Supplementary File of "Constrained Multi-Objective Optimization With Deep Reinforcement Learning Assisted Operator Selection"

Fei Ming ⬢, Wenyin Gong ⬢, *Member, IEEE*, Ling Wang ⬢, *Member, IEEE*, and Yaochu Jin ⬢, *Fellow, IEEE*

This file is the supplementary file of "Constrained Multi-objective Optimization with Deep Reinforcement Learning Assisted Operator Selection". It contains detailed explanations, experimental results, and discussions on these results. All experiments were conducted on PlatEMO [1].

I. SUMMARY OF SYMBOLS

TABLE S-I
SUMMARY OF IMPORTANT SYMBOLS USED IN THIS PAPER

Abbreviation	Full name
x	decision vector
f	objective function
F	objective function vector
m	number of the objective functions
n	dimension of the decision vector
g	inequality constraints
h	equality constraints
φ	constraint violation degree of a constraint condition
$\phi = $ CV	overall constraint violation
OS	operator selection method
EP	experience replay
$\mathcal{A}$	set of actions
op	operator
$\mathcal{P}$	population of evolutionary algorithm
N	population size
$\mathcal{S}$	set of states
s	state
a	action
r	reward
t	record for the EP
$\mathcal{EP}$	set of the EP
g	current generation index
ms_{ep}	maximum size of EP
rs_{ep}	required size of EP
O	offspring set
Q	deep Q network
$\mathcal{T}$	training data for Q
s_{tr}	required smallest size of training data
ε	possibility of greedy selection in OS

II. MAIN DIFFICULTIES AND CHALLENGES OF BENCHMARKS

In this work, we adopted four very challenging CMOP benchmark test suites. Their main difficulties and challenges are summarized in Table S-II.

TABLE S-II
MAIN DIFFICULTIES AND CHALLENGES OF THE SELECTED BENCHMARKS

Benchmark	Main difficulties and challenges
CF [2]	Linkages between decision variables
DAS-CMOP [3]	Convergence-hardness, diversity-hardness, feasibility-hardness
DoC [4]	Constraints in both objective and decision spaces
LIR-CMOP [5]	Large infeasible regions

III. DETAILED INFORMATION ABOUT PERFORMANCE INDICATORS

IGD [6] represents the average distance from each reference point on the true constrained Pareto front (CPF) to the nearest solution. Suppose $\mathcal{S}^*$ is a set of uniformly distributed points on CPF and $\mathcal{S}$ is the solution set. Then IGD value is calculated by

$$\text{IGD}(\mathcal{S}^*, \mathcal{S}) = \frac{1}{|\mathcal{S}^*|} \sum_{j=1}^{|\mathcal{S}^*|} \min_{a_i \in \mathcal{S}} d(a_i, z_j) \qquad (1)$$

where $d(a_i, z_j)$ is the Euclidean distance between a and z.

Since IGD is not Pareto compliant [7], researchers have developed an improved indicator named IGD+. In IGD+, $d(a_i, z_j)$ is calculated by

$$d(a, z) = \sqrt{\sum_{k=1}^{M} (\max\{a_k - z_k, 0\})^2}. \qquad (2)$$

A smaller IGD+ value indicates a better performance.

HV [8] measures the volume or hypervolume of the objective space enclosed by the obtained solution set and the predefined reference point $\mathbf{z}^r$, HV of the solution set $\mathcal{S}$ can be formulated by

$$\text{HV}(\mathcal{S}) = \text{VOL}\left(\bigcup [z_1, z_1^r] \times \cdots \times [z_m, z_m^r] \right) \qquad (3)$$

where VOL indicates the Lebesgue measure. A larger HV value indicates better performance obtained.

10 000 uniformly distributed points were sampled on the true CPF for calculations of IGD+ according to [9]. As for

TABLE S-III
DETAILED EVOLUTIONARY SETTINGS AND PARAMETER SETTINGS IN THIS WORK

Parameter	Meaning	Value
N	Population size	91
E_{max}	Maximum function evaluations for DoC	200 000
	Maximum function evaluations for other benchmarks	100 000
G_{max}	Maximum number of iterations	Emax/N
ms_{ep}	Maximum size of EP	500
rs_{ep}	Required minimum size of EP	200
s_{tr}	Size of training data	200
γ	Decay in DQL	1.00E-04
ε	Greedy threshold	0.95

TABLE S-IV
DETAILED DESCRIPTION OF NAMES OF THE ALGORITHMS IN THE EXPERIMENTAL RESULTS IN THIS WORK

Name	Description
RandOS-XX	CMOEA using random operator selection
DRLOS-XX	CMOEA using DQL-assisted adaptive operator selection
DRLOS-XXep1	Variant for parameter analysis using 100 as rs_{ep}
DRLOS-XXep2	Variant for parameter analysis using 300 as rs_{ep}
DRLOS-XXg1	Variant for parameter analysis using 0.9 as greedy threshold ε
DRLOS-XXg2	Variant for parameter analysis using 0.98 as greedy threshold ε
DRLOS-EMCMO-Decay	Variant for parameter analysis of DQN using decay 2.00E-04
DRLOS-EMCMO-LearningRate	Variant for parameter analysis of DQN using learning rate 0.02
DRLOS-EMCMO-NumIte	Variant for parameter analysis of DQN using maximum iteration 100 000
DRLOS-EMCMO-NumNeu	Variant for parameter analysis of DQN using 50 neurons
DRLOS-EMCMO-Indi	Variant for ablation analysis using HV and Spacing indicators

HV, the objective values were first normalized, and then, $(1.1, 1.1, \ldots, 1.1)$ was adopted as the reference point in the normalized objective space.

IV. DETAILED PARAMETER SETTINGS

We use 91 as the population size because if 100 is used, then some decomposition-based CMOEAs actually generate 91 solutions due to the method of generating reference vectors [10]. Therefore, 91 is used to conduct a fair comparison. DoC needs more function evaluations because the constraints in both objective and decision spaces are very hard to satisfy. All algorithms use the same function evaluations rather than the same number of iterations because some CMOEAs may consume more function evaluations in an iteration.

V. DETAILED DESCRIPTION OF NAMES OF THE METHODS IN THE EXPERIMENTAL RESULTS

The names of all methods involved in the experimental results of this work are described in Table S-IV.

REFERENCES

[1] Y. Tian, R. Cheng, X. Zhang, and Y. Jin, "PlatEMO: A MATLAB platform for evolutionary multi-objective optimization," *IEEE Computational Intelligence Magazine*, vol. 12, pp. 73–87, 11, 2017.

[2] Q. Zhang, A. Zhou, S. Zhao, P. Suganthan, W. Liu, and S. Tiwari, "Multiobjective optimization test instances for the cec 2009 special session and competition," *Mechanical Engineering*, p. 01, 2008.

[3] Z. Fan, W. Li, X. Cai, H. Li, C. Wei, Q. Zhang, K. Deb, and E. Goodman, "Difficulty adjustable and scalable constrained multiobjective test problem toolkit," *Evolutionary Computation*, vol. 28, no. 3, pp. 339–378, 2020.

[4] Z. Liu and Y. Wang, "Handling constrained multiobjective optimization problems with constraints in both the decision and objective spaces," *IEEE Trans. Evolutionary Computation*, vol. 23, no. 5, pp. 870–884, 2019.

[5] Z. Fan, W. Li, X. Cai, H. Huang, Y. Fang, Y. Yugen, J. Mo, C. Wei, and E. Goodman, "An improved epsilon constraint-handling method in moea/d for cmops with large infeasible regions," *Soft Computing*, vol. 23, p. 12, 2019.

[6] P. A. N. Bosman and D. Thierens, "The balance between proximity and diversity in multiobjective evolutionary algorithms," *IEEE Trans. Evolutionary Computation*, vol. 7, no. 2, pp. 174–188, 2003.

[7] H. Ishibuchi, R. Imada, N. Masuyama, and Y. Nojima, "Comparison of hypervolume, igd and igd+ from the viewpoint of optimal distributions of solutions," in *Evolutionary Multi-Criterion Optimization*, 01 2019, pp. 332–345.

[8] E. Zitzler and L. Thiele, "Multiobjective evolutionary algorithms: a comparative case study and the strength pareto approach," *IEEE Trans. Evolutionary Computation*, vol. 3, no. 4, pp. 257–271, 1999.

[9] Y. Tian, T. Zhang, J. Xiao, X. Zhang, and Y. Jin, "A coevolutionary framework for constrained multiobjective optimization problems," *IEEE Trans. Evolutionary Computation*, vol. 25, no. 1, pp. 102–116, 2021.

[10] K. Deb and H. Jain, "An evolutionary many-objective optimization algorithm using reference-point-based nondominated sorting approach, part i: Solving problems with box constraints," *IEEE Trans. Evolutionary Computation*, vol. 18, no. 4, pp. 577–601, 2014.

