Comparison tables: BBOB 2009 noisy testbed in 40-D

The BBOBies

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Abstract

This document provides tabular results of the workshop for Black-Box Optimization Benchmarking at GECCO 2009, see http://coco.gforge.inria.fr/doku.php?id=bbob-2009. More than 30 algorithms have been tested on 24 benchmark functions in dimensions between 2 and 40. A description of the used objective functions can be found in [9, 5]. The experimental set-up is described in [8].

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. Consequently, the best (smallest) value is 1 and the value 1 appears in each column at least once. See [8] for details on how ERT is obtained. All numbers are computed with no more than two digits of precision.

Table 1: 40-D, running time excess ERT/ERT_{best} on f_{101} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

				1											
		Δ ftarget	$\text{ERT}_{ ext{hest}}/ ext{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-07	80.9	89	35			1.5	1	8.5		13	13		1.4
		1e-05	63.9	55	37			1.5	-	8.2		13	4.7		1.4
		1e-04	55.7	52	37	25e-5/2e3		1.5	-1	7.9		13	4.4		1.4
	anss	1e-03	47.8	48	36	41		1.5	П	7.7		13	3.4		1.4
	moderate Gauss			45	38	38	٠	1.5	-	7.2	٠	13	8.8		1.4
nc	$\mathbf{r}\mathbf{e}$	1e-01	31.4	41	39	38		1.5	П	6.4	17e-2/2e3	13	2.3		1.4
dimensi	101 Sphere n	1e+00	. 4	37	40	39		1.5	1	5.7	31	12	2.3		1.4
ded by		1e+01	14.6	29	37	40		1.5	1	ಬ	8.6	11	2.6		1.4
this value divided by dimension			6.48	13	25	37	30e+1/2e3	1.4	1	4.4	4.7	8.9	7	14e+1/1e6	1.2
reach th		1e + 03	0.025	П	1	п	1	1	1	п	1	1	П	1	1
unction evaluations to reach		$\Delta { m ftarget}$	${ m ERT_{best}/D}$	ALPS	AMaLGaM IDEA	BayEDAcG	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES
II															

Table 2: 40-D, running time excess ERT/ERT_{best} on f_{102} , in italics is given the median final function value and the median number of

<u></u>						[4]			10]	2			[4]			[13]
ne median nama			Δ ftarget	$\text{ERT}_{\text{best}}/\text{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
value amu i			1e-07	113	59	26			1.1	19e-7/1e4			5.6			1
UIICETOII			1e-05	~	43	26			1.1				9.7			П
alali iiiai i			1e-04	77.5	40	26	29e-5/2e3		1.1	11	42e-4/3e5		9.6			1
ome ome		unif								3.7	6.6e4		9.6			П
ICS IS SIVEII		moderate unif	1e-02	55.3	35	26	28	-	1.1	1.5	1200	16e-2/2e3	9.2		-	-
/102, III 10ai		$102 \mathrm{\ Sphere}$ n	1e-01	43.6	32	27	28	•	1.1	1	100	230	9.1	27e-1/1e6		П
est ou .	value divided by dimension	102	1e+00	32.1	28	27	28		1.1	1.1	16	23	8.7	4.4e5		-
1,111/1	divided		1e+01	20.5	23	30	29		1.1	1.3	14	7.1	∞	3900		-
IC CACCOS LILL	ch this value		1e+02	8.36	11	22	30	29e+1/2e3	1.1	1.5	5.3	4	6.4	22	13e+1/1e6	П
ming emin	to read		1e + 03	0.025	1	1	п	П	-	П	1	П	-	1	1	-
Table 2. 40-D, tunning time excess DAL/ DAL best on 1102, in trance is given the median innerton value and the median number of	function evaluations to reach this		Δ ftarget	$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS	AMaLGaM IDEA	$_{ m BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 3: 40-D, running time excess ERT/ERT_{best} on f_{103} , in italics is given the median function value and the median number of

												Ŧ			13
		Δ ftarget	${ m ERT_{best}/D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-07	95.4 124		130		œ	1.1	•			260	•		-
		1e-05	95.4		89		10	1.1	٠			320	٠		-
		1e-04	81.6	-	36	33e-5/2e3	12	1.1			-	82			_
	auchy	1e-03	89	-	22	29	13		13e-3/1e4				84e-4/1e6		_
	Sphere moderate Cauchy	1e-02	54	41e-3/1e5	24	31	17	1.1	1300	36e-3/3e5		21	2.3e4		_
ension	Sphere mo	$^{-}$ 1e-01	42.3	120	26	28	21	1.1	5.3	260	79e-2/2e3	12	6.5		-
by dim	103	1e+00	30.6	28	30	59	29	1.1	1.1	5.1	62	9.1	П		-
divided		1e + 01	13.2	34	47	44	48	1.7	1.1	6.1	12	13	1		r.
n this value		1e+02	5.92	15	24	41	73	1.5	1.3	4.2	5.2	8.6	1	14e+1/1e6	8
to reach		1e + 03	0.025	1	1	1	П	1	1	1	1	1	1	1	-
function evaluations to reach this value divided by dimension		Δ ftarget	${ m ERT_{best}/D}$	ALPS	AMaLGaM IDEA	$_{ m BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 4: 40-D, running time excess ERT/ERT_{best} on f_{104} , in italics is given the median function value and the median number of function evaluations to reach this value divided by dimension

		Δ ftarget	$\text{ERT}_{\text{best}}/\text{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ÈS [13]
			94100		3.7			1				27	•		•
			93400		3.7			1				27	•		•
		1e-04	93000		3.7		٠	1			٠	27	•		•
	auss	1e-03	92600	14e-1/1e5	3.7			1				28			
	erate (1e-02	92200	20	3.7			1				28			-
_	Rosenbrock moderate Gauss	1e-01	91400	9.2	3.7		٠	П	•	74e-1/4e5		23	٠		
Ilmension	Rosenb	1e+00	89900	3.4	3.7		•	1	•	31	•	20	٠		
aividea by o	104 F		77200	1	4.1	63e+0/2e3		1.1	39e+0/1e4	4.9	96e+0/2e3	18	45e+0/1e6		37e+0/1e4
is value		1e + 02	243	21	3.3	7.9		1	П	45	13	1.3	24		5.3
to reach this		1e+03	18.6	34	23	31	50e+4/1e3	1.4	1	5.5	13	9.4	1.5	93e + 3/1e6	1.3
runction evaluations to reach the		Δ ftarget	${ m ERT_{best}/D}$	ALPS	AMaLGaM IDEA	$_{ m BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 5: 40-D, running time excess ERT/ERT_{best} on f_{105} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

