BBO-Benchmarking of the GLOBAL method for the Noisy Function Testbed

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ABSTRACT

GLOBAL is a multistart type stochastic method for bound constrained global optimization problems. Its goal is to find all the local minima that are potentially global. For this reason it involves a combination of sampling, clustering, and local search. We report its results on the noisy problems given.

Categories and Subject Descriptors

G.1.6 [Numerical Analysis]: Optimization, Global Optimization, Unconstrained Optimization; F.2.1 [Analysis of Algorithms and Problem Complexity]: Numerical Algorithms and Problems

Keywords

Benchmarking, Black-box optimization, Clustering

1. INTRODUCTION

The multistart clustering global optimization method called GLOBAL [2] has been introduced in the 80s for bound constrained global optimization problems with black-box type objective function. The algorithm is based on Boender's algorithm [1] and its goal is to find all local minimizer points that are potentially global. The local search procedure used by GLOBAL was either a quasi-Newton procedure with the DFP update formula or a random walk type direct search method called UNIRANDI [7]. GLOBAL was originally coded in Fortran and C languages.

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GECCO'09, July 8–12, 2009, Montréal Québec, Canada. Copyright 2009 ACM 978-1-60558-505-5/09/07 ...\$5.00. Based on the old GLOBAL method we introduced a new version [3] coded in MATLAB. The algorithm was carefully studied and it was modified in some places to achieve better reliability and efficiency while allowing higher dimensional problems to be solved. In the new version we use the quasi-Newton local search method with the BFGS update instead of the earlier DFP. We also combined GLOBAL with other local search methods like the Nelder-Mead simplex method. All three versions (Fortran, C, MATLAB) of the algorithm are freely available for academic and nonprofit purposes at www.inf.u-szeged.hu/~csendes/regist.php (after registration and limited for low dimensional problems).

In this paper, the algorithm is benchmarked on the noisy BBOB 2009 testbed [4, 6] according to the experimental design from [5].

2. ALGORITHM PRESENTATION

The GLOBAL method has two phases: a global and a local one. The global phase consists of sampling and clustering, while the local phase is based on local searches. The local minimizer points are found by means of a local search procedure, starting from appropriately chosen points from the sample drawn uniformly within the set of feasibility. In an effort to identify the region of attraction of a local minimizer, the procedure invokes a clustering procedure. The main steps of GLOBAL are summarized in Algorithm 1.

3. EXPERIMENTAL PROCEDURE

GLOBAL has six parameters to set: the number of sample points, the number of best points selected, the stopping criterion parameter for the local search, the maximum number of function evaluations for local search, the maximum number of local minima to explore, and the used local method. All these parameters have a default value and usually it is enough to change only the first three of them.

In all dimensions and functions we used 300 sample points, and the 2 best points. In 2, 3 and 5 dimensions the local search tolerance was 10^{-8} , the maximum number of function evaluations for local search was 5000 and the local search was the simplex method. In 10 and 20 dimensions

Algorithm 1 A concise description of the GLOBAL optimization algorithm

- Step 1: Draw N points with uniform distribution in X, and add them to the current cumulative sample C. Construct the transformed sample T by taking the γ percent of the points in C with the lowest function value.
- Step 2: Apply the clustering procedure to T one by one. If all points of T can be assigned to an existing cluster, go to Step 4.
- Step 3: Apply the local search procedure to the points in T not yet clustered. Repeat Step 3 until every point has been assigned to a cluster.
- **Step 4:** If a new local minimizer has been found, go to Step 1.
- Step 5: Determine the smallest local minimum value found, and stop.

with the 103,108,110,111,114,116,117,120,123,126,129 functions we used the BFGS local search with tolerance 10^{-9} and with at most 10000 function evaluations. For the rest of the functions we applied the previous settings with the simplex local search procedure.

The corresponding crafting effort is: $CrE_{10} = CrE_{20} = -(\frac{11}{30}\ln\frac{11}{30} + \frac{19}{30}\ln\frac{19}{30}) = 0.6572$.

4. CPU TIMING EXPERIMENT

For the timing experiment the GLOBAL algorithm was run on f8 and restarted until at least 30 seconds had passed (according to Figure 2 in [5]). These experiments have been conducted with an Intel Core 2 Duo 2.00 GHz under Windows XP using MATLAB 7.6.0.324 version. We have done two experiments using the BFGS and the simplex local search methods. The other algorithm parameters were the same. In the first case (BFGS) the results were $(2.8, 2.9, 3.0, 3.0, 3.2, 3.2) \cdot 10^{-4}$ seconds, while in the second case (simplex) they were $(2.6, 2.9, 3.4, 4.6, 7.5, 21.0) \cdot 10^{-4}$ seconds per function evaluation in dimensions 2, 3, 5, 10, 20, and 40, respectively.

5. RESULTS

Results from experiments according to [5] on the benchmarks functions given in [4, 6] are presented in Figures 1 and 2 and in Tables 1 and 2.

6. CONCLUSION

We have summarized the results of the GLOBAL stochastic multistart algorithm on the noisy function testbed. Based on these results we can conclude that GLOBAL performs well on most functions in lower dimensions, while in higher dimensions it usually fails to find the global optimum due to the high number of local minimizers.