TABLE S-V

STATISTICAL RESULTS OF HV OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
CF1	5.5709e-1 (1.03e-3) –	5.6279e-1 (5.36e-4) –	**5.6333e-1 (4.50e-4)**	5.5982e-1 (2.70e-3) =	5.5912e-1 (3.46e-3) =	5.5940e-1 (3.40e-2)	5.5717e-1 (1.11e-3) –	5.6282e-1 (4.65e-4) –	**5.6343e-1 (4.18e-4)**	5.6205e-1 (1.11e-3) +	5.5462e-1 (1.79e-3) +	5.5141e-1 (2.83e-3)
CF2	6.2777e-1 (2.12e-2) –	6.6988e-1 (4.65e-3) –	**6.7309e-1 (1.88e-3)**	6.0008e-1 (3.09e-2) –	**6.2442e-1 (2.99e-2)** =	6.1770e-1 (5.18e-2)	6.3155e-1 (2.25e-2) –	6.6667e-1 (4.94e-3) –	**6.7170e-1 (3.41e-3)**	6.7455e-1 (2.11e-3) –	6.7340e-1 (3.68e-3) –	**6.7513e-1 (2.70e-3)**
CF3	1.6293e-1 (4.33e-2) –	1.8706e-1 (5.18e-2) –	**2.1030e-1 (5.76e-2)**	1.5613e-1 (5.23e-2) –	**1.6179e-1 (5.44e-2)** =	1.5111e-1 (5.15e-2)	1.8550e-1 (4.17e-2) =	1.7695e-1 (4.28e-2) –	**2.0155e-1 (4.98e-2)**	1.7036e-1 (5.33e-2) =	1.7237e-1 (4.98e-2) =	**1.8023e-1 (5.01e-2)**
CF4	4.1551e-1 (3.98e-2) –	4.6955e-1 (1.32e-2) =	**4.8483e-1 (1.28e-2)**	3.6572e-1 (4.35e-2) –	4.0530e-1 (5.64e-2) =	**4.0961e-1 (5.13e-2)**	4.1681e-1 (3.93e-2) –	4.6602e-1 (1.20e-2) –	**4.7513e-1 (1.12e-2)**	**4.5863e-1 (3.60e-2)** =	4.4028e-1 (5.93e-2) =	4.5494e-1 (4.37e-2)
CF5	2.6378e-1 (7.06e-2) –	**3.2222e-1 (9.57e-2)** =	3.1494e-1 (7.42e-2)	2.7065e-1 (6.53e-2) –	2.7235e-1 (8.98e-2) =	**2.7342e-1 (5.30e-2)**	2.7355e-1 (7.26e-2) –	2.7028e-1 (8.38e-2) –	**3.3080e-1 (8.71e-2)**	**3.1083e-1 (5.59e-2)** =	2.9860e-1 (8.03e-2) =	2.9866e-1 (6.83e-2)
CF6	6.5208e-1 (1.36e-2) –	6.6830e-1 (6.20e-3) =	**6.7057e-1 (5.86e-3)**	6.3720e-1 (2.65e-2) –	6.5149e-1 (4.81e-2) =	**6.7018e-1 (8.62e-3)**	6.5277e-1 (1.56e-2) –	6.6268e-1 (8.12e-3) –	**6.6654e-1 (6.98e-3)**	6.4460e-1 (1.09e-2) –	6.5041e-1 (1.34e-2) =	**6.5293e-1 (1.44e-2)**
CF7	4.2697e-1 (1.20e-1) –	**5.0007e-1 (1.11e-1)** =	4.8910e-1 (1.01e-1)	3.7857e-1 (1.08e-1) =	3.9422e-1 (9.92e-2) =	**4.0649e-1 (1.24e-1)**	4.5217e-1 (9.58e-2) –	4.8848e-1 (1.01e-1) =	**4.9553e-1 (1.21e-1)**	**4.2017e-1 (8.94e-2)** =	3.7735e-1 (1.08e-1) =	4.0432e-1 (1.07e-1)
CF8	3.1312e-1 (6.65e-2) +	3.1345e-1 (2.37e-2) =	3.0556e-1 (2.74e-2)	3.6617e-1 (9.70e-2) –	4.0030e-1 (4.05e-2) =	**4.0312e-1 (5.99e-2)**	2.6765e-1 (7.80e-2) –	**2.9618e-1 (2.85e-2)** =	2.9022e-1 (2.70e-2)	2.7493e-1 (3.64e-2) –	3.7120e-1 (1.91e-2) =	**3.7286e-1 (2.08e-2)**
CF9	**4.1521e-1 (3.55e-2)** +	4.0543e-1 (1.54e-2) –	4.0291e-1 (1.59e-2)	4.4558e-1 (2.06e-2) –	4.5191e-1 (2.21e-2) =	**4.5692e-1 (6.15e-3)**	**4.1209e-1 (1.59e-2)** +	3.9553e-1 (1.49e-2) –	3.9006e-1 (2.07e-2)	4.0850e-1 (2.26e-2) –	**4.4554e-1 (1.42e-2)** –	4.5425e-1 (1.36e-2)
CF10	1.4903e-1 (4.78e-2) =	1.5627e-1 (4.71e-2) =	**1.6093e-1 (5.26e-2)**	1.5987e-1 (7.38e-2) –	**2.7809e-1 (7.71e-2)** =	2.6128e-1 (8.97e-2)	1.5343e-1 (4.29e-2) =	1.5016e-1 (4.73e-2) =	**1.4939e-1 (5.13e-2)**	1.4661e-1 (3.88e-2) –	2.2431e-1 (8.32e-2) =	**2.5890e-1 (7.19e-2)**
+/-/=	2/7/1	0/4/6		0/6/4	0/1/9		1/6/3	0/6/4		1/4/5	1/1/8	

TABLE S-VI

STATISTICAL RESULTS OF IGD+ OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
CF1	7.1865e-3 (7.79e-4) –	2.7246e-3 (4.44e-4) –	**2.2811e-3 (3.70e-4)**	4.5866e-3 (2.02e-3) –	5.3053e-3 (2.74e-3) –	5.0790e-3 (2.70e-3)	7.1196e-3 (8.68e-4) –	2.6965e-3 (3.85e-4) –	**2.1957e-3 (3.45e-4)**	3.3366e-3 (9.13e-4) +	9.4685e-3 (1.51e-3) +	1.2193e-2 (2.35e-3)
CF2	3.1565e-2 (1.03e-2) –	8.1888e-3 (3.55e-3) –	**6.3466e-3 (1.96e-3)**	5.1545e-2 (3.12e-2) –	**2.3258e-2 (1.37e-2)** +	2.5583e-2 (2.75e-2)	3.1454e-2 (1.15e-2) –	1.0472e-2 (3.40e-3) –	**6.7656e-3 (2.69e-3)**	3.8481e-3 (3.17e-4) –	4.4865e-3 (7.22e-4) –	**3.7240e-3 (5.11e-4)**
CF3	2.4434e-1 (4.21e-2) –	1.9008e-1 (6.60e-2) =	**1.7704e-1 (7.03e-2)**	2.7391e-1 (1.21e-1) –	**2.7229e-1 (1.50e-1)** =	3.0487e-1 (1.39e-1)	2.0796e-1 (4.19e-2) =	2.1335e-1 (4.52e-2) –	**1.8764e-1 (6.02e-2)**	2.7282e-1 (1.36e-1) =	**2.5465e-1 (1.16e-1)** =	2.6365e-1 (1.39e-1)
CF4	7.8297e-2 (2.78e-2) –	4.3667e-2 (8.57e-3) =	**3.3520e-2 (8.10e-3)**	1.2675e-1 (4.04e-2) –	9.8198e-2 (5.72e-2) =	**9.3645e-2 (4.90e-2)**	7.7527e-2 (2.86e-2) –	4.6381e-2 (7.75e-3) –	**4.0393e-2 (7.07e-3)**	**5.5646e-2 (2.99e-2)** =	7.1547e-2 (5.99e-2) =	5.9749e-2 (3.73e-2)
CF5	2.4225e-1 (9.01e-2) –	**1.7469e-1 (1.01e-1)** =	1.8182e-1 (8.01e-2)	**2.3057e-1 (8.05e-2)** =	2.3479e-1 (1.14e-1) =	2.3798e-1 (6.80e-2)	2.2236e-1 (9.50e-2) –	2.2511e-1 (9.19e-2) –	**1.6987e-1 (9.96e-2)**	**1.9452e-1 (6.69e-2)** =	2.0927e-1 (1.01e-1) =	2.1211e-1 (7.99e-2)
CF6	3.6676e-2 (1.31e-2) –	2.6446e-2 (4.16e-3) –	**2.4233e-2 (3.99e-3)**	5.1914e-2 (2.75e-2) –	3.6013e-2 (2.99e-2) =	**2.2752e-2 (7.15e-3)**	3.6568e-2 (1.48e-2) –	3.1550e-2 (6.05e-3) –	**2.8311e-2 (5.73e-3)**	4.5791e-2 (1.02e-2) –	4.0368e-2 (1.26e-2) –	**3.8197e-2 (1.33e-2)**
CF7	2.1610e-1 (1.36e-1) –	**1.4830e-1 (1.12e-1)** =	1.5000e-1 (9.75e-2)	2.3603e-1 (1.27e-1) =	2.2140e-1 (9.04e-2) =	**2.0546e-1 (1.19e-1)**	1.9053e-1 (1.13e-1) =	1.5353e-1 (1.01e-1) =	**1.4147e-1 (1.10e-1)**	**1.9106e-1 (7.14e-2)** =	2.2493e-1 (9.47e-2) =	2.0739e-1 (9.18e-2)
CF8	**1.4565e-1 (5.29e-2)** +	1.4828e-1 (1.67e-2) =	1.5084e-1 (2.12e-2)	3.5670e-1 (1.31e+0) –	1.0035e-1 (3.37e-2) =	**9.9690e-2 (4.83e-2)**	1.7632e-1 (6.12e-2) =	**1.6585e-1 (2.41e-2)** =	1.6727e-1 (2.80e-2)	1.7127e-1 (5.13e-2) =	**1.0934e-1 (9.57e-3)** =	1.1099e-1 (1.06e-2)
CF9	**6.8180e-2 (1.62e-2)** +	7.7751e-2 (8.84e-3) –	7.7920e-2 (1.03e-2)	5.1901e-2 (9.28e-3) –	4.7981e-2 (9.54e-3) –	**4.6378e-2 (2.88e-3)**	**7.0088e-2 (7.44e-3)** +	8.2605e-2 (8.39e-3) –	8.4547e-2 (1.32e-2)	8.3803e-2 (1.61e-2) –	**5.2585e-2 (7.17e-3)** =	5.3836e-2 (9.90e-3)
CF10	2.9696e-1 (1.23e-1) =	**2.7028e-1 (7.78e-2)** =	2.7362e-1 (6.37e-2)	3.1289e-1 (1.25e-1) –	**1.6197e-1 (1.19e-1)** =	1.9639e-1 (1.44e-1)	2.6433e-1 (6.85e-2) =	2.7371e-1 (9.48e-2) =	**2.6734e-1 (7.38e-2)**	3.6516e-1 (8.87e-2) –	2.3170e-1 (1.31e-1) =	**1.9201e-1 (1.13e-1)**
+/-/=	2/7/1	0/4/6		0/6/4	1/1/8		1/6/3	0/6/4		1/5/4	1/1/8	

TABLE S-VII

STATISTICAL RESULTS OF HV OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
DASC-MOP1	1.2925e−2 (1.55e−2) −	2.1081e−1 (9.59e−4) −	2.1129e−1 (8.92e−4)	2.0338e−2 (2.66e−2) −	1.6910e−1 (4.62e−3) −	1.7117e−1 (2.64e−3)	1.0425e−2 (1.55e−2) −	2.1091e−1 (1.09e−3) −	2.1122e−1 (7.81e−4)	1.7167e−1 (5.31e−2) =	1.0796e−1 (8.15e−2) −	1.7781e−1 (5.19e−2)
DASC-MOP2	2.5757e−1 (3.39e−3) −	3.5380e−1 (3.40e−4) −	3.5432e−1 (2.42e−4)	2.8450e−1 (1.68e−2) −	3.0548e−1 (1.94e−2) =	3.1747e−1 (2.65e−2)	2.5742e−1 (1.89e−3) −	3.5341e−1 (1.01e−3) −	3.5405e−1 (2.67e−4)	3.4839e−1 (1.91e−2) −	3.2582e−1 (3.27e−2) −	3.5398e−1 (4.37e−3)
DASC-MOP3	2.1449e−1 (1.46e−2) −	3.0902e−1 (3.93e−3) =	3.1042e−1 (1.00e−3)	2.0340e−1 (4.87e−2) −	2.0811e−1 (1.77e−2) −	2.2991e−1 (2.48e−2)	2.1098e−1 (9.57e−3) −	3.0742e−1 (4.76e−3) −	3.0916e−1 (2.89e−3)	2.3137e−1 (4.20e−2) =	2.1214e−1 (1.88e−2) =	2.1174e−1 (9.34e−3)
DASC-MOP4	2.0028e−1 (4.16e−3) +	1.0031e−1 (7.35e−2) −	1.5188e−1 (6.24e−2)	2.0172e−1 (5.48e−3) =	1.5313e−1 (5.26e−2) −	2.0230e−1 (4.32e−3)	2.0082e−1 (4.31e−3) +	1.4128e−1 (6.05e−2) −	1.7883e−1 (4.36e−2)	9.6586e−2 (7.18e−2) −	1.4058e−1 (5.92e−2) −	1.8867e−1 (2.62e−2)
DASC-MOP5	3.5119e−1 (2.65e−4) +	2.5076e−1 (1.22e−1) −	3.1731e−1 (5.25e−2)	3.4690e−1 (2.98e−3) −	3.2159e−1 (6.31e−2) −	3.4813e−1 (2.84e−3)	3.5082e−1 (2.09e−3) +	2.5687e−1 (1.05e−1) −	3.4533e−1 (1.26e−2)	2.3060e−1 (1.47e−1) −	3.0166e−1 (8.89e−2) −	3.5005e−1 (2.90e−3)
DASC-MOP6	2.9359e−1 (2.37e−2) =	1.6273e−1 (1.18e−1) −	2.4675e−1 (9.47e−2)	2.9055e−1 (2.53e−2) −	2.5751e−1 (9.54e−2) −	3.0820e−1 (9.23e−3)	3.0522e−1 (1.09e−2) =	2.1147e−1 (1.21e−1) −	2.9414e−1 (3.54e−2)	1.2245e−1 (1.33e−1) =	8.3274e−2 (1.12e−1) =	7.8552e−2 (1.13e−1)
DASC-MOP7	2.8819e−1 (4.58e−4) +	1.5368e−1 (8.75e−2) −	2.4177e−1 (7.17e−2)	2.8424e−1 (2.07e−3) =	2.8192e−1 (1.98e−3) −	2.8414e−1 (1.75e−3)	2.8821e−1 (5.47e−4) +	1.6626e−1 (7.41e−2) −	2.3065e−1 (6.40e−2)	1.4912e−1 (1.00e−1) −	2.8297e−1 (2.01e−3) =	2.8378e−1 (7.33e−4)
DASC-MOP8	2.0699e−1 (7.14e−4) +	1.2633e−1 (8.68e−2) −	1.6314e−1 (5.34e−2)	2.0139e−1 (6.91e−3) −	1.9461e−1 (9.24e−3) −	2.0279e−1 (3.26e−3)	2.0698e−1 (8.07e−4) +	1.2107e−1 (8.14e−2) −	1.9030e−1 (2.98e−2)	1.4130e−1 (7.07e−2) −	2.0231e−1 (9.51e−4) =	2.0223e−1 (1.06e−1)
DASC-MOP9	1.2874e−1 (1.45e−2) −	2.0436e−2 (5.41e−4) −	2.0480e−1 (4.20e−4)	9.3713e−2 (4.16e−2) −	1.6818e−1 (5.28e−2) +	1.2851e−1 (4.49e−2)	1.2964e−1 (1.18e−2) −	2.0437e−1 (3.80e−4) −	2.0477e−1 (4.38e−4)	1.5581e−1 (3.76e−2) =	1.6923e−1 (2.52e−2) =	1.5384e−1 (4.20e−2)
+/−/=	4/4/1	0/6/3		0/6/3	1/7/1		4/4/1	0/7/2		0/5/4	0/4/5	