onis value divided by differentiation	105 Rosenbrock moderate unif	1e+02 $1e+01$ $1e+00$ $1e-01$ $1e-02$ $1e-03$ $1e-04$ $1e-05$ $1e-07$	166 1.4e5 1.48e5 1.51e5 1.52e5 1.53e5 1.54e5	36 1.4 3.6 10e+0/1e5 . . . ALPS [11]	5.3 $35e+0/1e6$. AMal Gam IDEA [4]	$14 81e+0/2e3 \qquad . \qquad . \qquad . \qquad . \qquad . \qquad B$	000 BFGS [14]	1 1 1 1 1 1 BIPOP-CMA-ES [10]	23 $72e+0/1e4$	2100 96e+0/3e5 DASA [12]	32 10e + 1/2e3 DEPSO [7]	1.9 $35e+0/1e6$ iAMaLGaM IDEA [4]	4.4e4 15e+1/1e6 (1+1)-ES [1]	(e6	0.9 98.10.12.1
ded by difficient	105 Rosenbroc	1e+00	1.48e5 1	3.6	5e+0/1e6 .	1e+0/2e3 .		1 1	2e+0/1e4 .	5e+0/3e5 .	0e+1/2e3 .	5e+0/1e6 .	5e+1/1e6 .		80+10/10/
acii ciiis value ciivic		1e+02	23.9 166	25 36	5.3	14 8	46e+4/900 .	1.1	1.4 23 72e	6.9 2100 96 e	7	6,3	7	99e+3/1e6 .	1 0.0 386
Infiction evaluations to reach the		Δ ftarget 1	_	ALPS	AMaLGaM IDEA	BayEDAcG		BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES		IPOP_SEP_CM A_ES

Table 6: 40-D, running time excess ERT/ERT_{best} on f_{106} , in italics is given the median function value and the median number of

		$\Delta { m ftarget}$	$\mathrm{ERT}_{\mathrm{best}}/\mathrm{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES $[2]$	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-07	2600					1.3							П
		1e-04 $1e-05$	2540	•	•		•	1.3	•				•		П
					•		•	1.3	•				•		П
	hy	1e-03	2450 2490		•		•	1.3	•				•		
	Canc	1e-02	2450		٠			1.3	٠						
	moderate	1e-01	2390	39e-1/1e5	•		•	1.3	•	73e-2/7e5					-
mension	106 Rosenbrock moderate Cauchy	1e+00	2270	160	•	-		1.2	-	200			13e+0/1e6		-1
livided by din	$10 m \acute{e}$ Re	1e+01	1730	38	27e+0/1e6	10e+1/2e3		1	28e+0/1e4	14	11e+1/2e3	29e+0/1e6	8300	-	1
value d		1e+02	47.9	09	18	71		1.6	1	22	92	6.5	2.5		1.3
to reach this		1e + 03	16.9	36	26	34	12e+3/4e3	1.6	1.1	5.8	15	10	П	92e + 3/1e6	1.3
function evaluations to reach this value divided by dimension		Δ ftarget	$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS	AMaLGaM IDEA	$_{ m BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 7: 40-D, running time excess ERT/ERT_{best} on f_{107} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

CUIDII EVALUAUIDIIS UN IEACII		nins value divided i	ed by difficulated	SIOII							
			1(.07 Sphere Gauss	ere Ga						
Δ ftarget	1e + 03	1e+02	1e+01	$1e+\tilde{0}0$	$1e + \bar{0}0$ $1e - 01$ $1e - 02$		1e-03	1e-04	1e-05	1e-07	$\Delta { m ftarget}$
$\text{ERT}_{\text{best}}/\text{D}$	0.025	225	096	1440	1870	2170	2440	2720	3010	3620	${ m ERT_{best}/D}$
ALPS	1	10	35e+0/1e5								ALPS [11]
AMaLGaM IDEA	1	1.5	15	48	20	45	41	39	36	32	AMaLGaM IDEA [4]
$_{ m BayEDAcG}$	1	2.7	22e+0/2e3								BayEDAcG [6]
BFGS	1	29e+1/1e3									BFGS [14]
BIPOP-CMA-ES	1	1.7	1	1	1	1	1	П	П	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	22e+1/1e4								٠	(1+1)-CMA-ES $[2]$
DASA	1	20e+1/2e5									DASA [12]
DEPSO	1	19e+1/2e3									DEPSO [7]
iAMaLGaM IDEA	1	-1	130	110	140	170	120	140	130	110	iAMaLGaM IDEA [4]
(1+1)-ES	1	17e+1/1e6									(1+1)-ES [1]
Monte Carlo	1	13e+1/1e6									Monte Carlo [3]
IPOP-SEP-CMA-ES	П	099	17e+1/1e4								IPOP-SEP-CMA-ES [13]

Table 8: 40-D, running time excess ERT/ERT_{best} on f_{108} , in italics is given the median final function value and the median number of

10000	0		Jest /	, (OOT //	201100	00	1		1	200	the state of the state of the period of the period of the state of the
function evaluations to reach this value divided by dimension	to reac	this value	divided by d	imension							
			•	108	108 Sphere unif	unif					
Δ ftarget	1e + 03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-03 1e-04	1e-05 1e-07	1e-07	Δ ftarget
$\text{ERT}_{\text{best}}/ ext{D}$	0.025	2340	5370	14000	23400	37400	45900	52500	70400	1.06e5	${ m ERT_{best}/D}$
ALPS	1	120	11e+1/1e5	-							ALPS [11]
AMaLGaM IDEA	1	4.1	130	520	630	46e-1/1e6	٠		•		AMaLGaM IDEA [4]
BayEDAcG	1	22e+1/2e3									BayEDAcG [6]
BFGS	1	32e+1/800		٠	٠		•	•		•	BFGS [14]
BIPOP-CMA-ES	1	1	1	1	1	1	1	1	1	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	22e+1/1e4	-		•		•			٠	(1+1)-CMA-ES [2]
DASA	1	23e+1/2e5									DASA [12]
DEPSO	1	31e+1/2e3		٠	٠		•	•		•	DEPSO [7]
iAMaLGaM IDEA	1	20	270	520	82e-1/1e6						iAMaLGaM IDEA [4]
(1+1)-ES	1	18e+1/1e6			•		•	٠	•	٠	(1+1)-ES [1]
Monte Carlo	1	14e+1/1e6									Monte Carlo [3]
IPOP-SEP-CMA-ES	1	29e+1/1e4		٠	٠		•	•	•	•	IPOP-SEP-CMA-ES [13]