7. REFERENCES

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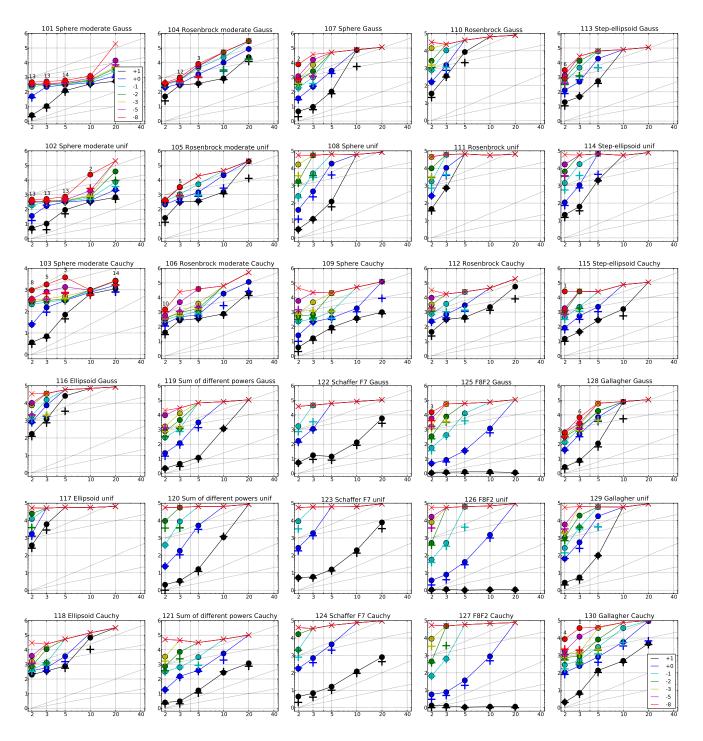


Figure 1: Expected Running Time (ERT, ullet) to reach $f_{\rm opt}+\Delta f$ and median number of function evaluations of successful trials (+), shown for $\Delta f=10,1,10^{-1},10^{-2},10^{-3},10^{-5},10^{-8}$ (the exponent is given in the legend of f_{101} and f_{130}) versus dimension in log-log presentation. The ERT(Δf) equals to $\#{\rm FEs}(\Delta f)$ divided by the number of successful trials, where a trial is successful if $f_{\rm opt}+\Delta f$ was surpassed during the trial. The $\#{\rm FEs}(\Delta f)$ are the total number of function evaluations while $f_{\rm opt}+\Delta f$ was not surpassed during the trial from all respective trials (successful and unsuccessful), and $f_{\rm opt}$ denotes the optimal function value. Crosses (×) indicate the total number of function evaluations $\#{\rm FEs}(-\infty)$. Numbers above ERT-symbols indicate the number of successful trials. Annotated numbers on the ordinate are decimal logarithms. Additional grid lines show linear and quadratic scaling.