TABLE S-VIII

STATISTICAL RESULTS OF IGD+ OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
DASC-MOP1	6.9977e−1 (6.90e−2) −	2.8477e−3 (3.24e−4) −	2.6347e−3 (8.06e−4)	6.7266e−1 (1.10e−1) −	1.6136e−1 (4.60e−3) −	1.5920e−1 (3.90e−3)	7.1348e−1 (6.71e−2) −	2.8130e−3 (3.50e−4) −	2.5278e−3 (2.52e−4)	1.4286e−1 (1.80e−1) =	3.6636e−1 (2.82e−1) −	1.1914e−1 (1.80e−1)
DASC-MOP2	1.4128e−1 (6.25e−3) −	4.8794e−3 (3.67e−4) −	4.3054e−3 (2.53e−4)	1.2833e−1 (2.07e−2) −	4.5790e−2 (2.47e−2) =	3.7001e−2 (3.04e−2)	1.4199e−1 (7.81e−3) −	5.1463e−3 (8.45e−4) −	4.5000e−3 (2.92e−4)	1.3523e−2 (2.84e−2) −	4.4102e−2 (4.81e−2) −	4.4246e−3 (2.16e−3)
DASC-MOP3	1.8187e−1 (2.53e−2) −	8.2956e−3 (3.36e−3) −	6.8896e−3 (8.38e−4)	2.2118e−1 (1.22e−1) −	1.9280e−1 (3.42e−2) −	1.5792e−1 (4.59e−2)	1.8881e−1 (1.93e−2) −	1.0081e−2 (4.39e−3) =	9.2764e−3 (5.89e−3)	1.5008e−1 (7.48e−2) =	1.8622e−1 (3.52e−2) =	1.8414e−1 (1.66e−2)
DASC-MOP4	1.4620e−3 (8.66e−4) +	2.7860e−1 (2.73e−1) −	1.1334e−1 (1.76e−1)	2.1711e−3 (3.45e−3) =	1.6809e−1 (1.54e−1) −	1.5892e−3 (1.96e−3)	1.5146e−3 (1.18e−3) +	1.4013e−1 (1.56e−1) −	4.5370e−2 (1.05e−1)	3.2329e−1 (2.40e−1) −	1.6776e−1 (1.61e−1) −	4.3946e−2 (8.43e−2)
DASC-MOP5	2.0323e−3 (2.23e−4) +	1.8053e−1 (2.32e−1) −	5.3014e−2 (8.29e−2)	6.5895e−3 (2.90e−2) −	4.2787e−2 (1.00e−1) −	5.3318e−3 (2.65e−3)	2.5769e−3 (2.55e−3) +	1.6992e−1 (2.32e−1) −	9.7416e−3 (1.92e−2)	2.5370e−1 (3.22e−1) −	8.3726e−2 (1.64e−1) −	4.2004e−3 (3.50e−3)
DASC-MOP6	3.3181e−2 (4.03e−2) =	3.4449e−1 (3.14e−1) −	1.3004e−1 (1.85e−1)	3.8709e−2 (4.65e−2) −	1.3661e−1 (2.55e−1) −	1.2580e−2 (1.54e−2)	1.3926e−2 (1.54e−2) =	2.0354e−1 (2.44e−1) −	3.8780e−2 (7.10e−2)	4.5814e−1 (3.38e−1) =	5.3659e−1 (2.95e−1) −	5.5552e−1 (3.01e−1)
DASC-MOP7	2.3442e−2 (1.06e−3) +	3.6071e−1 (2.89e−1) −	1.3052e−1 (1.84e−1)	3.2294e−2 (4.44e−3) −	3.6205e−2 (4.35e−3) −	3.2002e−2 (3.71e−3)	2.3856e−2 (1.30e−3) +	3.0014e−1 (1.95e−1) −	1.4519e−1 (1.45e−1)	3.7098e−1 (2.85e−1) −	3.9280e−2 (5.87e−3) −	3.6732e−2 (2.29e−3)
DASC-MOP8	1.8561e−2 (1.02e−3) +	2.4569e−1 (2.96e−1) =	9.6590e−2 (1.02e−1)	3.0085e−2 (1.65e−2) −	3.8050e−2 (1.36e−2) −	2.6790e−2 (4.78e−3)	1.9026e−2 (1.67e−3) +	2.0824e−1 (2.04e−1) −	4.6088e−2 (5.16e−2)	1.8010e−1 (2.15e−1) −	2.6799e−2 (1.55e−3) =	2.6822e−2 (1.48e−3)
DASC-MOP9	2.4232e−1 (4.68e−2) −	2.2330e−2 (9.76e−4) −	2.1548e−2 (7.80e−4)	3.5752e−1 (1.48e−1) −	1.2483e−1 (1.70e−1) +	2.4978e−1 (1.49e−1)	2.3865e−1 (3.91e−2) −	2.2214e−2 (8.82e−4) −	2.1323e−2 (1.10e−3)	1.5300e−1 (1.22e−1) =	1.0529e−1 (8.58e−2) =	1.5930e−1 (1.43e−1)
+/−/=	4/4/1	0/7/2		0/6/3	1/7/1		4/4/1	0/7/2		0/5/4	0/5/4	

TABLE S-IX

STATISTICAL RESULTS OF HV OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
DOC1	7.0504e-4 (3.86e-3) –	3.3382e-1 (6.31e-2) –	**3.4576e-1 (4.36e-4)**	2.0505e-1 (4.98e-2) =	**2.2161e-1 (5.34e-2)** =	2.1171e-1 (4.42e-2)	3.4123e-3 (1.87e-2) –	3.4505e-1 (9.15e-4) =	**3.4550e-1 (5.73e-4)**	**2.9287e-1 (2.91e-2)** =	2.6978e-1 (3.02e-2) =	2.8345e-1 (3.49e-2)
DOC2	NaN (NaN)	4.6490e-1 (1.76e-1) =	**5.1686e-1 (1.32e-1)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	5.3228e-1 (1.13e-1) –	**5.7595e-1 (7.72e-2)**	4.7779e-1 (8.39e-2) =	2.1990e-1 (9.71e-2) =	3.4609e-1 (1.27e-1)
DOC3	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0) =	**1.9884e-2 (6.11e-2)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	0.0000e+0 (0.00e+0) =	7.6400e-3 (2.97e-2) =	**9.1084e-3 (3.06e-2)**	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0)
DOC4	4.1710e-1 (8.89e-2) –	5.1560e-1 (1.15e-2) =	**5.1928e-1 (1.37e-2)**	2.6124e-2 (6.88e-2) =	**9.8005e-2 (1.30e-1)** =	5.8476e-2 (1.05e-1)	1.1764e-1 (1.41e-1) –	5.1105e-1 (3.02e-2) –	**5.1684e-1 (4.06e-2)**	2.2918e-1 (6.97e-2) =	2.0586e-1 (4.39e-2) =	2.2468e-1 (5.77e-2)
DOC5	NaN (NaN)	3.3732e-1 (1.99e-1) =	**3.9768e-1 (1.38e-1)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	**4.0362e-1 (1.40e-1)** =	3.8120e-1 (1.79e-1)	**1.5064e-1 (1.49e-1)** =	7.8485e-2 (1.26e-1) =	9.8382e-2 (1.16e-1)
DOC6	1.5120e-2 (3.40e-2) –	4.7393e-1 (9.72e-2) =	**5.1129e-1 (1.80e-2)**	0.0000e+0 (0.00e+0) =	3.5404e-3 (1.37e-2) =	**4.1556e-3 (1.72e-2)**	2.4716e-2 (8.78e-2) –	4.7839e-1 (7.92e-2) =	**5.0181e-1 (4.65e-2)**	1.6557e-1 (3.91e-1) =	1.8713e-1 (1.10e-1) =	**2.1140e-1 (1.20e-1)**
DOC7	0.0000e+0 (0.00e+0) –	**3.3541e-1 (1.85e-1)** =	2.5829e-1 (2.29e-1)	0.0000e+0 (0.00e+0) =	**3.7105e-3 (1.93e-2)** =	0.0000e+0 (0.00e+0)	0.0000e+0 (0.00e+0) –	3.6718e-1 (1.92e-1) =	**3.9080e-1 (1.88e-1)**	**5.6818e-2 (8.59e-2)** +	1.0804e-2 (1.69e-2) =	6.1536e-3 (8.58e-3)
DOC8	0.0000e+0 (0.00e+0) =	4.2625e-1 (1.39e-1) –	**5.8168e-1 (1.00e-1)**	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0)	0.0000e+0 (0.00e+0) =	4.0379e-1 (1.67e-1) –	**5.2609e-1 (1.17e-1)**	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0)
DOC9	NaN (NaN)	NaN (NaN)	NaN (NaN)	0.0000e+0 (0.00e+0) =	NaN (NaN)	0.0000e+0 (0.00e+0)	NaN (NaN)	NaN (NaN)	NaN (NaN)	0.0000e+0 (0.00e+0)	NaN (NaN)	NaN (NaN)
+/-/=	0/5/1	0/4/4		0/0/6	0/0/5		0/5/1	0/3/5		1/0/7	0/0/8	