Table 9: 40-D, running time excess ERT/ERT_{best} on f_{109} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

function evaluations to reach this value divided by dimension	to reack	this value c	livided by di	mension							
			•	109 Sphere Cauchy	ere Ca	uchy					
Δ ftarget	1e+03	1e+02	1e+01	1e+00	1e-01 1e-02	1e-02	1e-03	1e-04	1e-04 $1e-05$	1e-07	$\Delta { m ftarget}$
$\text{ERT}_{\text{best}}/\text{D}$	0.025	7.73	21	36.4	62.6	91.8	124	156	188	251	ERT_{best}/D
ALPS	1	12	1.4e4	11e+0/1e5	-		-				ALPS [11]
AMaLGaM IDEA	1	16	16	16	15	46	130	140	150	150	AMaLGaM IDEA [4]
$_{ m BayEDAcG}$	1	31	28	26	23	46	10e-3/2e3				BayEDAcG [6]
BFGS	1	33e+1/2e3							٠		BFGS [14]
BIPOP-CMA-ES	1	1	1	1.1	1.1	1.1	1	Н	-	П	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	5.6	390	87e-1/1e4							(1+1)-CMA-ES [2]
DASA	1	240	37e+0/2e5								DASA [12]
DEPSO	1	4.8	09	62e-1/2e3					٠		DEPSO [7]
iAMaLGaM IDEA	1	7.4	9.7	27	87	230	490	430	410	350	iAMaLGaM IDEA [4]
(1+1)-ES	П	1.9	1600	52e-1/1e6							(1+1)-ES [1]
Monte Carlo	1	13e+1/1e6									Monte Carlo [3]
IPOP-SEP-CMA-ES	1	1	1	1	1	Т	1	1	_	_	IPOP-SEP-CMA-ES [13]

Table 10: 40-D, running time excess ERT/ERT_{best} on f_{110} , in italics is given the median function value and the median number of function evaluations to reach this value divided by dimension

for of sucitations as the sol	roach this w	this viel divided by dimension	by dimension	5)						
	ICACII MILIS V	arac arriaca	110 R	110 Bosenbrock Cause	J. A.	23116					
			OTT OTT	COLLEGE	3	200					
$\Delta { m ftarget}$	1e + 03	1e+02	1e+01	1e+00 1e-01 1e-02	1e-01	1e-02	1e-03	1e-04	1e-03 1e-04 1e-05 1e-07	1e-07	$\Delta { m ftarget}$
${ m ERT}_{ m best}/{ m D}$	388	4140	nan	nan	nan	nan	nan	nan	nan	nan	$_{ m ERT_{best}/D}$
ALPS	160	73e+1/1e5	•					•			ALPS [11]
AMaLGaM IDEA	4.6	3.7	38e+0/1e6	٠	•	٠	٠	•	•		AMaLGaM IDEA [4]
BayEDAcG	4.5	72e+1/2e3									BayEDAcG [6]
BFGS	52e+4/500		•	•	•			•	•	•	BFGS [14]
BIPOP-CMA-ES	1	1	37e+0/1e6								BIPOP-CMA-ES [10]
(1+1)-CMA-ES	24e+4/1e4		•	•	•	•		•	•		(1+1)-CMA-ES [2]
DASA	23e+4/2e5										DASA $[12]$
DEPSO	35e+4/2e3		•	•	•			•	•	•	DEPSO [7]
iAMaLGaM IDEA	9	33	39e+0/1e6								iAMaLGaM IDEA [4]
(1+1)-ES	14e+4/1e6		•		•			•	•		(1+1)-ES [1]
Monte Carlo	92e+3/1e6										Monte Carlo [3]
IPOP-SEP-CMA-ES	40e+3/1e4		•								IPOP-SEP-CMA-ES [13]

in italics is given the median final function value and the median number of Table 11: 40-D, running time excess $ERT/ERT_{\rm b}$, function evaluations to reach this value divided b

DIe	1: 40-D, running t	ime excess i	iki/EK	$^{\mathrm{L}\mathrm{best}}$ on J_{1}	11, In IC	ancs is	given t	ne mec	nan nn	al muc	tion val	when it 40-D, running time excess EK1/EK1 $_{ m best}$ on f_{111} , in traites is given the median must function value and the median number
nction	nction evaluations to reach this value divided by dimension	ach this valu	ae divide	d by dimens	sion							
				111	111 Rosenbrock unif	prock	unif					
	Δ ftarget	1e + 03	1e + 02	1e+01	1e+00	1e+00 $1e-01$ $1e-02$	1e-02	1e-03	1e-03 $1e-04$ $1e-05$ $1e-07$	1e-05	1e-07	$\Delta ext{ftarget}$
	ERT_{best}/D	2640	15500	nan	nan	nan	nan	nan	nan	nan	nan	$\text{ERT}_{\text{best}}/\text{D}$
l	ALPS	30e+3/1e5	-									ALPS [11]
	AMaLGaM IDEA	6.2	18	71e+0/1e6	•		٠	•	•	٠	•	AMaLGaM İDEA [4]
	BayEDAcG	21e+3/2e3										BayEDAcG [6]
	BFGS	46e+4/400	٠		٠	•	•	•	•	•	•	BFGS [14]
	BIPOP-CMA-ES	1	1	38e+0/1e6								BIPOP-CMA-ES [10]
	(1+1)-CMA-ES	27e+4/1e4	٠	•	٠			•	•	•	•	(1+1)-CMA-ES [2]
	DASA	24e+4/2e5										DASA [12]
	DEPSO	44e+4/2e3						•				DEPSO [7]
	iAMaLGaM IDEA	44	37	59e+0/1e6								iAMaLGaM IDEA [4]
	(1+1)-ES	16e+4/1e6				•	•	•	•		•	(1+1)-ES [1]
	Monte Carlo	94e+3/1e6										Monte Carlo [3]
	IPOP-SEP-CMA-ES	49e+4/1e4			•							IPOP-SEP-CMA-ES [13]

Table 12: 40-D, running time excess ERT/ERT_{best} on f_{112} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

			$\Delta { m ftarget}$	ERT_{best}/D	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
			1e-07	7160		٠			1.5	•				•		Н
				7030		•		•	1.5	•		•		•		-
			1e-04	0969				•	1.5	•		•		•		П
			1e-03	0689		•		•	1.5			•				-
		achy	1e-02	0089		•		•	1.5			•				П
0		ck Car	1e-01	0299	•	•		•	1.5	•		•		•		-
	_	senbro	1e+00 $1e-01$ $1e-02$	6350		•		•	1.5	•		•		•		Н
Dest Jitz	this value divided by dimension	112 Rosenbrock Cauchy	1e+01	4450	11e+1/1e5	21e+0/1e6	89e+0/2e3	•	1.1	63e+0/1e4	97e+0/3e5	•	28e+0/1e6	51e+0/1e6		-
	alue divided		1e+02	72.3	3900	12	28	٠	П	35	4e3	24e+1/2e3	5.1	94		2.2
			1e + 03	18.4	33	27	32	51e+4/2e3	1.4	1.2	ы	15	9.6	П	89e+3/1e6	1.2
0	unction evaluations to reach		Δ ftarget	$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS	AMaLGaM IDEA	BayEDAcG	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 13: 40-D, running time excess ERT/ERT_{best} on f_{113} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