	f101 in 5-D, # ERT 109	N=15, m	FE=1059	f101 in 2	20-D, N=15, 10% 90%	, mFE=30333	Δf	f102 in	5-D, N	N=15, m 90%	FE=835	f102 in # ERT	20-D , 10%	N=15, n	nFE=24267
$\frac{\Delta f}{10}$	15 1.2e2 9.9		RT _{succ}	15 5.4e2			$\frac{\Delta J}{10}$		1076 1 6.4e1		RT _{succ}		5.2e2		RT _{succ} 6.6e2
1	15 3.0e2 2.8		3.0e2		1.0e3 1.7e3		1	15 3.2e2			3.2e2	15 2.2e3			2.2e3
1e - 1	15 3.4e2 3.4e	e2 3.4e2	3.4e2	15 2.6e3	1.9e3 $3.2e3$	3 2.6e3	1e - 1	15 3.4e2	$2 \ 3.4e2$	3.4e2	3.4e2	13 7.4e3	5.0e3	8.2e3	7.1e3
1e - 3	15 3.8e2 3.8e		3.8e2		4.6e3 6.2e3			15 3.9e2			3.9e2	0 24e-3	28e-4	19e-2	7.1e3
1e-5	15 4.3e2 4.2		4.3 e2		1.2e4 1.5e4			15 4.3e2			4.3e2				
1e-8	14 6.0e2 5.6		5.6e2		18e-8 96e-6		1e-8	13 7.3e2			6.3e2		00 D	N. 15	
Δf	# ERT 109		RT _{succ}	# ERT	20-D, N=15, 10% 90%		Δf	f104 in 8	5-D, N:	=15, ml	RT _{succ}	# ERT	20-D,	N=15, n	RT _{succ}
10	15 7.0e1 4.2		7.0e1		7.1e2 1.5e3			15 3.8e2			3.8e2	8 2.4 e4			9.1e3
1	15 3.2e2 3.1		3.2e2		1.2e3 1.9e3		1	9 1.6e3			9.1e2	3 8.6 e4			9.6e3
1e-1	15 3.4e2 3.4e	$e2 \ 3.5 e2$	3.4e2	14 2.5e3	$1.3e3 \ 3.3e3$	3 2.4e3	1e - 1	$5 4.4 \mathrm{e}3$	4.2e3	5.7e3	$1.7\mathrm{e}3$	1 3.0e5	2.7e5	3.1e5	1.2e4
1e - 3	13 5.0e2 4.7		4.4e2		1.9e3 3.3e3		1e - 3		4.8e3		$2.1\mathrm{e}3$	0 82e-1	40e-2	28e + 0	7.1e3
1e-5	7 1.3e3 1.2		6.4e2		2.0e3 3.6e3		1e-5	4 5.9e3			2.1 e3				
1e-8	3 3.8e3 3.5		7.4 e2		1.4e3 3.2e3		1e-8	3 8.2e3			2.3 e3				
Δf	f105 in 5-D, # ERT 10%		RT _{succ}		10% 90%	mFE=21426 RT _{succ}	Δf				FE=5966 RT _{succ}		20-D, 10%		nFE=64811 RT _{succ}
	15 3.7e2 3.4e		3.7e2		1.6e5 2.1e5		10	# ERT			3.6e2	12 2.2 e4			1.9e4
1	8 1.4e3 1.2e		7.6e2		19e+0 $40e+0$		1	14 6.7e2			6.2e2			1.5e5	2.4e4
1e - 1	3 5.2e3 4.5e		6.5e2		. , , , , , , , , , , , , , , , , , , ,		1e - 1	13 1.1e3			9.9e2			2 13e+0	1.4e4
1e - 3	0 75e-2 64e-	$3 \ 39e-1$	4.0e2				1e-3	$7 \ 3.8 e3$			2.0e3				
1e-5							1e-5	1 3.8 e4			4.2e3				
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Δf	# ERT 10			# ERT	10% 90%	, mFE=8001 RT _{succ}	Δf	# ERT			FE=5021 RT _{succ}	# ERT			nFE=6192 RT _{succ}
10	15 1.0e2 7.5		1.0e2		57e+0 90e+	-0 3.5 e3	10	15 1.2 e2			1.2e2			90e+0	2.8e3
1	11 2.8e3 1.9		2.5e3				1	3 1.9e4			4.6e3		. 0,0,0		2.000
1e-1	0 77e-2 38e	-2 23e-1	1.8e3				1e - 1	0 - 16e - 1	61e-2	36e-1	1.6e3				
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1e-5							1e-5								
1e-8	.!			1: :			1e-8					h.,			
Δf	f109 in 5-D, # ERT 109			# ERT	20-D, N=15, 10% 90%	, mFE=10701	Δf		5-D, N		FE=5655	# ERT	1.0%	, N=15, 90%	mFE=5604
10	15 8.9e1 6.2		RT _{succ} 8.9e1		7.8e2 1.2e3	RT _{succ}	10	4 8.6e3			RT _{succ} 2.5e3	0 46e+			RT _{succ} 2.0e3
1	14 4.0e2 3.6		3.5 e2		1.1e5 1.3e5		1	0 32e+0			7.9e2	. 400,	. 200,		2.000
1e - 1	9 1.1e3 9.2		4.6e2		12e-1 30e-1		1e-1					1			
1e-3	1 2.0e4 1.5		6.7e2				1e-3								
1e-5	0 49e-3 17e	-3 64e-2	3.5e2				1e-5								
1e-8		N 15	DD 5000			EE 4650	1e-8		· D N	15 1			00 D	NT 15	DD 00510
Δf	f111 in 5-D, # ERT 109		RT _{succ}	# ERT	20-D, N=15, 10% 90%		Δf	f112 in 5	10%		RT_{succ}	# ERT		N=15, n 90%	RT _{succ}
10	0 12e+1 48e-		2.0e3	0 58e+3		3 1.6e3		14 4.4e2			4.1 e2	3 5.5e4			1.1 e4
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							1e-3	0 16e-1 	15e-2	40e-1	4.5 e2		:		· · ·
1e-5 1e-8	f113 in 5-D	, N=15, n % 90%	nFE=5362			; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;	1e-3 1e-5 1e-8	0 16e-1 f114 in	15e-2 5- D , N	40e−1 : :=15, m	4.5 e2 FE=5358		20-D,		mFE=6051
1e-5	# ERT 10	% 90%	RT_{succ}	# ERT	10% 90%	RT _{succ}	1e-3 1e-5	0 16e-1 f114 in # ERT	15e-2 5-D, N 10%	40e-1 =15, m 90%	4.5 e2 FE=5358 RT _{succ}	# ERT	20-D,	90%	mFE=6051 RT _{succ}
$1e-5$ $1e-8$ Δf	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6	% 90% e2 6.1e2 e4 2.2e4	nFE=5362 RT _{succ} 5.5e2 4.1e3		10% 90%	RT _{succ}	$ \begin{array}{c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4	15e-2 5-D, N 10% 1.4e3 6.3e4	40e-1 : =15, m 90% 2.6e3 6.9e4	4.5 e2 FE=5358	# ERT	20-D,	90%	RT_{succ}
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$ \begin{array}{r} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{r} \Delta f \\ 10 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 . . N=15, m 90%	8T _{succ} 5.5e2 4.1e3 4.4e3 1.6e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 	6 RT _{succ} -1 2.5 e3	$ \begin{array}{r} 1e - 3 \\ 1e - 5 \\ 1e - 8 \end{array} $ $ \begin{array}{r} \Delta f \\ 10 \\ 1 \\ 1e - 1 \\ 1e - 3 \\ 1e - 5 \\ 1e - 8 \end{array} $	0 16e-1	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N	40e-1 1=15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90%	4.5e2 FE=5358 RTsucc 2.0e3 5.4e3 2.5e3	# ERT 0 36e+3	20-D, 10% 26e+:	90% 1 51e+1	RT _{succ} 2.0e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3	RT _{succ} 5.5 e 2 4.1 e 3 4.4 e 3 1.6 e 3 FE=3989 RT _{succ} 2.8 e 2 1.3 e 3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 	6 RT _{succ} -1 2.5 e3	$ \begin{array}{c c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ 10 \\ 1 \\ 1 \end{array} $	0 16e-1	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4	40e-1 1=15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4	4.5 e2 FE=5358 RT _{succ} 2.0 e3 5.4 e3 2.5 e3 	# ERT 0 36e+3	20-D, 10% 26e+:	90% 1 51e+1	RT _{succ} 2.0e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \end{array} $	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3	RT _{succ} 5.5 e2 4.1 e3 4.4 e3 1.6 e3 FE=3989 RT _{succ} 2.8 e2	# ERT 0 28e+1	10% 90% 20e+1 40e+ 	6 RT _{succ} -1 2.5 e3	$ \begin{array}{c c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ 10 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4	40e-1 