TABLE S-X

STATISTICAL RESULTS OF IGD+ OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
DOC1	6.6184e+0 (3.87e+0) –	4.4521e-1 (2.42e+0) –	**2.6149e-3 (1.48e-4)**	1.0015e-1 (1.30e-1) =	1.3603e-1 (1.05e-1) =	**9.0927e-2 (7.58e-2)**	5.3289e+0 (3.82e+0) –	2.8085e-3 (2.84e-4) –	**2.6377e-3 (1.82e-4)**	**5.0873e-2 (3.41e-2)** =	7.0321e-2 (4.94e-2) =	6.7505e-2 (5.93e-2)
DOC2	NaN (NaN)	1.4300e-1 (1.60e-1) =	**9.8726e-2 (1.24e-1)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	8.3075e-2 (1.06e-1) –	**4.3113e-2 (7.17e-2)**	1.0818e-1 (7.22e-2) =	3.5269e-1 (1.00e-1) =	2.2576e-1 (1.30e-1)
DOC3	6.8577e+2 (2.30e+2) =	5.2696e+2 (4.59e+2) =	**4.4296e+2 (4.68e+2)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	6.8897e+2 (2.03e+2) =	6.1584e+2 (4.74e+2) =	**6.0270e+2 (4.85e+2)**	2.5800e+2 (1.61e+2) =	1.9159e+2 (2.06e+2) =	**1.7225e+2 (1.63e+2)**
DOC4	1.6459e+0 (1.68e+0) –	4.1157e-2 (1.04e-2) =	**3.7856e-2 (1.22e-2)**	1.6115e+0 (8.01e-1) –	**7.6485e-1 (4.47e-1)** =	1.0128e+0 (5.73e-1)	8.8212e-1 (6.86e-1) –	4.5698e-2 (2.98e-2) –	**4.1216e-2 (4.26e-2)**	3.1630e-1 (8.21e-2) =	3.3357e-1 (5.86e-2) =	**3.0175e-1 (6.70e-2)**
DOC5	NaN (NaN)	3.0785e+1 (5.71e+1) =	**1.1949e+1 (3.93e+1)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	**1.3120e+1 (4.02e+1)** =	2.1808e+1 (5.00e+1)	**1.2361e+1 (3.94e+1)** =	3.9165e+1 (6.82e+1) =	1.7248e+1 (5.25e+1)
DOC6	2.1422e+0 (2.36e+0) –	3.1628e-2 (8.68e-2) =	**3.9238e-3 (3.95e-3)**	2.3125e+0 (7.27e-1) –	**1.5639e+0 (6.27e-1)** +	2.2171e+0 (1.04e+0)	2.0565e+0 (1.59e+0) –	2.5473e-2 (6.48e-2) –	**9.4061e-3 (3.24e-2)**	5.1163e-1 (7.34e-2) =	3.7023e-1 (1.79e-1) =	**3.6204e-1 (1.85e-1)**
DOC7	6.1113e+0 (2.41e+0) –	**2.3945e-1 (4.73e-1)** =	5.1921e-1 (7.93e-1)	3.6243e+0 (1.69e+0) =	**2.8120e+0 (1.82e+0)** =	3.5655e+0 (2.53e+0)	5.6632e+0 (1.78e+0) –	1.7519e-1 (2.97e-1) =	**1.4072e-1 (2.67e-1)**	**5.8292e-1 (1.71e-1)** +	7.0211e-1 (1.23e-1) =	7.6541e-1 (2.05e-1)
DOC8	8.0405e+1 (5.09e+1) =	4.1640e-1 (4.27e-1) –	**2.2857e-1 (7.67e-2)**	1.3035e+2 (8.85e+1) =	9.1713e+1 (1.02e+2) =	1.1700e+2 (8.66e+1)	5.9085e+1 (4.83e+1) =	4.1417e-1 (3.13e-1) –	**2.7264e-1 (8.88e-2)**	1.1702e+2 (4.24e+1) =	1.0091e+2 (3.18e+1) =	**9.8266e+1 (3.26e+1)**
DOC9	1.4050e-1 (1.17e-1) =	**6.6689e-2 (4.37e-2)** =	7.5523e-2 (5.93e-2)	1.2136e-1 (1.16e-1) =	9.1770e-2 (8.22e-2) =	1.0490e-1 (1.10e-1)	1.0830e-1 (1.01e-1) =	5.4080e-2 (9.86e-3) =	**5.0283e-2 (9.22e-3)**	2.9157e-1 (2.19e-2) –	2.7328e-1 (2.29e-2) –	**2.6181e-1 (2.13e-2)**
+/-/=	0/6/1	0/2/7		0/1/5	1/0/5		0/5/2	0/5/4		1/2/6	0/1/8	

TABLE S-XI

STATISTICAL RESULTS OF HV OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
LIRC-MOP1	1.2141e-1 (1.74e-2) -	1.3372e-1 (1.88e-2) =	1.4116e-1 (2.14e-2)	1.5316e-1 (1.71e-2) -	1.7453e-1 (1.55e-2) -	1.8646e-1 (9.22e-3)	1.3084e-1 (1.76e-2) =	1.3745e-1 (2.12e-2) -	1.4210e-1 (1.90e-2)	2.1855e-1 (1.99e-2) +	2.0182e-1 (2.09e-2) =	2.0604e-1 (2.16e-2)
LIRC-MOP2	2.3503e-1 (1.99e-2) -	2.6857e-1 (2.73e-2) -	2.7618e-1 (2.83e-2)	2.5796e-1 (2.33e-2) -	2.7347e-1 (2.65e-2) -	2.8333e-1 (9.69e-3) =	2.4088e-1 (1.78e-2) -	2.6052e-1 (2.43e-2) =	2.6388e-1 (2.75e-2)	3.4333e-1 (2.25e-2) +	3.2759e-1 (2.71e-2) =	3.3468e-1 (2.30e-2)
LIRC-MOP3	1.0981e-1 (1.44e-2) =	1.2001e-1 (2.10e-2) =	1.1784e-1 (2.04e-2)	1.3999e-1 (1.34e-2) -	1.4645e-1 (1.41e-2) -	1.5824e-1 (1.51e-2)	1.0769e-1 (1.45e-2) -	1.2463e-1 (1.59e-2) =	1.1822e-1 (1.61e-2)	1.7058e-1 (2.83e-2) =	1.5609e-1 (2.99e-2) -	1.7237e-1 (2.83e-2)
LIRC-MOP4	2.0054e-1 (1.54e-2) =	2.1777e-1 (2.67e-2) =	2.1190e-1 (1.95e-2)	2.3008e-1 (1.17e-2) =	2.1979e-1 (1.64e-2) -	2.3061e-1 (1.41e-2)	2.0198e-1 (1.41e-2) -	2.1707e-1 (2.30e-2) =	2.1807e-1 (1.98e-2)	2.7685e-1 (3.04e-2) =	2.6385e-1 (3.93e-2) =	2.6475e-1 (3.60e-2)
LIRC-MOP5	1.5687e-1 (3.03e-2) -	2.8317e-1 (4.09e-3) -	2.8662e-1 (3.11e-3)	1.4300e-1 (2.14e-2) -	1.4076e-1 (2.26e-2) -	1.4556e-1 (1.87e-2)	1.6363e-1 (1.58e-2) -	2.7641e-1 (1.42e-2) -	2.8301e-1 (1.38e-2)	2.8941e-1 (2.26e-2) =	2.8891e-1 (2.26e-3) =	2.8995e-1 (1.58e-3)
LIRC-MOP6	1.1244e-1 (1.36e-2) -	1.9011e-1 (8.95e-3) -	1.9391e-1 (8.42e-4)	9.8290e-2 (8.35e-3) -	1.1948e-1 (1.65e-2) =	1.1840e-1 (1.77e-2)	1.1460e-1 (1.21e-2) -	1.8937e-1 (9.06e-3) -	1.9379e-1 (1.07e-3)	1.8892e-1 (1.06e-2) =	1.8219e-1 (1.21e-2) -	1.8552e-1 (3.59e-2)
LIRC-MOP7	2.5183e-1 (1.20e-2) -	2.8957e-1 (1.05e-2) -	2.9316e-1 (2.17e-3)	2.3591e-1 (8.75e-3) -	2.4183e-1 (1.04e-2) =	2.4143e-1 (1.15e-2)	2.4563e-1 (9.85e-3) -	2.8676e-1 (1.28e-2) -	2.9240e-1 (4.63e-3)	2.4327e-1 (5.04e-3) =	2.4275e-1 (5.76e-3) =	2.4478e-1 (9.38e-3)
LIRC-MOP8	2.3892e-1 (1.35e-2) -	2.9273e-1 (3.43e-3) -	2.9375e-1 (4.29e-4)	2.2228e-1 (6.26e-3) -	2.3908e-1 (1.31e-2) =	2.4105e-1 (1.13e-2)	2.3792e-1 (1.18e-2) -	2.9296e-1 (2.83e-3) -	2.9365e-1 (9.30e-4)	2.3601e-1 (1.47e-2) =	2.2928e-1 (8.82e-3) =	2.2976e-1 (4.43e-3)
LIRC-MOP9	3.3405e-1 (6.43e-2) -	4.4306e-1 (1.67e-2) =	4.5755e-1 (3.23e-2)	4.9033e-1 (3.95e-2) +	4.3191e-1 (1.09e-1) =	4.5037e-1 (8.45e-2)	3.3965e-1 (6.33e-2) -	4.3568e-1 (1.12e-2) =	4.4138e-1 (2.17e-2)	4.2558e-1 (4.18e-2) =	4.3308e-1 (4.50e-2) =	4.4779e-1 (2.95e-2)
LIRC-MOP10	6.0733e-1 (2.72e-2) -	6.7497e-1 (1.44e-2) -	6.8876e-1 (1.26e-2)	6.6345e-1 (7.95e-2) =	6.2112e-1 (1.26e-1) =	6.1235e-1 (1.53e-1)	5.9404e-1 (5.28e-2) -	6.6867e-1 (1.42e-2) -	6.8631e-1 (1.23e-2)	5.5559e-1 (7.88e-2) =	5.9763e-1 (1.02e-1) =	5.7544e-1 (1.03e-1)
LIRC-MOP11	6.5013e-1 (2.92e-2) -	6.7822e-1 (1.78e-2) -	6.8697e-1 (6.50e-3)	6.5064e-1 (9.21e-2) =	6.3510e-1 (1.05e-1) =	6.2257e-1 (1.44e-1)	6.5883e-1 (2.84e-2) -	6.7224e-1 (1.20e-2) -	6.8144e-1 (9.55e-3)	5.2925e-1 (1.07e-1) =	5.5979e-1 (1.05e-1) =	5.8452e-1 (8.07e-2)
LIRC-MOP12	5.0646e-1 (4.29e-2) -	5.6648e-1 (2.21e-2) -	5.8587e-1 (1.38e-2)	5.7912e-1 (4.16e-2) +	5.4107e-1 (4.48e-2) =	5.5036e-1 (3.26e-2)	5.0355e-1 (3.75e-2) -	5.6414e-1 (1.08e-2) -	5.7470e-1 (1.69e-2)	5.3072e-1 (5.75e-2) =	5.3255e-1 (3.93e-2) =	5.2892e-1 (4.19e-2)
LIRC-MOP13	5.5405e-1 (1.53e-3) +	5.2409e-1 (3.67e-3) =	5.2370e-1 (3.31e-3)	5.5455e-1 (9.86e-4) -	5.5565e-1 (1.82e-3) =	5.5605e-1 (1.34e-3)	5.5903e-1 (1.26e-3) +	5.3345e-1 (3.83e-3) =	5.3441e-1 (3.20e-3)	4.9866e-1 (2.65e-2) =	5.2393e-1 (4.98e-3) =	5.2564e-1 (3.81e-3)
LIRC-MOP14	5.5410e-1 (1.24e-3) +	5.4631e-1 (2.27e-3) +	5.4517e-1 (1.86e-3)	5.5228e-1 (1.50e-3) +	5.5061e-1 (1.36e-2) =	5.5097e-1 (1.17e-3)	5.5525e-1 (1.30e-3) +	5.4888e-1 (1.83e-3) =	5.4856e-1 (1.82e-3)	5.2640e-1 (8.86e-3) -	5.3504e-1 (4.57e-3) =	5.3451e-1 (4.69e-3)
+/-/=	2/11/1	1/8/5		3/6/5	0/4/10		2/11/1	0/7/7		2/3/9	0/2/12	