		Δ ftarget	${ m ERT_{best}/D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES $[2]$	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
			75100		2.1			Н				5.1			
		1e-05	75000	-	2.1			-				5.1			
		1e-04	75000		2.1		٠	1			٠	5.1			
		1e-03	75000		2.1		٠	1			٠	5.1			
	Sauss	1e-02	75000		2.1			1				5.1			
	psoid ($^{-1e-01}$	67400		2.1			1				5.3			
on	113 Step-ellipsoid Gauss	1e+00	63500 67400 7		2.1			1				5.1			
this value divided by dimension	113 St	1e+01	11000	10e+1/1e5	3.2			1				15			-
value divided		1e+02	1430	140	1.9	18e+1/2e3		П	11e+2/1e4	89e+1/2e5	13e + 2/2e3	3.6	72e+1/1e6	52e+1/1e6	51e+1/1e4
o reach this		1e+03	51.8	2.1	1.9	4	19e + 2/1e3	7	870	3200	120	1	1900	24	29
unction evaluations to reach		Δ ftarget	${ m ERT_{best}/D}$	ALPS	AMaLGaM IDEA	$\operatorname{BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 14: 40-D, running time excess ERT/ERT_{best} on f_{114} , in italics is given the median function value and the median number of

Dest	0	1 / 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Sec	114,							
function evaluations to reach this value divided by dimension	to reach this	s value divide	ed by di	mension							
			,	114 Step-ellipsoid unif	ellipsoid	l unif					
$\Delta { m ftarget}$	1e + 03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-05 1e-07	1e-07	Δ ftarget
$\text{ERT}_{\text{best}}/\text{D}$	165	7220	42000	1.64e5	2.51e5	2.88e5	2.88e5	2.88e5		2.92e5	ERT_{best}/D
ALPS	2.1	50e+1/1e5			•						ALPS [11]
AMaLGaM IDEA	П	6	62	12e+0/1e6	٠	•	•	•		٠	AMaLGaM İDEA [4]
$_{ m BayEDAcG}$	12	94e+1/2e3									BayEDAcG [6]
BFGS	19e+2/700		٠	•	•		٠	٠			BFGS [14]
BIPOP-CMA-ES	2.6	1	1	1	1	1	1	1	1	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	430	13e + 2/1e4	÷	•	•		٠	٠		•	(1+1)-CMA-ES [2]
DASA	066	99e+1/2e5									DASA [12]
DEPSO	20e + 2/2e3		٠	•	•		٠	٠			DEPSO [7]
iAMaLGaM IDEA	10	29	360	19e+0/1e6							iAMaLGaM IDEA [4]
(1+1)-ES	1200	74e+1/1e6	÷	•	•		٠	٠		•	(1+1)-ES [1]
Monte Carlo	11	54e+1/1e6									Monte Carlo [3]
IPOP-SEP-CMA-ES	19e + 2/1e4				•					•	IPOP-SEP-CMA-ÈS [13]

Table 15: 40-D, running time excess ERT/ERT_{best} on f_{115} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

		Δ ftarget	$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-07	10500		1			4			٠	5.9			
		1e-05	10500		1			4				9			
		1e-04	10500		1			4				9			
		1e-03	10500		1			4				9			
	15 Step-ellipsoid Cauchy	1e-02	10500		1			4				9			31e-1/1e4
	ipsoid	1e-01	9320		1			4.1				4.5			15
SIOIL	tep-ell	1e+00	4860		1			9.9				3.4			29
value divided by dimension	115 S	1e+01	514	41e+0/1e5	1.1	25e+0/2e3		1.8	10e+1/1e4		59e+0/2e3	1	12e+1/1e6		1.1
		1e+02	26.7	16	12	25	٠	1.1	470	17e+1/2e5	24	4.8	2.6e5	53e+1/1e6	Н
to reach the		1e + 03	4.15	8.9	11	14	17e + 2/2e3	1	1.2	7.1	3.8	4.9	2.2	420	1.1
Idilicaton evaluations to reach time		Δ ftarget	$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS	AMaLGaM IDEA	${ m BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 16: 40-D, running time excess ERT/ERT_{best} on f_{116} , in italics is given the median function value and the median number of function evaluations to reach this value divided by dimension

					4			[10]	[2]			1 [4]			5 [2]
		Δ ftarget	ERT_{best}/D	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13
		1e-07	1.36e5		1			1.2	٠			3.3	•		
		1e-05 1e-07	1.28e5		1			1.2				3.4			
		1e-04	1.25e5		1			1.2				3.4			
	œ	1e-03	1.21e5		1			1.3				3.5			
	116 Ellipsoid Gauss	1e-02	1.17e5		1			1.3				3.6			
_	Ilipsoid	$1\tilde{e}$ -01	1.13e5		1			1.3				3.7			
mension	116 E	1e+00	1.08e5		1		٠	1.3	•		٠	3.8 8.	÷		
ed by di	•	1e+01	1.04e5		1			1				3.6	٠		
ne divid		1e + 02	60200		1.2			1				3.2	٠		
each this valu		1e + 03	13100	65e+2/1e5	1	20e+3/2e3	19e+4/500	1.1	93e + 3/1e4	71e+3/2e5	14e+4/2e3	6.1	49e+3/1e6	37e+3/1e6	52e+3/1e4
action evaluations to reach this value divided by dimension		Δ ftarget	ERT_{best}/D	ALPS	AMaLGaM IDEA	BayEDAcG	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES
ctic															