1=15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4	4.5 e2 FE=5358 RT _{succ} 2.0 e3 5.4 e3 2.5 e3 hFE=5576 RT _{succ} 4.9 e3	# ERT 0 36e+3	20-D, 10% 26e+:	90% 1 51e+1	RT _{succ} 2.0e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \end{array} $	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3	RT _{succ} 5.5 e 2 4.1 e 3 4.4 e 3 1.6 e 3 FE=3989 RT _{succ} 2.8 e 2 1.3 e 3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 	6 RT _{succ} -1 2.5 e3	$ \begin{array}{c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-1 \\ 1e-1 \\ 1e-3 \end{array} $	0 16e-1	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4	40e-1 1=15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4	4.5 e2 FE=5358 RT _{succ} 2.0 e3 5.4 e3 2.5 e3 hFE=5576 RT _{succ} 4.9 e3	# ERT 0 36e+3	20-D, 10% 26e+:	90% 1 51e+1	RT _{succ} 2.0e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-3 \\ 1e-5 \end{array} $	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3	RT _{succ} 5.5 e 2 4.1 e 3 4.4 e 3 1.6 e 3 FE=3989 RT _{succ} 2.8 e 2 1.3 e 3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 	6 RT _{succ} -1 2.5 e3	$ \begin{array}{c c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ \hline 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ \hline 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-3 \\ 1e-5 \end{array} $	0 16e-1	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4	40e-1 1=15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4	4.5 e2 FE=5358 RT _{succ} 2.0 e3 5.4 e3 2.5 e3 hFE=5576 RT _{succ} 4.9 e3	# ERT 0 36e+3	20-D, 10% 26e+:	90% 1 51e+1	RT _{succ} 2.0e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \end{array} $	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1e2 e4 2.2e4 e4 6.5e4 -2 42e-1 N=15, m 6 90% e2 3.0e2 e3 2.6e3 -2 25e-1	RTsucc 5.5e2 4.1e3 4.4e3 1.6e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+	6 RTsucc -1 2.5 e3 	$ \begin{array}{c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-1 \\ 1e-1 \\ 1e-3 \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9 86e-1	40e-1 1=15, m 90% 2.6e3 6.9e4 94e-1 N=15, m 90% 3.1e4 40e+1	4.5 e2 FE=5358 RT _{Succ} 2.0 e3 5.4 e3 2.5 e3 FE=5576 RT _{Succ} 4.9 e3 2.2 e3	# ERT 0 36e+3	20-D, 10% 26e+1	90% 1 51e+1 , N=15, . 90% 3 27e+3	RTsucc 2.0e3 mFE=6045 RT _{succ} 2.2e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \end{array} $	# ERT 10 15 5.5 e2 3.1 3 1.9 e4 1.6 1 5.9 e4 4.9 0 18e-1 39e	% 90% e2 6.1e2 e4 2.2e4 e4 6.5e4 -2 42e-1 N=15, m % 90% e2 3.0e2 e3 2.6e3 -2 25e-1 N=15, m	RTsucc 5.5 e 2 4.1 e 3 4.4 e 3 1.6 e 3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932	$ \begin{array}{c c} 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ \hline 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c c} \Delta f \\ \hline 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-3 \\ 1e-5 \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in 9	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9 86e-1	40e-1 1=15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4 40e+1 	4.5 e2 FE=5358 RTsucc 2.0 e3 5.4 e3 2.5 e3 nFE=5576 RTsucc 4.9 e3 2.2 e3 FE=6632	# ERT 0 36e+3	20-D, 10% 26e+1 20-D, 10% 20-D,	90% 1 51e+1 , N=15, . 90% 3 27e+3	RT _{succ} 2.0e3
$ \begin{array}{c} 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \end{array} $	# ERT 10 15 5.5 e2 3.1 3 1.9 e4 1.6 1 5.9 e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3 -2 25e-1 N=15, m % 90%	RTsucc 5.5e2 4.1e3 4.4e3 1.6e3	# ERT 0 28e+1	10% 90% 20e+1 40e+	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932 RTsucc	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \text{le}-5\\ \text{le}-8 \\ \text{le}-5\\ \text{le}-8 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f118 in # ERT 2 2.6e4 0 94e+6 f118 in # # ERT	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9 86e-1 5-D, N: 10% 5.6e2	40e-1 =15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4 40e+1 15, ml 90% 7.8 e2	4.5 e2 FE=5358 RT _{succ} 2.0e3 5.4e3 2.5e3 FE=5576 RT _{succ} 4.9e3 2.2e3 FE=6632 RT _{succ} 7.7e2	# ERT 0 36e+3	20-D, 10% 26e+: 10% 10% 10%	90% l 51e+1 , N=15, 90% 3 27e+3 N=15, n 90%	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 nFE=29124
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline 10 \\ 1 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \begin{array}{c} \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \end{array}$	# ERT 10 15 5.5 e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3 -2 25e-1 N=15, m % 90%	RTsucc 5.5 e2 4.1 e3 4.4 e3 1.6 e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932 RTsucc	$\begin{array}{c} \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array}$ $\begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array}$ $\begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array}$ $\begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array}$	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9.86e-1 5-D, N 10% 5.6e2 2.8e3	40e-1 =15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4 40e+1 15, ml 90% 7.8 e2 4.5 e3	4.5 e2	# ERT 0 36e+3	20-D, 10% 26e+: 10% 10% 10%	90% l 51e+1 , N=15, 90% 3 27e+3 N=15, n 90%	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 nFE=29124 RTsucc