TABLE S-XII

STATISTICAL RESULTS OF IGD+ OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
LIRC-MOP1	2.2605e-1 (4.37e-2) -	1.9544e-1 (4.35e-2) =	1.8166e-1 (4.80e-2)	1.4696e-1 (2.90e-2) -	1.4042e-1 (5.01e-2) =	1.0514e-1 (1.66e-2)	2.0418e-1 (4.43e-2) =	1.8725e-1 (4.70e-2) =	1.7898e-1 (3.70e-2)	3.1630e-2 (3.19e-2) +	6.3923e-2 (3.61e-2) =	5.0521e-2 (3.46e-2)
LIRC-MOP2	1.5414e-1 (2.96e-2) -	1.0718e-1 (3.06e-2) =	9.8504e-2 (3.06e-2)	8.9233e-2 (1.27e-2) =	1.1586e-1 (3.71e-2) -	9.4115e-2 (3.87e-2)	1.4319e-1 (2.40e-2) -	1.1750e-1 (3.00e-2) =	1.1141e-1 (3.32e-2)	2.3030e-2 (2.19e-2) +	4.0595e-2 (2.55e-2) =	3.1777e-2 (2.27e-2)
LIRC-MOP3	2.3443e-1 (3.69e-2) -	1.9910e-1 (5.82e-2) =	2.0504e-1 (5.76e-2)	1.5478e-1 (2.72e-2) =	1.8096e-1 (4.98e-2) -	1.4124e-1 (4.18e-2)	2.3316e-1 (3.65e-2) -	1.9143e-1 (3.96e-2) =	2.0513e-1 (4.35e-2)	7.5469e-2 (6.69e-2) =	1.0799e-1 (7.33e-2) =	7.0081e-2 (6.30e-2)
LIRC-MOP4	1.7442e-1 (2.52e-2) -	1.4389e-1 (4.17e-2) =	1.5243e-1 (3.14e-2)	1.2905e-1 (1.85e-2) =	1.3605e-1 (2.80e-2) =	1.1815e-1 (2.28e-2)	1.6946e-1 (2.33e-2) -	1.4408e-1 (3.71e-2) =	1.4234e-1 (3.22e-2)	5.4615e-2 (4.14e-2) =	7.5154e-2 (5.57e-2) =	7.2644e-2 (5.09e-2)
LIRC-MOP5	2.2476e-1 (6.78e-2) -	2.0866e-2 (7.30e-3) -	1.4657e-2 (6.31e-3)	2.5473e-1 (5.36e-2) -	2.6887e-1 (5.63e-2) =	2.5638e-1 (4.66e-2)	2.0538e-1 (3.45e-2) -	3.0793e-2 (1.80e-2) -	1.9500e-2 (1.83e-2)	8.0751e-3 (3.63e-3) -	8.6841e-3 (2.93e-3) -	7.2731e-3 (2.14e-3)
LIRC-MOP6	2.5029e-1 (4.84e-2) -	2.1977e-2 (3.24e-2) =	1.1160e-2 (1.55e-3)	2.9855e-1 (4.39e-2) =	2.9144e-1 (5.96e-2) =	2.9540e-1 (6.39e-2)	2.4431e-1 (4.52e-2) -	2.3334e-2 (3.09e-2) -	1.1651e-2 (2.33e-3)	2.8781e-2 (3.37e-2) =	5.0511e-2 (3.98e-2) +	6.2842e-2 (2.43e-1)

TABLE S-XII

STATISTICAL RESULTS OF IGD+ OBTAINED BY CMOEA WITH ORIGINAL, RANDOM, AND DRL-ASSISTED ADAPTIVE SELECTION OPERATOR ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED (CONTINUED)

Problem	CCMO	RandOS-CCMO	DRLOS-CCMO	MOEADDAE	RandOS-MOEADDAE	DRLOS-MOEADDAE	EMCMO	RandOS-EMCMO	DRLOS-EMCMO	PPS	RandOS-PPS	DRLOS-PPS
LIRC-MOP7	9.1239e-2 (2.99e-2) −	1.5081e-2 (2.09e-2) −	7.7800e-3 (3.10e-3)	1.3007e-1 (2.21e-2) =	1.1938e-1 (2.74e-2) =	1.2048e-1 (3.04e-2)	1.0712e-1 (2.52e-2) −	2.0060e-2 (2.47e-2) −	9.5164e-3 (8.30e-3)	1.1256e-1 (1.25e-2) =	1.1412e-1 (1.41e-2) =	1.0937e-1 (2.11e-2)
LIRC-MOP8	1.4447e-1 (4.81e-2) −	8.5020e-3 (5.40e-3) −	6.9280e-3 (6.95e-4)	1.9543e-1 (3.03e-2) −	1.2699e-1 (3.45e-2) −	1.2194e-1 (2.96e-2)	1.4429e-1 (4.08e-2) −	8.0718e-3 (3.80e-3) −	7.0347e-3 (7.57e-4)	1.4862e-1 (4.52e-2)	1.7157e-1 (3.93e-2) =	1.6705e-1 (2.43e-2)
LIRC-MOP9	4.3127e-1 (1.51e-1) −	1.6588e-1 (1.69e-2) −	1.4893e-1 (3.47e-2)	1.4103e-1 (8.88e-2) +	2.7837e-1 (2.63e-1) −	2.3429e-1 (2.05e-1)	4.0913e-1 (1.17e-1) −	1.7451e-1 (1.32e-2) −	1.6668e-1 (2.37e-2)	2.2893e-1 (6.91e-2) −	2.2089e-1 (6.94e-2) =	2.0240e-1 (4.93e-2)
LIRC-MOP10	1.4788e-1 (4.04e-2) −	6.3123e-2 (2.79e-2) −	3.5973e-2 (2.44e-2)	5.9308e-2 (9.64e-2) =	1.0120e-1 (1.59e-1) =	1.1618e-1 (2.09e-1)	1.6303e-1 (6.91e-2) −	7.3316e-2 (2.56e-2) −	4.0278e-2 (2.44e-2)	2.2597e-1 (1.09e-1) =	1.6259e-1 (1.45e-1) =	1.9290e-1 (1.47e-1)
LIRC-MOP11	7.0190e-2 (3.82e-2) −	2.2508e-2 (2.37e-2) −	1.0432e-2 (9.45e-3)	7.4884e-2 (1.66e-1) =	9.8739e-2 (1.87e-1) =	1.2628e-1 (2.63e-1)	5.5770e-2 (4.04e-2) −	3.1932e-2 (1.83e-2) −	1.8288e-2 (1.42e-2)	2.0860e-1 (1.37e-1) =	1.6899e-1 (1.29e-1) =	1.3919e-1 (9.70e-2)
LIRC-MOP12	1.9425e-1 (8.37e-2) −	9.3404e-2 (3.22e-2) −	6.6395e-2 (2.30e-2)	8.9886e-2 (1.16e-1) +	1.7522e-1 (1.35e-1) −	1.3288e-1 (8.04e-2)	1.9852e-1 (6.40e-2) −	9.6753e-2 (1.42e-2) −	8.1841e-2 (2.49e-2)	1.4145e-1 (8.41e-2)	1.4171e-1 (5.75e-2) =	1.4758e-1 (5.88e-2)
LIRC-MOP13	4.5294e-2 (1.59e-3) +	7.4517e-2 (3.78e-3) −	7.4755e-2 (3.32e-3) −	4.3830e-2 (1.06e-3) −	4.3023e-2 (1.77e-3) =	4.2671e-2 (1.20e-3)	4.0744e-2 (1.27e-3) +	6.5324e-2 (3.80e-2) −	6.4215e-2 (3.36e-2)	8.9290e-2 (2.53e-2) −	6.4702e-2 (2.99e-2) =	6.3727e-2 (2.70e-2)
LIRC-MOP14	4.6427e-2 (1.18e-3) +	5.3804e-2 (2.34e-3) =	5.4903e-2 (1.88e-3)	4.7372e-2 (1.65e-3) +	4.9277e-2 (1.38e-3) =	4.8875e-2 (1.13e-3)	4.5456e-2 (1.35e-3) +	5.1693e-2 (1.89e-3) =	5.1796e-2 (1.80e-3)	6.5599e-2 (7.39e-3) −	5.7780e-2 (2.69e-3) −	5.7911e-2 (3.06e-3)
+/−/=	2/12/0	0/8/6	3/4/7	3/4/7	0/4/10		2/11/1	0/7/7		2/3/9	1/2/11	

TABLE S-XIII

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND OTHER METHODS ON CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	cDPEA	ToP	CMOEA_MS	BiCo	MFOSPEA2	ShiP_A	DSPCMDE	NSGAIIIToR	CCEA	DRLOS-EMCMO
CF1	5.5658e-1 (1.12e-3) −	5.6087e-1 (1.04e-3) −	5.2593e-1 (2.66e-2) −	5.4489e-1 (3.30e-3) −	5.5928e-1 (1.04e-3) −	5.5433e-1 (1.57e-3) −	5.5888e-1 (3.44e-3) −	3.2062e-3 (1.32e-2) −	5.5533e-1 (1.94e-3) −	5.5343e-1 (4.18e-4)
CF2	6.3602e-1 (1.79e-2) −	6.5364e-1 (4.34e-2) −	5.9150e-1 (3.24e-2) −	6.1353e-1 (2.78e-2) −	6.2392e-1 (2.29e-2) −	6.1535e-1 (2.13e-2) −	6.6024e-1 (8.97e-2) −	4.5094e-1 (7.80e-2) −	6.1092e-1 (2.40e-2) −	6.7170e-1 (3.41e-3)
CF3	1.9246e-1 (4.16e-2) ≈	1.2149e-1 (4.83e-2) −	1.8171e-1 (4.88e-2) −	1.8883e-1 (3.85e-2) ≈	1.8640e-1 (4.06e-2) −	1.8568e-1 (3.86e-2) +	2.6244e-1 (5.56e-2) +	0.0000e+0 (0.00e+0) −	1.8093e-1 (4.28e-2) ≈	2.0155e-1 (4.98e-2)
CF4	4.2389e-1 (3.13e-2) −	4.6080e-1 (1.84e-2) −	3.8539e-1 (4.99e-2) −	4.1150e-1 (3.55e-2) −	4.1614e-1 (4.07e-2) −	4.1531e-1 (2.79e-2) −	4.6331e-1 (1.04e-2) −	2.5524e-1 (4.81e-2) −	3.9955e-1 (3.72e-2) −	4.7513e-1 (1.12e-2)
CF5	2.9089e-1 (6.73e-2) −	1.9695e-1 (8.05e-2) −	2.7177e-1 (7.21e-2) −	2.6503e-1 (6.18e-2) −	2.8187e-1 (7.32e-2) −	2.9291e-1 (8.21e-2) −	2.9220e-1 (1.12e-1) ≈	7.2625e-2 (6.73e-2) −	2.3362e-1 (6.59e-2) −	3.3080e-1 (8.71e-2)
CF6	6.5388e-1 (1.61e-2) −	6.4202e-1 (1.50e-2) −	6.2368e-1 (1.65e-2) −	6.2804e-1 (1.94e-2) −	6.4731e-1 (2.26e-2) −	6.4962e-1 (1.71e-2) −	6.6840e-1 (7.87e-3) ≈	4.0838e-1 (2.80e-2) −	6.3510e-1 (1.85e-2) −	6.6654e-1 (6.98e-3)
CF7	4.2580e-1 (1.17e-1) −	4.3309e-1 (7.17e-2) −	4.0579e-1 (8.85e-2) −	4.3111e-1 (9.61e-2) −	4.6528e-1 (6.36e-2) −	4.2790e-1 (9.28e-2) −	5.2874e-1 (8.17e-2) ≈	1.7750e-1 (1.01e-1) −	4.2709e-1 (8.43e-2) −	4.9553e-1 (1.21e-1)
CF8	3.0192e-1 (6.61e-2) +	4.8490e-2 (2.71e-2) −	3.2683e-1 (3.80e-2) +	3.1265e-1 (5.14e-2) +	3.1785e-1 (1.01e-1) +	3.5795e-1 (4.45e-2) +	3.4026e-1 (1.37e-2) +	NaN (NaN)	3.6127e-1 (3.73e-2) +	2.9022e-1 (2.70e-2)
CF9	4.2221e-1 (3.26e-2) +	1.4626e-1 (6.89e-2) −	4.1236e-1 (2.52e-2) +	4.2063e-1 (2.72e-2) +	4.1693e-1 (3.50e-2) +	4.5072e-1 (1.28e-2) +	4.0996e-1 (1.15e-2) +	1.2773e-1 (5.80e-2) −	4.1757e-1 (4.63e-2) +	3.9006e-1 (2.07e-2)
CF10	1.3772e-1 (4.28e-2) ≈	0.0000e+0 (0.00e+0) −	2.1488e-1 (9.12e-2) +	1.2393e-1 (1.87e-2) −	1.6021e-1 (3.87e-2) ≈	1.2672e-1 (5.36e-2) −	1.5406e-1 (7.12e-2) −	NaN (NaN)	1.8637e-1 (8.50e-2) ≈	1.4939e-1 (5.13e-2)
+/−/≈	2/6/2	0/10/0	3/6/1	2/6/2	2/6/2	2/7/1	3/3/4	0/8/0	2/6/2	