Table 17: 40-D, running time excess ERT/ERT $_{\rm best}$ on f_{117} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

table 17: 40-D, running time	g unne excess	S ERI/I	$^{2}\Omega^{1}\mathrm{best}$	t on 1117, 111	Italics	is given	rne me		ri imice	on value	excess $\text{Err}_1/\text{Err}_1$ best on f_{117} , in trancs is given the median innarrance value and the median number	Ŋ
unction evaluations to reach	reach this va	alue divi	ided by	this value divided by dimension								
			•	117 Ellipsoid unif	lipsoid	lunif						
Δ ftarget	1e + 03	1e + 02	1e + 01	1e+00	$\tilde{1}e-01$	1e-02	1e-03		1e-05	1e-07	$\Delta { m ftarget}$	
$\text{ERT}_{ ext{best}}/ ext{D}$	31300	1.35e5	2.11e5	2.97e5	3.4e5		4.33e5	4.57e5	4.79e5	5.28e5	${ m ERT_{best}/D}$	
ALPS	31e+3/1e5										ALPS [11]	
AMaLGaM IDEA	4.3	11	23	90e+0/1e6						•	AMaLGaM IDEA [4]	
BayEDAcG	58e+3/2e3										BayEDAcG [6]	
BFGS	16e+4/400								•	٠	BFGS [14]	
BIPOP-CMA-ES	1	1	1	1	1	1	1	1	1	1	BIPOP-CMA-ES [10]	
(1+1)-CMA-ES	12e+4/1e4				•					٠	(1+1)-CMA-ES [2]	
DASA	82e+3/2e5										DASA [12]	
DEPSO	18e+4/2e3								•	٠	DEPSO [7]	
iAMaLGaM IDEA	14	15	7.1	13e+1/1e6							iAMaLGaM IDEA [4]	
(1+1)-ES	50e + 3/1e6										(1+1)-ES [1]	
Monte Carlo	37e+3/1e6			•							Monte Carlo [3]	
IPOP-SEP-CMA-ES	14e+4/1e4							•	•		IPOP-SEP-CMA-ES [13]	

Table 18: 40-D, running time excess ERT/ERT_{best} on f_{118} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

			Δ ftarget	$\mathrm{ERT}_{\mathrm{best}}/\mathrm{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA $[12]$	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
			1e-07	3290		16		٠	1.4	٠		٠	23	٠		-
			1e-05	3110		16			1.3				24			П
			1e-04	2920		16			1.2				56			1
			1e-03	2720		10			1.2		-		23			Т
		uchy	1e-02	2410		3.2			1.1				18			1
		oid Ca	1e+00 $1e-01$	2050		7			1.1				7.3			1
	ion	18 Ellipsoid Cauchy	1e+00	1200	-	1			1.4				6.5			1.4
(6116)	dimens	118	1e + 01	086		1			1				1.8			1.1
san /	e divided by	•	1e + 02	363	38e+1/1e5	2.1			1.2	46e+1/1e4	13e + 2/4e5		1	96e+1/1e6	-	1.6
	ach this valu		1e + 03	139	35	3.5	28e+2/2e3	16e+4/2e3	1	7.7	1.9e4	24e+2/2e3	1.6	8200	38e + 3/1e6	1.3
0	nction evaluations to reach this value divided by dimension		Δ ftarget	$\mathrm{ERT_{best}/D}$	ALPS	AMaLGaM IDEA	BayEDAcG	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES
	$_{ m nctio}$															

Table 19: 40-D, running time excess ERT/ERT_{best} on f_{119} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

10. 10. 10-D, 1 million	eg umme en	CCSS TIL	t/ Title pest	on J119, m	LOCALICE	E 811011	OTTO TITO	11011	ar remor	TOTE ACTE	early 19. To by running time carees fart lest on 1119, in reares as given the meaning runner on value and the meaning running
nction evaluations to reach this value divided by dimension	reach thi	is value	divided by c	limension							
			119 S	119 Sum of different powers Gauss	erent	powers	Gauss				
Δ ftarget	1e + 03	1e+03 $1e+02$	1e + 01	1e+00	1e-01	1e-01 = 1e-02	1e-03	1e-03 1e-04	1e-05 1e-07	1e-07	$\Delta ext{ftarget}$
ERT_{best}/D	0.025	1.28	1060	3080	3930	13300	53000	1.18e5	2.51e5	3.2e5	ERT_{best}/D
ALPS	1	1.8	20	88e-1/1e5							ALPS [11]
AMaLGaM IDEA	1	1	4.8	17	24	8. 8.	3.9	2.5	1.2	1.3	AMaLGaM IDEA [4]
$\operatorname{BayEDAcG}$	1.1	1.2	2.2	93e-1/2e3							BayEDAcG [6]
BFGS	1	029	95e+0/1e3								BFGS [14]
BIPOP-CMA-ES	1	7.7	1	1	П	1	1	1	1	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	180	51e+0/1e4			٠					(1+1)-CMA-ES [2]
DASA	1	069	43e+0/2e5								DASA [12]
DEPSO	1.1	8.6	35e+0/2e3								DEPSO [7]
iAMaLGaM IDEA	1	2.7	5.5	57	84	27	7	3.2	1.5	1.5	iAMaLGaM IDEA [4]
(1+1)-ES	1.7	72	36e+0/1e6								(1+1)-ES [1]
Monte Carlo	1	1.2	28e+0/1e6								Monte Carlo [3]
TECE CED CMA FC	-	_	060±0/10/								TOOD SED CMA ES [13]

Table 20: 40-D, running time excess ERT/ERT_{best} on f_{120} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

table 20. 40-D, I milling time	ming time	CACCESS F	$n_{\rm L}/m_{ m Pest}$	OII J120, IL	LICATICS	is given	eme me	aigii iiii	ar runce	ion value	excess ELLI ELLI Best, on J120, in traines is given the median mila runction value and the median number
unction evaluations to reach	to reach	this value	this value divided by dimension	dimension							
			$1\overline{20}$	120 Sum of different powers unif	ifferent	t power					
$\Delta { m ftarget}$	1e+03	19 + 02	1e+01	1e+00	1e-01	1e-02		1e-04	1e-05	1e-07	Δ ftarget
ERT_{best}/D	0.025	5 1.02	4090	17700	43300	84100	2.84e5	6.09e5	1.08e6	5.96e6	ERT_{best}/D
ALPS	1	1	23e+0/1e5								ALPS [11]
AMaLGaM IDEA	7.A 1	2.8	17	30e - 1/1e6						٠	AMaLGaM IDEA [4]
BayEDAcG	П	1.2	53e+0/2e3								BayEDAcG [6]
BFGS	3.7	550	82e+0/800	٠					•	•	BFGS [14]
BIPOP-CMA-ES	S	89	1	1	1	1	1	1	П	П	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	S	400	61e+0/1e4							٠	(1+1)-CMA-ES [2]
DASA	П	1200	47e+0/2e5								DASA [12]
DEPSO	1	1300	95e+0/2e3	٠					•	•	DEPSO [7]
iAMaLGaM IDEA	3A 1	5.4	64	48e-1/1e6							iAMaLGaM IDEA [4]
(1+1)-ES	1	220	39e+0/1e6								(1+1)-ES [1]
Monte Carlo	1	1.9	29e+0/1e6	٠							Monte Carlo [3]
IPOP-SEP-CMA-ES	E.E.S	1500	61e+0/1e/						٠		IPOP-SEP-CMA-ES [13]

Table 21: 40-D, running time excess ERT/ERT_{best} on f_{121} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