$\begin{array}{c} 1e-5 \\ 1e-8 \\ \hline \\ \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \\ \hline \\ \Delta f \\ 10 \\ 1e-3 \\ 1e-5 \\ 1e-8 \\ \hline \\ \Delta f \\ 10 \\ 1e-1 \\ \end{array}$	# ERT 10 15 5.5 e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3 -2 25e-1 N=15, m % 90%	RTsucc 5.5 e2 4.1 e3 4.4 e3 1.6 e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932 RTsucc	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \text{le}-5\\ \text{le}-8 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f118 in # ERT 2 2.6e4 0 94e+6 f118 in # # ERT	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9.86e-1 5-D, N 10% 5.6e2 2.8e3	40e-1 =15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4 40e+1 15, ml 90% 7.8 e2 4.5 e3	4.5 e2 FE=5358 RT _{succ} 2.0e3 5.4e3 2.5e3 FE=5576 RT _{succ} 4.9e3 2.2e3 FE=6632 RT _{succ} 7.7e2	# ERT 0 36e+3	20-D, 10% 26e+: 10% 10% 10%	90% l 51e+1 , N=15, 90% 3 27e+3 N=15, n 90%	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 nFE=29124 RTsucc
$\begin{array}{c} 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}-1 \\ 1\mathrm{e}-3 \\ 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}-3 \\ 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}-3 \\ 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}-3 \\ 1\mathrm{e}-3 \\ \end{array}$	# ERT 10 15 5.5 e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3 -2 25e-1 N=15, m % 90%	RTsucc 5.5 e2 4.1 e3 4.4 e3 1.6 e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932 RTsucc	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $ $ \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $ $ \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $ $ \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9.86e-1 5-D, N 10% 5.6e2 2.8e3	40e-1 =15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4 40e+1 15, ml 90% 7.8 e2 4.5 e3	4.5 e2	# ERT 0 36e+3	20-D, 10% 26e+: 10% 10% 10%	90% l 51e+1 , N=15, 90% 3 27e+3 N=15, n 90%	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 nFE=29124 RTsucc
$\begin{array}{c} 1e-5 \\ 1e-8 \\ \hline \\ \Delta f \\ 10 \\ 1 \\ 1e-1 \\ 1e-3 \\ 1e-5 \\ 1e-8 \\ \hline \\ \Delta f \\ 10 \\ 1e-3 \\ 1e-5 \\ 1e-8 \\ \hline \\ \Delta f \\ 10 \\ 1e-1 \\ \end{array}$	# ERT 10 15 5.5 e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1 e2 e4 2.2 e4 e4 6.5 e4 -2 42e-1 N=15, m % 90% e2 3.0 e2 e3 2.6 e3 -2 25e-1 N=15, m % 90%	RTsucc 5.5 e2 4.1 e3 4.4 e3 1.6 e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932 RTsucc	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \text{le}-5\\ \text{le}-8 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9.86e-1 5-D, N 10% 5.6e2 2.8e3	40e-1 =15, m 90% 2.6 e3 6.9 e4 94e-1 N=15, m 90% 3.1 e4 40e+1 15, ml 90% 7.8 e2 4.5 e3	4.5 e2	# ERT 0 36e+3	20-D, 10% 26e+: 10% 10% 10%	90% l 51e+1 , N=15, 90% 3 27e+3 N=15, n 90%	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 nFE=29124 RTsucc
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!$	# ERT 10 15 5.5 e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% c2 6.1e2 d4 2.2e4 d4 6.5e4 -2 42e-1 N=15, m 6 90% N=15, m 90% N=15, m 15, m 90% N=15, m 15, m 1	RTsucc 5.5e2 4.1e3 4.4e3 1.6e3 FE=3989 RTsucc 2.8e2 1.3e3 7.9e2 FE=4655 RTsucc 1.3e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 119e+3 33e+	6 RTsucc -1 2.5e3 , mFE=11507 RTsucc 0 2.5e3 , mFE=4932 RTsucc	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \text{le}-5\\ \text{le}-8 \\ \\ \hline 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \hline \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \hline \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3 0 74e-2	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 0 86e-1 5-D, N 10% 5.6e2 2.8e3 19e-2	40e-1 .: =15, m 90% 2.6e3 6.9e4 94e-1 .: N=15, m 90% 3.1e4 40e+1 15, ml 90% 7.8e2 4.5e3 63e-1 	4.5 e2	# ERT 0 36e+1	20-D, 10% 26e+: 210-D 20-D, 10% 12e+1	90% 1 51e+1 , N=15, n 90% 3 27e+3 N=15, n 90% 23e+1	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 nFE=29124 RTsucc
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!$	# ERT 10 15 5.5c2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% c2 6.1c2 c4 2.2e4 c4 6.5e4 -2 42e-1 N=15, m c5 2 0.0e2 c3 2.6e3 -2 25e-1 . N=15, m c4 90% N=15, m c5 90%	RTsucc 5.5e2 4.1e3 4.4e3 1.6e3 FE=3989 RTsucc 2.8e2 1.3e3 7.9e2 FE=4655 RTsucc 1.3e3	# ERT 0 28e+1 f115 in 2 # ERT 0 29e+0 f117 in 2 # ERT 0 26e+3 f119 in	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 119e+3 33e+	, mFE=11507 RT _{succ} 0 2.5 e3 , mFE=4932 RT _{succ} 3 3.2 e3 , mFE=4932	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \hline 10\\ 1\\ 1\\ \text{le}-1\\ \text{le}-3\\ 1\text{le}-5\\ \text{le}-8 \\ \\ \hline \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \\ \hline \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3 0 74e-2 f120 in # ERT	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4) 86e-1 5-D, N= 10% 5.6e2 2.8e3 19e-2 5-D, N	40e-1 .:=15, m 90% 2.6e3 6.9e4 94e-1 N=15, m 90% 3.1e4 40e+1 190% 7.8e2 4.5e3 63e-1 190%	4.5 e2	# ERT 0 36e+1	20-D, 10% 20e+ 20-D, 10% 20-D, 10% 12e+1 20-D,	90% 1 51e+1 , N=15, n 90% 3 27e+3 N=15, n 90% 23e+1	MTSucc 2.0 e3 mFE=6045 RTSucc 2.2 e3 nFE=29124 RTSucc 1.4 e4