TABLE S-XIV

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND OTHER METHODS ON CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	cDPEA	ToP	CMOEA_MS	BiCo	MFOSPEA2	ShiP_A	DSPCMDE	NSGAIIToR	CCEA	DRLOS-EMCMO
CF1	7.7129e-3 (9.07e-4) −	4.2893e-3 (8.54e-4) −	3.1069e-2 (1.88e-2) −	1.6688e-2 (2.57e-3) −	5.3899e-3 (7.63e-4) −	9.4716e-3 (1.28e-3) −	6.0356e-3 (2.89e-3) −	7.1825e-1 (1.28e-1) −	8.1834e-3 (1.48e-3) −	2.1957e-3 (3.45e-4)
CF2	2.8529e-2 (1.10e-2) −	2.9227e-2 (6.66e-2) −	4.5046e-2 (1.36e-2) −	3.9931e-2 (1.20e-2) −	3.5098e-2 (1.28e-2) −	3.6964e-2 (9.01e-2) −	1.3966e-2 (7.41e-3) −	1.5274e-1 (9.43e-2) −	4.3673e-2 (1.25e-2) −	6.7656e-3 (2.69e-3)
CF3	2.0522e-1 (9.00e-2) ≈	2.5173e-1 (7.40e-2) −	2.4200e-1 (1.02e-1) ≈	2.0995e-1 (6.47e-2) ≈	2.4342e-1 (9.82e-2) ≈	1.9776e-1 (5.74e-2) ≈	1.0023e-1 (5.92e-2) +	1.0365e+0 (1.70e-1) −	2.3013e-1 (7.18e-2) −	1.8764e-1 (6.02e-2)
CF4	7.2643e-2 (2.34e-2) −	5.2251e-2 (1.44e-2) −	1.0907e-1 (5.30e-2) −	8.1102e-2 (2.47e-2) −	7.6929e-2 (2.78e-2) −	7.7605e-2 (2.09e-2) −	4.8040e-2 (6.23e-3) −	2.3304e-1 (6.55e-2) −	9.1881e-2 (3.19e-2) −	4.0393e-2 (7.07e-3)
CF5	2.0289e-1 (8.19e-2) ≈	3.1055e-1 (1.06e-1) −	2.2655e-1 (9.00e-2) −	2.3689e-1 (8.23e-2) −	2.1359e-1 (9.38e-2) −	2.0771e-1 (1.02e-1) ≈	2.1429e-1 (1.21e-1) ≈	5.1751e-1 (1.53e-1) −	2.7699e-1 (8.44e-2) −	1.6987e-1 (9.96e-2)
CF6	3.6220e-2 (1.60e-2) ≈	4.8500e-2 (1.40e-2) −	6.5405e-2 (1.76e-2) −	6.0665e-2 (1.96e-2) −	4.1211e-2 (2.34e-2) −	3.9738e-2 (1.77e-2) −	2.7855e-2 (6.05e-3) ≈	2.7328e-1 (3.78e-2) −	5.2152e-2 (1.87e-2) −	2.8311e-2 (5.73e-3)
CF7	2.0884e-1 (1.37e-1) −	2.1338e-1 (8.51e-2) −	2.2300e-1 (9.45e-2) −	2.0416e-1 (1.03e-1) −	1.5994e-1 (5.81e-2) −	2.1532e-1 (1.05e-1) −	1.1945e-1 (9.09e-2) ≈	4.9911e-1 (1.46e-1) −	1.9868e-1 (8.77e-2) −	1.4147e-1 (1.10e-1)
CF8	1.4889e-1 (4.26e-2) +	6.0045e-1 (7.17e-2) −	1.7275e-1 (8.07e-2) ≈	1.4885e-1 (3.31e-2) +	1.4999e-1 (7.00e-2) +	1.3344e-1 (6.58e-2) +	1.4442e-1 (1.89e-2) +	NaN (NaN)	1.3137e-1 (2.76e-2) +	1.6727e-1 (2.80e-2)
CF9	6.4008e-2 (1.44e-2) +	3.0551e-1 (8.81e-2) −	6.4967e-2 (1.12e-2) +	6.2269e-2 (1.16e-2) +	6.5014e-2 (1.62e-2) +	4.7019e-2 (3.79e-3) +	8.4804e-2 (1.07e-2) ≈	3.7620e-1 (1.58e-1) −	6.0017e-2 (2.02e-2) +	8.4547e-2 (1.32e-2)
CF10	3.7491e-1 (1.30e-1) −	1.3702e+0 (6.71e-1) −	2.5958e-1 (1.54e-1) ≈	4.4595e-1 (8.47e-2) −	2.7825e-1 (9.47e-2) −	3.8785e-1 (1.20e-1) −	2.8277e-1 (9.71e-2) ≈	NaN (NaN)	2.8017e-1 (1.52e-1) ≈	2.6734e-1 (7.38e-2)
+/−/≈	2/5/3	0/10/0	1/6/3	2/7/1	2/6/2	2/6/2	2/3/5	0/8/0	2/7/1	

TABLE S-XV

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND OTHER METHODS ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	cDPEA	ToP	CMOEA_MS	BiCo	MFOSPEA2	ShiP_A	DSPCMDE	NSGAIIToR	CCEA	DRLOS-EMCMO
DASCMOP1	1.8732e-2 (2.22e-2) −	2.8266e-3 (5.95e-3) −	7.3099e-3 (5.60e-3) −	6.9763e-3 (6.09e-3) −	8.4924e-3 (1.14e-2) −	2.1072e-1 (1.30e-3) ≈	2.1067e-1 (8.36e-4) −	6.7194e-4 (1.81e-2) −	4.3836e-2 (3.03e-2) −	2.1122e-1 (7.81e-4)
DASCMOP2	2.6019e-1 (4.41e-3) −	5.3711e-2 (6.73e-2) −	2.5363e-1 (4.56e-3) −	2.4798e-1 (3.94e-3) −	2.5787e-1 (3.80e-3) −	3.3074e-1 (1.07e-2) −	3.5376e-1 (2.36e-4) −	1.0541e-1 (9.81e-2) −	2.7343e-1 (4.44e-3) −	3.5405e-1 (2.67e-4)
DASCMOP3	2.1550e-1 (1.44e-2) −	1.8624e-2 (1.18e-2) −	2.1027e-1 (8.20e-3) −	2.0985e-1 (2.91e-3) −	2.1796e-1 (1.75e-2) −	2.5611e-1 (1.43e-3) −	3.1051e-1 (6.06e-4) ≈	1.3266e-2 (1.12e-2) −	2.2813e-1 (1.43e-2) −	3.0916e-1 (2.89e-3)
DASCMOP4	2.0212e-1 (3.95e-3) +	NaN (NaN)	1.4965e-1 (5.43e-2) ≈	1.2292e-1 (6.80e-2) −	2.0081e-1 (3.79e-3) +	1.9097e-1 (1.38e-2) −	7.2610e-2 (9.29e-2) −	NaN (NaN)	1.5444e-1 (5.10e-2) ≈	1.7883e-1 (4.36e-2)
DASCMOP5	3.5129e-1 (1.70e-4) +	NaN (NaN)	2.7920e-1 (1.14e-1) ≈	3.0828e-1 (1.02e-1) −	3.5092e-1 (1.95e-4) +	3.4603e-1 (1.24e-2) ≈	2.0973e-2 (1.95e-2) −	NaN (NaN)	2.2154e-1 (1.16e-1) ≈	3.4533e-1 (1.26e-2)
DASCMOP6	3.0851e-1 (6.83e-3) +	NaN (NaN)	1.5495e-1 (1.15e-1) −	2.3832e-1 (8.91e-2) −	3.0687e-1 (1.09e-2) +	2.7602e-1 (5.14e-2) ≈	4.1780e-2 (6.89e-2) −	NaN (NaN)	1.8559e-1 (1.04e-1) −	2.9414e-1 (3.54e-2)
DASCMOP7	2.8748e-1 (4.24e-4) +	NaN (NaN)	2.8634e-1 (1.33e-2) +	2.8639e-1 (1.70e-3) +	2.8558e-1 (3.75e-3) +	2.8222e-1 (8.21e-4) +	3.1514e-1 (5.48e-2) −	NaN (NaN)	2.8833e-1 (2.56e-4) +	2.3065e-1 (6.40e-2)
DASCMOP8	2.0634e-1 (5.18e-4) +	NaN (NaN)	2.0719e-1 (2.04e-3) +	2.0567e-1 (9.58e-4) +	2.0599e-1 (4.80e-4) +	2.0063e-1 (1.05e-3) −	3.6811e-2 (8.17e-2) −	NaN (NaN)	2.0740e-1 (2.89e-4) +	1.9030e-1 (2.98e-2)
DASCMOP9	1.4508e-1 (1.35e-2) −	6.2276e-2 (1.86e-2) −	1.2081e-1 (1.23e-2) −	1.2152e-1 (1.07e-2) −	1.2333e-1 (1.09e-2) −	1.6319e-1 (1.79e-2) −	2.0184e-1 (9.47e-4) −	5.4047e-2 (8.89e-3) −	1.3031e-1 (1.44e-2) −	2.0477e-1 (4.38e-4)
+/−/≈	5/4/0	0/4/0	2/5/2	2/7/0	5/4/0	1/3/5	0/8/1	0/4/0	2/5/2	

