFGS	**1.4**(1)	**3.5**(5)	3.3(4)	30(34)	∞	∞ *5e5*	0/15
SNES	**2.8**(2)	35(38)	46(54)	416(461)	399(470)	384(460)	1/15
xNES	3.4(3)	66(68)	755(795)	∞	∞	∞ *8e5*	0/15
xNESas	**2.2**(2)	97(97)	∞	∞	∞	∞ *1e6*	0/15

Table 25: 05-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	1622	2.2e5	6.4e6	9.6e6	1.3e7	1.3e7	3/15
ACOR	8.2(6)	155(162)	∞	∞	∞	∞ *1e7*	0/15
BIPOPaCMA	**1.3**(1)	**1.0**(1)	**1.1**(1)	**1.3**(1)	**0.96**(1.0)	**0.96**(1)	5/15
BIPOPsaACM	**1.8**(1)	**1.0**(1)	**0.69**(0.8)	**0.97**(1)	**0.73**(0.8)	**0.73**(0.8)	6/15
CMA	**1.9**(1)	9.4(12)	∞	∞	∞	∞ *1e6*	0/15
CMAES	**1.6**(2)	3.1(3)	∞	∞	∞	∞ *3e5*	0/15
CMAa	**1.5**(2)	13(16)	∞	∞	∞	∞ *1e6*	0/15
CMAm	**2.2**(2)	19(23)	∞	∞	∞	∞ *1e6*	0/15
CMAma	**1.3**(1)	65(72)	∞	∞	∞	∞ *1e6*	0/15
CMAmah	**1.6**(1)	19(21)	∞	∞	∞	∞ *1e6*	0/15
CMAmh	**1.4**(1)	13(18)	**2.2**(3)	**1.5**(2)	**1.1**(1)	**1.1**(1)	1/15
DBRCGA	11(12)	5.6(6)	∞	∞	∞	∞ *5e5*	0/15
DE	10(8)	5.4(6)	∞	∞	∞	∞ *2e5*	0/15
DE-AUTO	10(11)	10(12)	∞	∞	∞	∞ *5e5*	0/15
DE-BFGS	**1.3**(1)	4.3(5)	**0.19**(0.2)	**0.24**(0.3)	**0.18**(0.2)	**0.18**(0.2)	3/15
DE-ROLL	13(11)	16(17)	∞	∞	∞	∞ *5e5*	0/15
DE-SIMPLEX	3.5(3)	10(11)	**0.56**(0.6)	**0.76**(0.8)	**0.57**(0.6)	**0.57**(0.7)	1/15
DEctpb	12(8)	17(18)	∞	∞	∞	∞ *2e5*	0/15
IPOPsaACM	**1.9**(1)	42(52)	11(13)	∞	∞	∞ *5e6*	0/15
JADEb	4.2(4)	7.8(9)	∞	∞	∞	∞ *2e5*	0/15
JADEctpb	6.5(5)	∞	∞	∞	∞	∞ *2e5*	0/15
MVDE	13(10)	69(74)	∞	∞	∞	∞ *1e6*	0/15
NBIPOPaCMA	**2.0**(1)	**0.64**(0.5)	**0.92**(1)	**0.81**(0.9)	**0.71**(0.8)	**0.88**(1)	5/15
NIPOPaCMA	**1.8**(1)	**2.1**(4)	**0.61**(0.7)	**0.46**(0.4)	**0.35**(0.3)	**0.35**(0.3)	11/15
PSO-BFGS	3.2(2)	**0.69**(1)	**0.20**(0.2)	**0.23**(0.3)	**0.18**(0.2)	**0.18**(0.2)	3/15
SNES	**1.6**(2)	3.2(4)	∞	∞	∞	∞ *1e6*	0/15
xNES	7.5(10)	12(13)	∞	∞	∞	∞ *8e5*	0/15
xNESas	6.2(8)	26(27)	∞	∞	∞	∞ *1e6*	0/15

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