1000	0		lsad/	T 1121;	9						171) in the control of the control o
unction evaluations to reach	reach t	his value	this value divided by dimension	dimension							
			121 S	121 Sum of different powers Cauchy	erent pow	ers Ca					
Δ ftarget	1e + 03	1e + 02	1e+01	1e+00	$1e-0\overline{1}$	1e-02		1e-04	1e-05		Δ ftarget
$\text{ERT}_{ ext{best}}/ ext{D}$	0.025	1.4	18.2	43.5	84	202		1430	2430	5040	${ m ERT_{best}/D}$
ALPS	1	1	1600	84e-1/1e5							ALPS [11]
AMaLGaM IDEA	1	1.8	14	13	37	130	72	35	21	11	AMaLGaM İDEA [4]
BayEDAcG	1	2.3	33	35	38e-2/2e3						BayEDAcG [6]
BFGS	1	1600	92e+0/2e3								BFGS [14]
BIPOP-CMA-ES	1	1.8	1.1	1.1	1.1	1	1	1.3	1.6	77	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	1.9	2400	14e+0/1e4							(1+1)-CMA-ES [2]
DASA	1	35	27e+0/2e5								DASA [12]
DEPSO	1.1	3.4	28	54e-1/2e3							DEPSO [7]
iAMaLGaM IDEA	1	1.5	8.3	28	100	310	130	100	110	65	iAMaLGaM IDEA [4]
(1+1)-ES	1	2.7	4.8e4	95e-1/1e6							(1+1)-ES [1]
Monte Carlo	1.1	1.2	28e+0/1e6								Monte Carlo [3]
IPOP-SEP-CMA-ES	1	2.2	1	Н	1	1	1	П	1	1	IPOP-SEP-CMA-ES [13]

Table 22: 40-D, running time excess ERT/ERT $_{\rm best}$ on f_{122} , in italics is given the median function value and the median number of

		Δ ftarget	${ m ERT_{best}/D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-07	8.23e5				•	1			•	49e-6/1e6	•		•
		1e-05	3.02e5	•	11e-5/1e6		•	-	٠		•	20	•	•	٠
		1e-04	1.12e5		14			1				13			
	ssn	1e-03	70200		13			1				15			
	122 Schaffer F7 Gauss	1e-01 $1e-02$ $1e-03$	26800		22		٠	1	٠		٠	39			•
n.	chaffer	1e-01	16100		22			1				09			
by dimensic	122 S	1e+00	6830	58e-1/1e5	29	59e-1/2e3		1	13e+0/1e4		12e+0/2e3	51	10e+0/1e6	88e-1/1e6	99e-1/1e4
alue divided		1e + 01	123	7.9	1.6	3.1	18e+0/1e3	1.8	1200	12e+0/2e5	53	1	1.5e4	1200	110
ı this va		1e + 02	0.025	1	1.3	П	37	4.3	1.8	11	1.1	1	09	1.2	1
to reach		1e + 03	0.025	1	1	-	1	1	1	1	1	1	П	1	-
function evaluations to reach this value divided by dimension		Δ ftarget	$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS	AMaLGaM IDEA	BayEDAcG	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 23: 40-D, running time excess ERT/ERT_{best} on f_{123} , in italics is given the median function value and the median number of function evaluations to reach this value divided by dimension

unction evaluations to reach		his value	this value divided by dimension	dimension							
			•	123 Schaffer F7 unif	affer F	7 unif					
Δ ftarget	1e + 03	1e+02	1e+01	1e+00	1e-01	1e-02	1e-03			1e-07	Δ ftarget
ERT_{best}/D	0.025	0.025	331	59200	2.36e5	3.88e5	5.98e5	9.4e5	5.67e6 1	1.83e7	$\text{ERT}_{ ext{best}}/ ext{D}$
ALPS	1	1.5	20	82e-1/1e5							ALPS [11]
AMaLGaM IDEA	1	1.3	П	43e-1/1e6						•	AMaLGaM IDEA [4]
BayEDAcG	1	1.1	13e+0/2e3								BayEDAcG [6]
BFGS	1	28	18e+0/900								BFGS [14]
BIPOP-CMA-ES	1	2.2	3.3	1	1	1	1	1	1	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	1	430	14e+0/1e4				•			(1+1)-CMA-ES [2]
DASA	1	6.6	12e+0/2e5								DASA [12]
DEPSO	1	1.1	20e+0/2e3								DEPSO [7]
iAMaLGaM IDEA	1	1.1	11	46e-1/1e6							iAMaLGaM IDEA [4]
(1+1)-ES	1	34	1.4e4	11e+0/1e6				•			(1+1)-ES [1]
Monte Carlo	П	1.2	470	88e - 1/1e6							Monte Carlo [3]
IPOP-SEP-CMA-ES	Н	П	13e+0/1e4		•						IPOP-SEP-CMA-ES [13]

Table 24: 40-D, running time excess ERT/ERT $_{\rm best}$ on f_{124} , in italics is given the median function value and the median number of

				0 - 0 - 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0							
uations	to reack	ı thıs va	function evaluations to reach this value divided by dimension	Dy chimension	-						
				$124~\mathrm{Sch}$	124 Schaffer F7 Cauchy	Cauchy					
Δ ftarget	1e + 03		1e+01	1e+00	1e-01	1e-02 $1e-03$	1e-03	1e-04	1e-05	1e-07	Δ ftarget
ERT_{hest}/D	0.025	0.025	14.3	754	5310	6580	9160	20500	28600	56000	ERT_{best}/D
ALPS	1	1.2	13	59e-1/1e5							ALPS [11]
AMaLGaM IDEA	1	1.1	6.6	1.4	5.4	4.6	3.5	1.6	1.3	1	AMaLGaM IDEA [4]
BayEDAcG	1	1.1	20	5.2	11e-1/2e3						BayEDAcG [6]
BFGS	1	180	17e+0/2e3					٠			BFGS [14]
IPOP-CMA-ES	1	4.1	П	1	1	П	1	П	1	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	П	200	95e-1/1e4				•			(1+1)-CMA-ES [2]
DASA	1	1.3	1.6e5	11e+0/2e5							DASA [12]
DEPSO	П	1.3	8.2	58e-1/2e3		•		•			DEPSO [7]
iAMaLGaM IDEA	1	1.3	4.6	3.5	16	27	19	80. 80.	6.4	3.3	iAMaLGaM IDEA [4]
(1+1)-ES	1	4.2	4600	84e-1/1e6				•			(1+1)-ES [1]
Monte Carlo	П	1.4	1.2e4	89e-1/1e6							Monte Carlo [3]
IPOP-SEP-CMA-ES	Н	3.1	П	3.2	1.4	1.5	2.5	16e-4/1e4			IPOP-SEP-CMA-ES [13]

Table 25: 40-D, running time excess ERT/ERT_{best} on f_{125} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