TABLE S-XVI

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND OTHER METHODS ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	cDPEA	ToP	CMOEA_MS	BiCo	MFOSPEA2	ShiP_A	DSPCMDE	NSGAIIIToR	CCEA	DRLOS-EMCMO
DASCMOP1	6.6998e-1 (8.82e-2) −	7.8498e-1 (4.49e-2) −	7.2588e-1 (2.72e-2) −	7.2948e-1 (2.99e-2) −	7.1957e-1 (4.97e-2) −	3.5427e-3 (2.03e-3) −	2.9471e-3 (2.81e-4) −	8.0346e-1 (2.55e-2) −	5.6058e-1 (1.10e-1) −	2.5278e-3 (2.52e-4)
DASCMOP2	1.3734e-1 (1.06e-2) −	6.8157e-1 (1.95e-1) −	1.5178e-1 (1.15e-2) −	1.5159e-1 (7.45e-3) −	1.4294e-1 (8.96e-3) −	4.2327e-2 (2.03e-2) −	5.0215e-3 (2.49e-4) −	5.2973e-1 (2.79e-1) −	1.1956e-1 (1.48e-2) −	4.5000e-3 (2.92e-4)
DASCMOP3	1.7784e-1 (2.39e-2) −	7.4714e-1 (5.24e-2) −	1.9017e-1 (1.66e-2) −	1.8897e-1 (9.75e-3) −	1.7895e-1 (3.14e-2) −	1.1013e-1 (5.63e-3) −	7.1776e-3 (6.26e-4) ≈	7.7001e-1 (6.16e-2) −	1.5701e-1 (2.77e-2) −	9.2764e-3 (5.89e-3)
DASCMOP4	1.2125e-3 (1.04e-3) +	NaN (NaN)	1.4264e-1 (1.47e-1) −	2.0742e-1 (2.03e-1) −	1.5737e-3 (9.34e-4) +	9.5947e-3 (1.60e-2) −	3.7463e-1 (2.91e-1) −	NaN (NaN)	1.0434e-1 (1.29e-1) −	4.5370e-2 (1.05e-1)
DASCMOP5	1.9632e-3 (1.06e-4) +	NaN (NaN)	1.2462e-1 (2.00e-1) ≈	8.7495e-2 (2.13e-1) −	2.2352e-3 (1.58e-4) +	8.2728e-3 (1.57e-2) −	8.3516e-1 (1.63e-1) −	NaN (NaN)	2.1358e-1 (1.96e-1) ≈	9.7416e-3 (1.92e-2)
DASCMOP6	1.0136e-2 (1.05e-2) +	NaN (NaN)	3.1592e-1 (2.50e-1) −	1.4387e-1 (1.91e-1) −	1.1485e-2 (1.51e-2) +	6.3037e-2 (9.73e-2) −	6.8604e-1 (2.16e-1) −	NaN (NaN)	2.3778e-1 (1.91e-1) −	3.8780e-2 (7.10e-2)
DASCMOP7	2.4738e-2 (1.26e-3) +	NaN (NaN)	2.8169e-2 (2.81e-2) +	2.5818e-2 (2.04e-2) +	2.6814e-2 (5.67e-3) +	3.6974e-2 (2.48e-3) +	8.9934e-1 (2.97e-1) −	NaN (NaN)	2.4691e-2 (9.93e-4) +	1.4519e-1 (1.45e-1)
DASCMOP8	1.9692e-2 (7.63e-4) +	NaN (NaN)	1.8937e-2 (2.69e-3) +	1.9943e-2 (1.43e-3) +	1.9682e-2 (9.47e-4) +	2.8019e-2 (1.43e-3) ≈	7.2091e-1 (3.70e-1) −	NaN (NaN)	1.6407e-2 (4.93e-4) +	4.6088e-2 (5.16e-2)
DASCMOP9	1.9194e-1 (3.92e-2) −	4.6070e-1 (7.33e-2) −	2.6686e-1 (4.32e-2) −	2.6292e-1 (3.86e-2) −	2.5745e-1 (3.68e-2) −	1.3462e-1 (5.57e-2) −	2.7404e-2 (1.71e-3) −	4.8719e-1 (4.10e-2) −	2.3632e-1 (4.56e-2) −	2.1323e-2 (1.10e-3)
+/−/≈	5/4/0	0/4/0	2/6/1	2/7/0	5/4/0	1/5/3	0/8/1	0/4/0	2/5/2	

TABLE S-XVII

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND OTHER METHODS ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	cDPEA	ToP	CMOEA_MS	BiCo	MFOSPEA2	ShiP_A	DSPCMDE	NSGAIIIToR	CCEA	DRLOS-EMCMO
DOC1	1.3395e-1 (1.38e-1) −	3.4448e-1 (3.95e-4) −	1.6534e-2 (5.39e-2) −	3.2443e-1 (2.97e-2) −	2.7835e-1 (9.41e-2) −	7.4260e-3 (2.67e-2) −	1.9027e-1 (1.75e-1) −	0.0000e+0 (0.00e+0) −	4.2700e-2 (7.97e-2) −	3.4550e-1 (5.73e-4)
DOC2	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	3.5968e-1 (8.27e-2) −	NaN (NaN)	NaN (NaN)	5.7595e-1 (7.72e-2)
DOC3	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	NaN (NaN)	1.8273e-1 (1.55e-1) +	NaN (NaN)	0.0000e+0 (0.00e+0) ≈	9.1084e-3 (3.06e-2)
DOC4	1.3355e-1 (1.54e-1) −	4.3864e-1 (8.74e-2) ≈	9.7308e-2 (1.47e-1) −	3.1494e-1 (1.53e-1) −	2.4730e-1 (1.64e-1) −	1.0502e-1 (1.36e-1) −	5.1522e-1 (8.05e-2) −	0.0000e+0 (0.00e+0) −	8.4827e-2 (1.12e-1) −	5.1684e-1 (4.06e-2)
DOC5	NaN (NaN)	1.4277e-1 (1.44e-1) −	0.0000e+0 (0.00e+0) −	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	3.8120e-1 (1.79e-1)
DOC6	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	3.9626e-2 (8.00e-2) −	1.1741e-1 (1.75e-1) −	1.2769e-1 (1.80e-1) −	3.7426e-2 (9.14e-2) −	5.2262e-1 (5.76e-3) +	0.0000e+0 (0.00e+0) −	2.0887e-2 (7.04e-2) −	5.0181e-1 (4.65e-2)
DOC7	0.0000e+0 (0.00e+0) −	1.4202e-2 (4.03e-2) −	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	NaN (NaN)	3.7316e-1 (1.90e-1) ≈	NaN (NaN)	0.0000e+0 (0.00e+0) −	3.9080e-1 (1.88e-1)
DOC8	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	5.9770e-1 (7.72e-2) +	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	5.2609e-1 (1.17e-1)
DOC9	NaN (NaN)	0.0000e+0 (0.00e+0) −	NaN (NaN)	NaN (NaN)	NaN (NaN)	0.0000e+0 (0.00e+0) −	NaN (NaN)	0.0000e+0 (0.00e+0) −	NaN (NaN)	NaN (NaN)
+/−/≈	0/5/1	0/5/2	0/6/1	0/5/1	0/5/1	0/4/0	3/3/1	0/4/0	0/5/1	

TABLE S-XVIII
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND OTHER METHODS ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