$\begin{array}{c} 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}-1 \\ 1\mathrm{e}-3 \\ 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ 1\mathrm{e}-1 \\ 1\mathrm{e}-3 \\ 1\mathrm{e}-5 \\ 1\mathrm{e}-8 \\ \hline \\ \frac{\Delta f}{10} \\ 1 \\ \frac{\Delta f}{10} \\ 1 \\ \frac{\Delta f}{10} \\ $	# ERT 10 15 5.5 e2 3.1 3 1.9 e4 1.6 1 5.9 e4 4.9 0 18e-1 39e	% 90% c2 6.1e2 d4 2.2e4 d4 6.5e4 -2 42e-1 N=15, m 8 90% N=15, m 90% N=15, m 10, m 1	RTsucc 5.5e2 4.1e3 4.4e3 1.6e3 FE=3989 RTsucc 2.8e2 1.3e3 7.9e2 FE=4655 RTsucc 1.3e3	# ERT 0 28e+1 f115 in 2 # ERT 0 29e+0 f117 in 2 # ERT 0 26e+3 f119 in	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 19e+3 33e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5 e3 -1 2.5 e3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -	$ \begin{array}{c} \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ \text{le} - 5 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in 1 # ERT 15 7.7e2 8 3.6e3 0 74e-2 f120 in # ERT 15 1.6e1	15e-2 . 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 2.2e4 9 86e-1 5-D, N 10% 5.6e2 2.8e3 19e-2	# 15, m 90% 1.5, m 90% 2.6 e3 6.9 e4 40e-1 # 15, m 90% 3.1 e4 40e+1 # 15, m 90% 7.8 e2 4.5 e3 63e-1 # 15, m 90% 2.3 e1 2	4.5 e2	# ERT 0 36e+1	20-D. 10% 26e+ 10% 20-D. 10% 20-D. 10% 20-D. 10%	90% 1 51e+1 , N=15, 90% 3 27e+3 N=15, 90% 23e+1 N=15, 90%	RTsucc 2.0e3 mFE=6045 RTsucc 2.2e3 mFE=29124 RTsucc 1.4e4 mFE=6192
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\end{array}$	# ERT 10 15 5.5e2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1e2 e4 2.2e4 e4 6.5e4 -2 42e-1 N=15, m 6 90% e2 3.0e2 e3 2.6e3 -2 25e-1 N=15, m 6 90% 6 90% e0 1.7e1 e0 34e+1	RTsucc 5.5e2 4.1e3 4.4e3 4.4e3 1.6e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 19e+3 33e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5 e3 -1 2.5 e3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \hline $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3 0 74e-2 f120 in # ERT 15 1.6e1 9 5.2e3	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 4.2.2e4 9.86e-1 5.6e2 2.8e3 19e-2 10% 1.2e1 4.2e3	40e-1 .: =15, m 90% 3.1e4 40e+1 =15, ml 90% 7.8e2 4.5e3 63e-1 =15, m 90% 2.3e1 5.9e3	4.5 e2	# ERT 0 36e+:	20-D. 10% 26e+ 10% 20-D. 10% 20-D. 10% 20-D. 10%	90% 1 51e+1 , N=15, 90% 3 27e+3 N=15, 90% 23e+1 N=15, 90%	RTsucc 2.0 e3 mFE=6045 RTsucc 2.2 e3 mFE=29124 RTsucc 1.4 e4 mFE=6192 RTsucc
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!$	# ERT 10 15 5.5 c2 3.1 3 1.9 c4 1.6 1 5.9 c4 4.9 0 18e-1 39e	% 90% e2 6.1e2 e4 2.2e4 e4 6.5e4 -2 42e-1 N=15, m 6 90% e2 3.0e2 e3 2.6e3 -2 25e-1 N=15, m 6 90% 6 90% e0 1.7e1 e0 34e+1	RTsucc 5.5e2 4.1e3 4.4e3 1.6e3 FE=3989 RTsucc 2.8e2 1.3e3 7.9e2 FE=4655 RTsucc 1.3e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 19e+3 33e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5 e3 -1 2.5 e3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $ $ \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $ $ \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $ $ \begin{array}{c} \Delta f\\ 10\\ 1\\ \text{le}-1\\ \text{le}-3\\ \text{le}-5\\ \text{le}-5\\ \text{le}-8 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 0 45e-1 f116 in # ERT 2 2.6e4 0 94e+6 f118 in 1 # ERT 15 7.7e2 8 3.6e3 0 74e-2 f120 in # ERT 15 1.6e1	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 4.2.2e4 9.86e-1 5.6e2 2.8e3 19e-2 10% 1.2e1 4.2e3	40e-1 .: =15, m 90% 3.1e4 40e+1 =15, ml 90% 7.8e2 4.5e3 63e-1 =15, m 90% 2.3e1 5.9e3	4.5 e2	# ERT 0 36e+:	20-D. 10% 26e+ 10% 20-D. 10% 20-D. 10% 20-D. 10%	90% 1 51e+1 , N=15, 90% 3 27e+3 N=15, 90% 23e+1 N=15, 90%	RTsucc 2.0 e3 mFE=6045 RTsucc 2.2 e3 mFE=29124 RTsucc 1.4 e4 mFE=6192 RTsucc
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\end{array}$	# ERT 10 15 5.5 e2 3.1 3 1.9 e4 1.6 1 5.9 e4 4.9 0 18e-1 39e	% 90% e2 6.1e2 c2 e4 e4 2.2e4 e4 6.5e4 -2 42e-1 N=15, m 6 90% e2 3.0e2 e3 2.6e3 -2 25e-1 N=15, m 6 90% 6 90% e0 34e+1 , N=15, m 7 90% e0 1.7e1 e3 3.9e3 e3 3.9e3	RTsucc 5.5e2 4.1e3 4.4e3 4.4e3 1.6e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 19e+3 33e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5 e3 -1 2.5 e3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -	$ \begin{array}{c} \text{le}-3\\ \text{le}-5\\ \text{le}-8 \\ \hline $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3 0 74e-2 f120 in # ERT 15 1.6e1 9 5.2e3	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 4.2.2e4 9.86e-1 5.6e2 2.8e3 19e-2 10% 1.2e1 4.2e3	40e-1 .: =15, m 90% 3.1e4 40e+1 =15, ml 90% 7.8e2 4.5e3 63e-1 =15, m 90% 2.3e1 5.9e3	4.5 e2	# ERT 0 36e+:	20-D. 10% 26e+ 10% 20-D. 10% 20-D. 10% 20-D. 10%	90% 1 51e+1 , N=15, 90% 3 27e+3 N=15, 90% 23e+1 N=15, 90%	RTsucc 2.0 e3 mFE=6045 RTsucc 2.2 e3 mFE=29124 RTsucc 1.4 e4 mFE=6192 RTsucc
$\begin{array}{c} 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ \hline 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \hline \Delta f \\ 10 \\ 1 \\ 1\mathrm{e}\!-\!3 \\ 1\mathrm{e}\!-\!5 \\ 1\mathrm{e}\!-\!8 \\ \mathrm{e}\!-\!6 \\ \mathrm{e}\!-\!6$	# ERT 10 15 5.5c2 3.1 3 1.9e4 1.6 1 5.9e4 4.9 0 18e-1 39e	% 90% e2 6.1e2 c2 e4 e4 2.2e4 e4 6.5e4 -2 42e-1 N=15, m 6 90% e2 3.0e2 e3 2.6e3 -2 25e-1 N=15, m 6 90% 6 90% e0 34e+1 , N=15, m 7 90% e0 1.7e1 e3 3.9e3 e3 3.9e3	RTsucc 5.5e2 4.1e3 4.4e3 4.4e3 1.6e3	# ERT 0 28e+1	10% 90% 20e+1 40e+ 20-D, N=15, 10% 90% 22e+0 50e+ 20-D, N=15, 10% 90% 19e+3 33e+ 20-D, N=15, 10% 90%	6 RTsucc -1 2.5 e3 -1 2.5 e3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -	$ \begin{array}{c} \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $ $ \begin{array}{c} \Delta f \\ 10 \\ 1 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 1 \\ \text{le} - 3 \\ \text{le} - 5 \\ \text{le} - 8 \\ \end{array} $	0 16e-1 f114 in # ERT 14 2.1e3 1 6.7e4 f116 in # ERT 2 2.6e4 0 94e+6 f118 in # ERT 15 7.7e2 8 3.6e3 0 74e-2 f120 in # ERT 15 1.6e1 9 5.2e3	15e-2 5-D, N 10% 1.4e3 6.3e4 27e-1 5-D, N 10% 4.2.2e4 9.86e-1 5.6e2 2.8e3 19e-2 10% 1.2e1 4.2e3	40e-1 .: =15, m 90% 3.1e4 40e+1 =15, ml 90% 7.8e2 4.5e3 63e-1 =15, m 90% 2.3e1 5.9e3	4.5 e2	# ERT 0 36e+:	20-D. 10% 26e+ 10% 20-D. 10% 20-D. 10% 20-D. 10%	90% 1 51e+1 , N=15, 90% 3 27e+3 N=15, 90% 23e+1 N=15, 90%	RTsucc 2.0 e3 mFE=6045 RTsucc 2.2 e3 mFE=29124 RTsucc 1.4 e4 mFE=6192 RTsucc