			$\text{ERT}_{ ext{best}}/ ext{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG $[6]$	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-05 1e-07	nan		٠	٠	•		٠		٠		٠	•	٠
		1e-05	nan		٠		•				•				•
	ro	1e-04	nan	•	•			41e-2/7e5	•	•	•		•		
	Gans	1e-03	1.36e7		•			1			•				
	nbrock	1e-02 $1e-03$	2.74e6 1		٠			1	•		•		•		•
TIOTO	125 Griewank-Rosenbrock Gauss	1e-01	2.64e6	64e-2/1e5	44e-2/1e6	69e-2/2e3	•	1	•		12e-1/2e3	44e-2/1e6	•	•	11e-1/1e4
d by difficult	125 Grie	1e+00	115	1.8	1.4	7	28e-1/2e3	1.8	15e-1/1e4	20e-1/2e5	240	1	15e-1/1e6	14e-1/1e6	1300
125 Griewan		1e+01	0.025	1.2	П	1.1	Н	П	Н	7.1	1	П	3.5	П	Н
		1e+02	0.025	1	1	1	-	1	П	1	1	1	П	1	-
		1e + 03	0.025	Т	П	Н	Н	П	Н	П	Т	П	Н	Н	-
TIONAL OF CITATION OF LOWER		Δ ftarget	$\text{ERT}_{\text{best}}/\text{D}$	ALPS	AMaLGaM IDEA	$\operatorname{BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 26: 40-D, running time excess ERT/ERT_{best} on f_{126} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

nction evaluations to reach this value divided by dimension	each this	value d	ivided b	y dimension	J						
			1	26 Griews	[26 Griewank-Rosenbrock unif	brock	unif				
Δ ftarget	1e + 03	1e + 02	1e + 01	1e+00	1e-01	1e-02	1e-03	1e-04	1e-04 $1e-05$ $1e-07$	1e-07	Δ ftarget
$\text{ERT}_{ ext{best}}/ ext{D}$	0.025	0.025	0.025	218	nan	nan	nan	nan	nan	nan	$\text{ERT}_{\text{best}}/\text{D}$
ALPS	1	1	1.1	10	81e-2/1e5						ALPS [11]
AMaLGaM IDEA	1	1	1.1	П	50e-2/1e6	•		•	•		AMaLGaM İDEA [4]
$_{ m BayEDAcG}$	1	1	1.1	12e-1/2e3							BayEDAcG [6]
BFGS	1	1	28	29e-1/1e3		•	•	•	•		BFGS [14]
BIPOP-CMA-ES	1	1	1	2.8	50e-2/4e5						BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	1	1	16e-1/1e4		•		•	•		(1+1)-CMA-ES [2]
DASA	1	1	1	20e-1/2e5							DASA [12]
DEPSO	1	1	1.1	23e-1/2e3		•		•			DEPSO [7]
iAMaLGaM IDEA	1	1	1	4.3	51e-2/1e6						iAMaLGaM IDEA [4]
(1+1)-ES	1	1	1	16e-1/1e6		•	•	•	•		(1+1)-ES [1]
Monte Carlo	1	1	1.1	14e-1/1e6							Monte Carlo [3]
IPOP-SEP-CMA-ES	П	1	Н	17e-1/1e4		•					IPOP-SEP-CMA-ES [13]

Table 27: 40-D, running time excess ERT/ERT_{best} on f_{127} , in italics is given the median final function value and the median number of

		Δ ftarget	$\text{ERT}_{\text{best}}/\text{D}$	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	IPOP-SEP-CMA-ES [13]
		1e-07	6.66e5		٠		•	1	٠		٠				
		1e-05 1e-07	6.49e5		٠			1	٠		•		•		
		1e-04	6.24e5	•	•		•	1	•		•		•		
	Cauchy	$1e-0\tilde{3}$	3.78e5		19e-3/1e6			1				11e-3/1e6			
	senbrock (1e-02	2.63e5		26			1				8.7			16e-2/1e4
ension	127 Griewank-Rosenbrock Cauchy	1e-01	44700	70e-2/1e5	2.3	59e-2/2e3		2.4			95e-2/2e3	3.5	11e-1/1e6		-
ded by dim		1e+00	17.6	7.1	7	13	28e-1/2e3	1	13e-1/1e4	20e-1/2e5	53	4	8.4e5	15e-1/1e6	1.1
due divi		1e + 01	0.025	1.1	1	1.2	300	1	1	1	-	1.2	1	1.1	-
$_{ m 1}$ this $_{ m Ve}$		1e+03 $1e+02$	0.025	1	1	1	1	1	1	1	1	1	1	1	-
to reacl		1e + 03	0.025	1	1	П	1	1	1	П	1	1	П	1	-
function evaluations to reach this value divided by dimension		Δ ftarget	$_{ m ERT_{best}/D}$	ALPS	AMaLGaM IDEA	BayEDAcG	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

Table 28: 40-D, running time excess ERT/ERT_{best} on f_{128} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

11c 20. 40-D, 1 milling	CITIES CAL	CCSS LILL	T/TILL Post	$011 \ /128$	חוו ונמוור	SIVE SIVE	III OHE II	regram m	nai iun	ינוסוו אמו	DE 20. 40° LUMINING MINE EXCESS ELVI / ELVI / ELVI $_{\rm PSC}$ OH J128, IN MAINES IS GIVEN MINE MINE MINE AND MINE MEMBER MINE MAINE M
ction evaluations to reach this value divided by dimension	reach this	s value	divided by di	imension	J						
			•	128 G	'allaghe	128 Gallagher Gauss	SS				
Δ ftarget	1e+03	1e + 02	1e+01	1e+00	1e-01	$1e+00$ $1e-0\overline{1}$ $1e-02$ $1e-03$	1e-03	1e-04	1e-05	1e-0.7	Δ ftarget
${ m ERT_{best}/D}$	0.025	0.025	1.03e5	9.57e5	2.82e6	2.82e6 2.82e6	2.82e6	2.82e6	2.82e6	2.82e6	${ m ERT_{best}/D}$
ALPS	1	1	70e+0/1e5								ALPS [11]
AMaLGaM IDEA	1	1	10	3.4	2.4	2.4	2.4	2.4	2.4	2.4	AMaLGaM IDEA [4]
BayEDAcG	1	П	73e+0/2e3								BayEDAcG [6]
BFGS	1	П	84e+0/1e3								BFGS [14]
BIPOP-CMA-ES	1	1	1	1	1	1	1	1	1	1	BIPOP-CMA-ES [10]
(1+1)-CMA-ES	1	1	81e+0/1e4								(1+1)-CMA-ES [2]
DASA	1	П	79e+0/2e5								DASA [12]
DEPSO	1	П	80e+0/2e3								DEPSO [7]
iAMaLGaM IDEA	1	1	32	4.8	2.5	2.5	2.5	2.5	2.5	2.5	iAMaLGaM IDEA [4]
(1+1)-ES	П	П	74e+0/1e6								(1+1)-ES [1]
Monte Carlo	1	П	68e+0/1e6								Monte Carlo [3]
IPOP-SEP-CMA-ES		-	82e+0/1e/								IPOP-SEP-CMA-ES [13]