Table 1: Shown are, for functions f_{101} - f_{120} and for a given target difference to the optimal function value Δf : the number of successful trials (#); the expected running time to surpass $f_{\rm opt} + \Delta f$ (ERT, see Figure 1); the 10%-tile and 90%-tile of the bootstrap distribution of ERT; the average number of function evaluations in successful trials or, if none was successful, as last entry the median number of function evaluations to reach the best function value (RT_{succ}). If $f_{\rm opt} + \Delta f$ was never reached, figures in *italics* denote the best achieved Δf -value of the median trial and the 10% and 90%-tile trial. Furthermore, N denotes the number of trials, and mFE denotes the maximum of number of function evaluations executed in one trial. See Figure 1 for the names of functions.

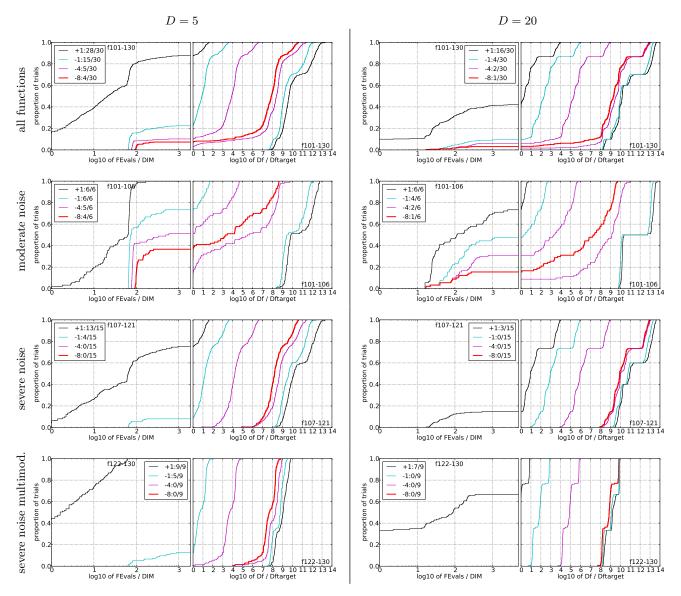


Figure 2: Empirical cumulative distribution functions (ECDFs), plotting the fraction of trials versus running time (left) or Δf . Left subplots: ECDF of the running time (number of function evaluations), divided by search space dimension D, to fall below $f_{\rm opt} + \Delta f$ with $\Delta f = 10^k$, where k is the first value in the legend. Right subplots: ECDF of the best achieved Δf divided by 10^k (upper left lines in continuation of the left subplot), and best achieved Δf divided by 10^{-8} for running times of $D, 10\,D, 100\,D\dots$ function evaluations (from right to left cycling black-cyan-magenta). Top row: all results from all functions; second row: moderate noise functions; third row: severe noise functions; fourth row: severe noise and highly-multimodal functions. The legends indicate the number of functions that were solved in at least one trial. FEvals denotes number of function evaluations, D and DIM denote search space dimension, and Δf and Df denote the difference to the optimal function value.