Table 29: 40-D, running time excess ERT/ERT_{best} on f_{129} , in italics is given the median final function value and the median number of function evaluations to reach this value divided by dimension

re	nction evaluations to reach this	value o	this value divided by dimension	mension		•					
				129 (Gallagk	129 Gallagher unif	<u>.</u>				
Ţė.	1e + 03	1e + 02	1e+01	1e+00	1e-01	1e+00 $1e-01$ $1e-02$	1e-03	1e-04	1e-04 $1e-05$	1e-07	Δ ftarget
0	025	0.025	8.67e5	9.4e5	2.54e6	2.55e6	2.56e6	2.58e6	2.59e6	2.62e6	$\text{ERT}_{\text{best}}/\text{D}$
	1	1	70e+0/1e5		•	•				•	ALPS [11]
	1	1	991/0 + 999	•	٠	٠	•	٠	٠	٠	AMaLGaM IDEA [4]
	П	п	81e+0/2e3								BayEDAcG [6]
	-	1	84e+0/800	٠	•	•			•	•	BFGS [14]
	-	1	1	1	1	1	1	1	1	1	BIPOP-CMA-ES [10]
	1	П	80e+0/1e4	٠	•	•			•	•	(1+1)-CMA-ES [2]
	П	1	79e+0/2e5								DASA [12]
	П	1	84e+0/2e3	٠	•	•			•	•	DEPSO [7]
	П	п	991/0 + 999								iAMaLGaM IDEA [4]
	1	-	74e+0/1e6	•	•	•		•	•	•	(1+1)-ES [1]
	Н	1	68e + 0/1e6	•					•	•	Monte Carlo [3]
	-	-	810+0/101								IPOP-SEP-CMA-ES [13]

Table 30: 40-D, running time excess ERT/ERT_{best} on f_{130} , in italics is given the median function value and the median number of function evaluations to reach this value divided by dimension

		Δ ftarget	ERT _{best} /D	ALPS [11]	AMaLGaM IDEA [4]	BayEDAcG [6]	BFGS [14]	BIPOP-CMA-ES [10]	(1+1)-CMA-ES [2]	DASA [12]	DEPSO [7]	iAMaLGaM IDEA [4]	(1+1)-ES [1]	Monte Carlo [3]	POP-SEP-CMA-ES [13]
					95			7.9				26			-
		1e-05	42400		95			7.9				97			-
		1e-03 1e-04 1e-05	42300		92			7.9				70			-
					95			7.9				89			П
	uchy	$1e-\tilde{0}2$	42200		92			7.9				20			П
	130 Gallagher Cauchy	1e-01	42100		92	17e-1/2e3		7.9				40			
dimension	130 Gall	1e+00	6930	-	100	1		24			20e+0/2e3	99	20e+0/1e6		1.6
this value divided by dimension		1e+01	317	42e+0/1e5	7.5	3.8	83e+0/2e3	1	47e+0/1e4	75e+0/2e5	12	3.4	2.2e4	68e+0/1e6	
his valu		1e + 02	0.025	1	1	1	1	1	1	1	1	1	1	1	
		1e+03	0.025	1	1	1	Т	1	1	1	Т	1	1	Н	Н
unction evaluations to reach		$\Delta { m ftarget}$	ERT_{best}/D	ALPS	AMaLGaM IDEA	${ m BayEDAcG}$	BFGS	BIPOP-CMA-ES	(1+1)-CMA-ES	DASA	DEPSO	iAMaLGaM IDEA	(1+1)-ES	Monte Carlo	IPOP-SEP-CMA-ES

References

- [1] Anne Auger. Benchmarking the (1+1)-ES with one-fifth success rule on the BBOB-2009 noisy testbed. In Rothlauf [15], pages 2453–2458.
- [2] Anne Auger and Nikolaus Hansen. Benchmarking the (1+1)-CMA-ES on the BBOB-2009 noisy testbed. In Rothlauf [15], pages 2467–2472.
- [3] Anne Auger and Raymond Ros. Benchmarking the pure random search on the BBOB-2009 noisy testbed. In Rothlauf [15], pages 2485–2490.
- [4] Peter A. N. Bosman, Jörn Grahl, and Dirk Thierens. AMaLGaM IDEAs in noisy black-box optimization benchmarking. In Rothlauf [15], pages 2351–2358.
- [5] S. Finck, N. Hansen, R. Ros, and A. Auger. Real-parameter black-box optimization benchmarking 2009: Presentation of the noisy functions. Technical Report 2009/21, Research Center PPE, 2009.
- [6] Marcus R. Gallagher. Black-box optimization benchmarking: results for the BayEDAcG algorithm on the noisy function testbed. In Rothlauf [15], pages 2383–2388.
- [7] José García-Nieto, Enrique Alba, and Javier Apolloni. Particle swarm hybridized with differential evolution: black box optimization benchmarking for noisy functions. In Rothlauf [15], pages 2343–2350.
- [8] N. Hansen, A. Auger, S. Finck, and R. Ros. Real-parameter black-box optimization benchmarking 2009: Experimental setup. Technical Report RR-6828, INRIA, 2009.
- [9] N. Hansen, S. Finck, R. Ros, and A. Auger. Real-parameter black-box optimization benchmarking 2009: Noisy functions definitions. Technical Report RR-6869, INRIA, 2009.
- [10] Nikolaus Hansen. Benchmarking a bi-population CMA-ES on the BBOB-2009 noisy testbed. In Rothlauf [15], pages 2397–2402.
- [11] Gregory S. Hornby. The Age-Layered Population Structure (ALPS) evolutionary algorithm, July 2009. Noisy testbed.
- [12] Peter Korosec and Jurij Silc. A stigmergy-based algorithm for black-box optimization: noisy function testbed. In Rothlauf [15], pages 2375–2382.
- [13] Raymond Ros. Benchmarking sep-CMA-ES on the BBOB-2009 noisy testbed. In Rothlauf [15], pages 2441–2446.
- [14] Raymond Ros. Benchmarking the BFGS algorithm on the BBOB-2009 noisy testbed. In Rothlauf [15], pages 2415–2420.
- [15] Franz Rothlauf, editor. Genetic and Evolutionary Computation Conference, GECCO 2009, Proceedings, Montreal, Québec, Canada, July 8-12, 2009, Companion Material. ACM, 2009.