f121 in 5-D, N=15, mFE=5224	f121 in 20-D, N=15, mFE=8482	f122 in 5-D, N=15, mFE=4992	f122 in 20-D, N=15, mFE=7955
Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}	Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}
10 15 1.6e1 8.8e0 2.2e1 1.6e1 1 15 3.9e2 3.6e2 4.2e2 3.9e2	15 1.2e3 8.5e2 1.5e3 1.2e3 0 62e-1 35e-1 79e-1 3.2e3	10 15 1.4e1 1.2e1 2.0e1 1.4e1 1 0 18e-1 15e-1 27e-1 2.5e3	10 5.8 e3 3.7 e3 7.3 e3 3.9 e3 0 92e-1 76e-1 11e+0 2.5 e3
1e-1 7 3.1e3 2.1e3 4.5e3 8.0e2		1e-1	0 926-1 766-1 116+0 2.363
1e-3 0 10e-2 15e-3 45e-2 3.5e2		1e-1	
1e-5		1e-5	
1e-8		1e-8	
f123 in 5-D, N=15, mFE=4714	f123 in 20-D, N=15, mFE=6507	f124 in 5-D, N=15, mFE=5088	f ₁₂₄ in 20-D, N=15, mFE=7396
Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}	Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}
10 15 1.5e1 8.1e0 1.8e1 1.5e1	8 7.8e3 6.8e3 9.0e3 4.4e3		15 7.9e2 6.3e2 9.5e2 7.9e2
1 0 20e-1 12e-1 35e-1 2.0e3	0 $99e-1$ $86e-1$ $12e+0$ $2.8e3$	1 8 4.3e3 3.5e3 5.4e3 1.9e3	$0 69e-1 51e-1 80e-1 \qquad 2.8e3$
1e-1		1e-1 0 91e-2 45e-2 16e-1 1.1e3	
1e-3		1e-3	
1e-5		1e-5	
1e-8	l e	1e-8	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
f125 in 5-D, N=15, mFE=4994	f125 in 20-D, N=15, mFE=8129	f126 in 5-D, N=15, mFE=4764	f126 in 20-D, N=15, mFE=6906
Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}	Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}
10 15 1.3e0 1.1e0 1.5e0 1.3e0	15 1.1e0 1.0e0 1.3e0 1.1e0	10 15 1.0e0 1.0e0 1.0e0 1.0e0	15 1.1e0 1.0e0 1.1e0 1.1e0
1 15 3.5e1 2.7e1 4.4e1 3.5e1 1e-1 4 1.3e4 1.2e4 1.5e4 3.5e3	0 14e-1 11e-1 16e-1 4.0e3	1 15 4.2e1 3.3e1 6.0e1 4.2e1 1e-1 1 6.2e4 6.0e4 6.4e4 4.2e3	0 $14e-1$ $12e-1$ $16e-1$ $1.8e3$
1e-1 4 1.3e4 1.2e4 1.3e4 3.5e5 1e-3 0 13e-2 85e-3 29e-2 2.0e3		1e-1 1 6.2e4 6.0e4 6.4e4 4.2e3 1e-3 0 23e-2 12e-2 34e-2 1.1e3	
1 2 1			
1e-5		1e-5	
f127 in 5-D, N=15, mFE=4606	f127 in 20-D, N=15, mFE=7118		
1 1 127 III 3-D, N=13, III E=4000			
A f # ERT 10% 90% BT		f128 in 5-D, N=15, mFE=5066	f128 in 20-D, N=15, mFE=7884
Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}	Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}
10 15 1.1e0 1.0e0 1.1e0 1.1e0	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0	\[\frac{\psi f}{\psi} \frac{\pm ERT}{\pm 10\%} \frac{90\%}{\pm RT_{SUCC}} \] \[\frac{10}{15} \frac{1.1e2}{1.1e2} \frac{7.6e1}{7.6e1} \frac{1.4e2}{1.4e2} \frac{1.1e2}{1.1e2} \]	
	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	Δf # ERT 10% 90% RT _{succ}	# ERT 10% 90% RT _{succ}
10 15 1.1e0 1.0e0 1.1e0 1.1e0 1 15 3.7e1 2.8e1 5.0e1 3.7e1	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ}
10 15 1.1e0 1.0e0 1.1e0 1.1e0 1 15 3.7e1 2.8e1 5.0e1 3.7e1 1e-1 0 24e-2 17e-2 34e-2 1.8e3	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ}
10 15 1.1e0 1.0e0 1.1e0 1.1e0 1 15 3.7e1 2.8e1 5.0e1 3.7e1 1e-1 0 24e-2 17e-2 34e-2 1.8e3 1e-3	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ}
10 15 1.1e0 1.0e0 1.1e0 1.1e0 1 1e0 1 1e0 1 15 3.7e1 2.8e1 5.0e1 3.7e1 1e-1 0 24e-2 17e-2 34e-2 1.8e3 1e-3	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ}
10 15 1.1e0 1.0e0 1.1e0 1.1e0 1 1 1e 1 15 3.7e1 2.8e1 5.0e1 3.7e1 1e-1 0 24e-2 17e-2 34e-2 1.8e3 1e-3 1e-5	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 0 69e+0 61e+0 72e+0 3.2e3
10 15 1.1e0 1.0e0 1.1e0 1.1e0 1 1e0 1 15 3.7e1 2.8e1 5.0e1 3.7e1 1e-1 0 24e-2 17e-2 34e-2 1.8e3 1e-3	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 0 69e+0 61e+0 72e+0 3.2e3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RTsucc 0 69e+0 61e+0 72e+0 3.2e3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 0 69e+0 61e+0 72e+0 3.2e3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RTsucc 0 69e+0 61e+0 72e+0 3.2e3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RT _{succ} 15 1.1e0 1.0e0 1.2e0 1.1e0 0 15e-1 13e-1 17e-1 3.2e3	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	# ERT 10% 90% RTsucc 0 69e+0 61e+0 72e+0 3.2e3

Table 2: Shown are, for functions f_{121} - f_{130} and for a given target difference to the optimal function value Δf : the number of successful trials (#); the expected running time to surpass $f_{\rm opt} + \Delta f$ (ERT, see Figure 1); the 10%-tile and 90%-tile of the bootstrap distribution of ERT; the average number of function evaluations in successful trials or, if none was successful, as last entry the median number of function evaluations to reach the best function value (RT_{succ}). If $f_{\rm opt} + \Delta f$ was never reached, figures in *italics* denote the best achieved Δf -value of the median trial and the 10% and 90%-tile trial. Furthermore, N denotes the number of trials, and mFE denotes the maximum of number of function evaluations executed in one trial. See Figure 1 for the names of functions.