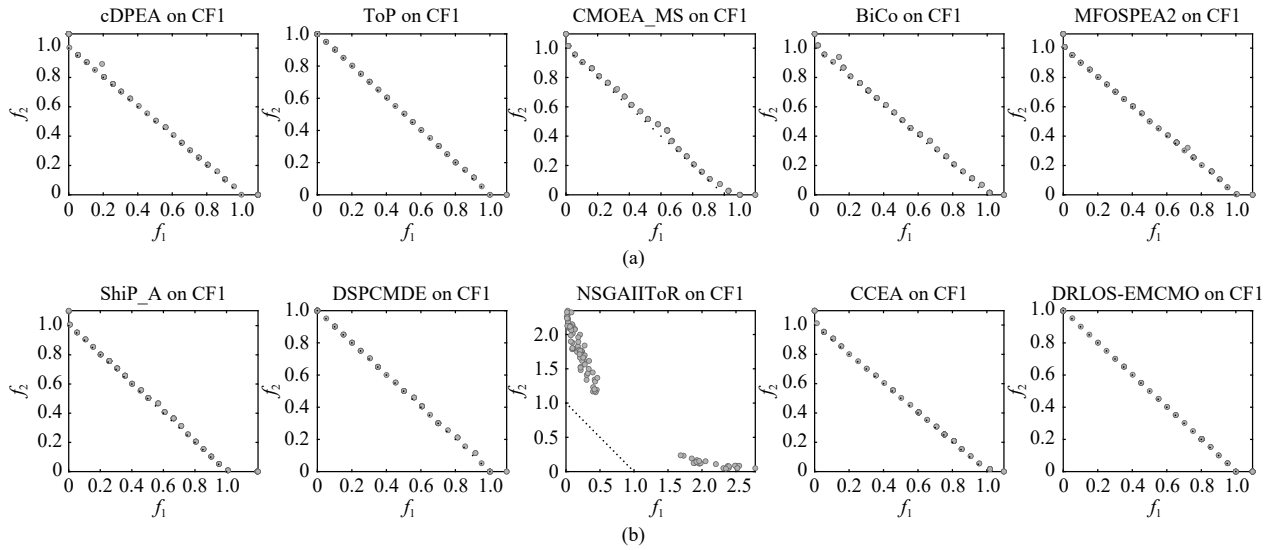| Problem	cDPEA	ToP	CMOEA_MS	BiCo	MFOSPEA2	ShiP_A	DSPCMDE	NSGAIIToR	CCEA	DRLOS-EMCMO
LIRCMOP1	1.2403e-1 (2.41e-2) +	2.6908e-1 (1.24e-2) −	2.6863e-1 (2.88e-2) −	1.8877e-1 (1.29e-2) ≈	2.0330e-1 (3.21e-2) −	1.3430e-2 (2.12e-3) +	8.8595e-2 (6.88e-2) +	2.9254e-1 (6.62e-3) −	1.2691e-1 (2.79e-2) +	1.7898e-1 (3.70e-2)
LIRCMOP2	8.7138e-2 (2.37e-2) +	1.8675e-1 (1.79e-2) −	1.7704e-1 (3.53e-2) −	1.2021e-1 (1.47e-2) ≈	1.2603e-1 (2.32e-2) −	1.5913e-2 (2.29e-3) +	5.1308e-2 (3.25e-2) +	2.0604e-1 (6.43e-3) −	7.2553e-2 (1.54e-2) +	1.1141e-1 (3.32e-2)
LIRCMOP3	1.3383e-1 (3.95e-2) +	2.8289e-1 (8.18e-3) −	2.5770e-1 (3.83e-2) −	1.8451e-1 (1.93e-2) +	2.0576e-1 (2.55e-2) ≈	3.3024e-2 (1.63e-2) +	1.0719e-1 (6.88e-2) +	2.8717e-1 (4.41e-3) −	1.2131e-1 (2.97e-2) +	2.0513e-1 (4.35e-2)
LIRCMOP4	9.7340e-2 (2.13e-2) +	2.0780e-1 (1.41e-2) −	1.9513e-1 (2.59e-2) −	1.3883e-1 (2.10e-2) ≈	1.4174e-1 (1.88e-2) ≈	3.6291e-2 (1.26e-2) +	7.8437e-2 (4.19e-2) +	2.1274e-1 (9.59e-3) −	8.7309e-2 (1.97e-2) +	1.4234e-1 (3.22e-2)
LIRCMOP5	2.2457e-1 (5.42e-2) −	1.2177e+0 (1.74e-2) −	5.0298e-1 (4.42e-1) −	1.2253e+0 (4.75e-3) −	2.4418e-1 (5.77e-2) −	2.3968e-1 (3.64e-2) −	5.0015e-2 (5.96e-2) −	2.6069e+0 (2.22e-1) −	6.2853e-2 (4.90e-1) −	1.9500e-2 (1.83e-2)
LIRCMOP6	2.8106e-1 (5.32e-2) −	1.2792e+0 (2.58e-1) −	6.7749e-1 (5.18e-1) −	1.3454e+0 (2.38e-4) −	2.6070e-1 (5.90e-2) −	3.0260e-1 (4.72e-2) −	9.2812e-2 (1.04e-1) −	2.8071e+0 (2.39e-1) −	7.7027e-1 (5.12e-1) −	1.1651e-2 (2.33e-3)
LIRCMOP7	9.5239e-2 (1.85e-2) −	1.5832e+0 (3.79e-1) −	1.1196e-1 (1.74e-2) −	5.8579e-1 (7.30e-1) −	9.3596e-2 (2.17e-2) −	1.0521e-1 (2.47e-2) −	1.4314e-2 (2.23e-2) −	3.1200e+0 (5.81e-1) −	1.1390e-1 (1.79e-2) −	9.5164e-3 (8.30e-3)
LIRCMOP8	1.5235e-1 (3.72e-2) −	1.5964e+0 (3.31e-1) −	1.8321e-1 (3.59e-2) −	1.2861e+0 (6.67e-1) −	1.4969e-1 (4.47e-2) −	1.6006e-1 (4.94e-2) −	8.3797e-3 (6.98e-4) −	3.2079e+0 (6.59e-1) −	1.9385e-1 (2.68e-2) −	7.0347e-3 (7.57e-4)
LIRCMOP9	3.2726e-1 (1.22e-1) −	4.1989e-1 (1.56e-1) −	5.9821e-1 (1.50e-1) −	9.5151e-1 (9.96e-2) −	4.4247e-1 (1.28e-1) −	3.2816e-1 (1.12e-1) −	3.1537e-1 (5.99e-2) −	1.2718e+0 (5.94e-2) −	6.6508e-1 (2.24e-1) −	1.6668e-1 (2.37e-2)
LIRCMOP10	2.4101e-1 (7.37e-2) −	3.5560e-1 (1.07e-1) −	4.5754e-1 (2.07e-1) −	9.7615e-1 (8.57e-2) −	2.7850e-1 (1.33e-1) −	4.5351e-1 (1.11e-1) −	1.7325e-1 (4.53e-2) −	1.0203e+0 (1.29e-1) −	8.6966e-1 (1.75e-1) −	4.0278e-2 (2.44e-2)
LIRCMOP11	8.9537e-2 (4.02e-2) −	3.9818e-1 (1.27e-1) −	4.2018e-1 (1.88e-1) −	7.9642e-1 (2.01e-1) −	1.1309e-1 (4.80e-2) −	3.1501e-1 (1.31e-1) −	9.7876e-2 (7.48e-2) −	1.2507e+0 (1.44e-1) −	6.2227e-1 (3.00e-1) −	1.8288e-2 (1.42e-2)
LIRCMOP12	1.7629e-1 (8.02e-2) −	2.2707e-1 (5.92e-2) −	3.4336e-1 (1.31e-1) −	5.9633e-1 (2.23e-1) −	1.7988e-1 (8.06e-2) −	1.9305e-1 (3.91e-2) −	1.7048e-1 (7.13e-2) −	1.3836e+0 (8.33e-2) −	4.7603e-1 (1.84e-1) −	8.1841e-2 (2.49e-2)
LIRCMOP13	4.4400e-2 (1.70e-3) +	1.3312e+0 (7.73e-2) −	4.9425e-2 (3.10e-2) +	1.3168e+0 (1.70e-3) −	1.3153e+0 (2.11e-3) −	4.4696e-2 (1.34e-3) +	8.5630e-2 (2.13e-3) −	1.4689e+0 (3.58e-2) −	4.0942e-2 (7.19e-4) +	6.4215e-2 (3.36e-3)
LIRCMOP14	4.6074e-2 (1.26e-3) +	1.2912e+0 (6.38e-2) −	4.4592e-2 (1.12e-3) +	1.2738e+0 (2.44e-3) −	1.2720e+0 (1.66e-3) −	5.3272e-2 (2.65e-3) ≈	6.1984e-2 (2.27e-3) −	1.4403e+0 (3.05e-2) −	4.2491e-2 (6.80e-4) +	5.1796e-2 (1.80e-3)
+/−/≈	6/8/0	0/14/0	2/12/0	1/10/3	0/11/3	5/8/1	4/10/0	0/14/0	6/8/0	

(a)

(b)

Fig. S-I.   The final solution sets obtained by DRLOS-EMCMO and other methods on CF1 with the median IGD+ value among 30 runs.
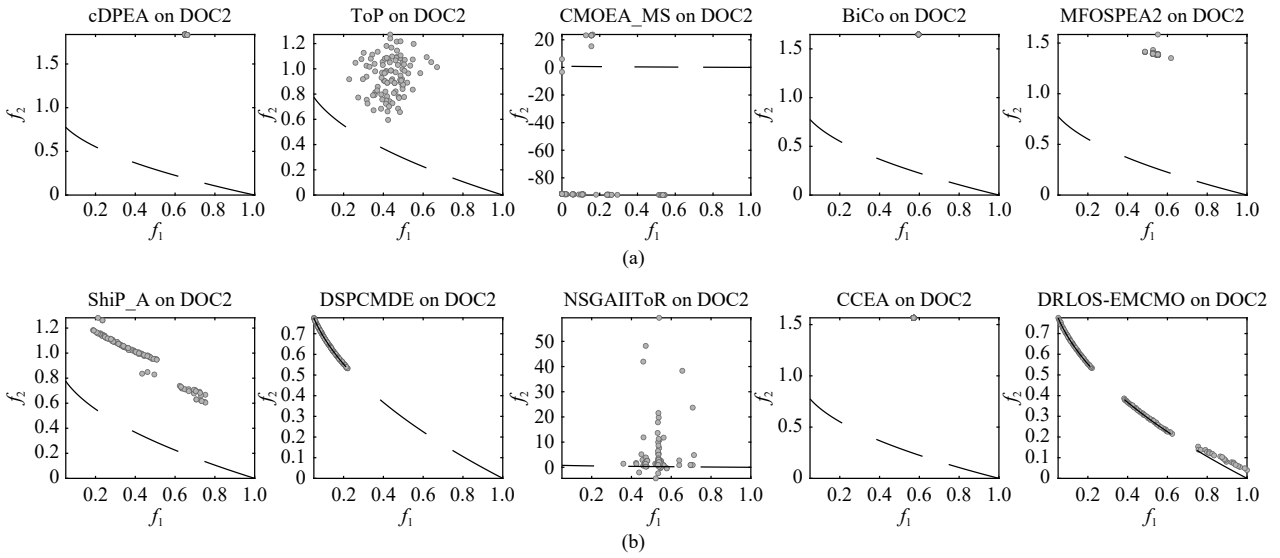

(a)

(b)

Fig. S-II.   The final solution sets obtained by DRLOS-EMCMO and other methods on DOC2 with the median IGD+ value among 30 runs.
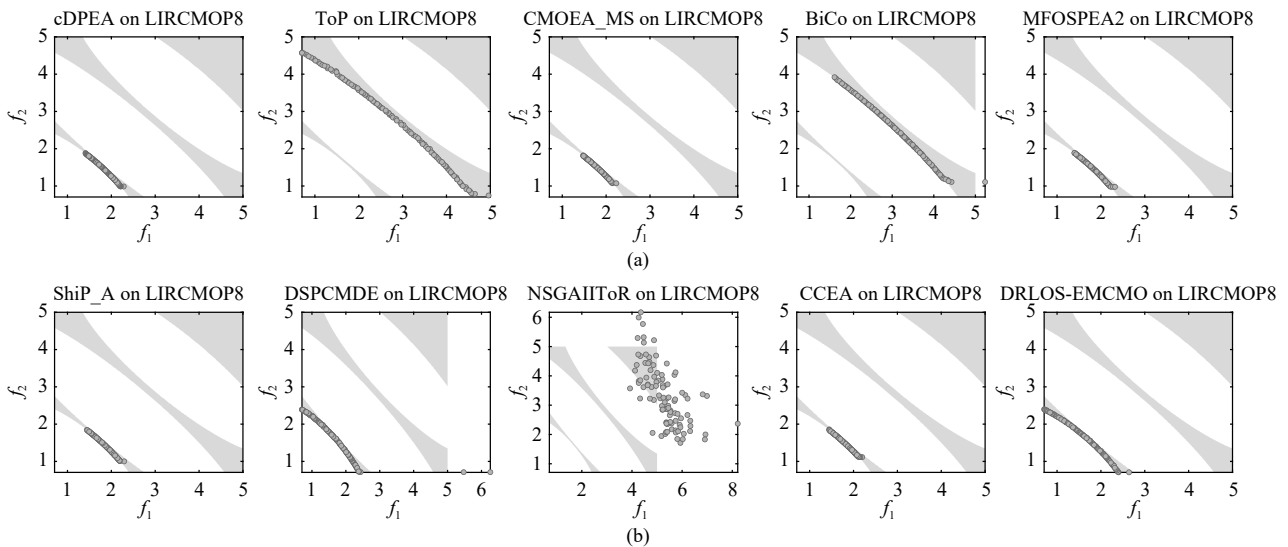

(a)

(b)

Fig. S-III.   The final solution sets obtained by DRLOS-EMCMO and other methods on LIR-CMOP8 with the median IGD+ value among 30 runs.

TABLE S-XIX
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON CF
BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
CF1	5.6313e−1 (5.10e−4) ≈	5.6326e−1 (4.35e−4) ≈	5.6326e−1 (4.64e−4) ≈	5.6328e−1 (4.58e−4) ≈	5.6333e−1 (4.50e−4)
CF2	6.7262e−1 (2.80e−3) ≈	6.7270e−1 (3.04e−3) ≈	6.7335e−1 (2.19e−3) ≈	6.7309e−1 (2.60e−3) ≈	6.7309e−1 (1.88e−3)
CF3	1.9107e−1 (4.58e−2) ≈	1.8652e−1 (5.14e−2) ≈	1.9817e−1 (5.39e−2) ≈	2.0581e−1 (5.69e−2) ≈	2.1030e−1 (5.76e−2)
CF4	4.8432e−1 (1.48e−2) ≈	4.7787e−1 (1.22e−2) −	4.7701e−1 (1.34e−2) −	4.7899e−1 (1.46e−2) ≈	4.8483e−1 (1.28e−2)
CF5	2.7989e−1 (7.00e−2) ≈	3.0365e−1 (8.79e−2) ≈	3.2459e−1 (8.53e−2) ≈	3.1269e−1 (7.62e−2) ≈	3.1494e−1 (7.42e−2)
CF6	6.6929e−1 (4.95e−3) ≈	6.7030e−1 (5.08e−3) ≈	6.7094e−1 (4.23e−3) ≈	6.7231e−1 (4.40e−3) ≈	6.7057e−1 (5.86e−3)
CF7	5.1362e−1 (9.61e−2) ≈	4.7874e−1 (1.20e−1) ≈	5.1654e−1 (9.05e−2) ≈	4.9327e−1 (9.46e−2) ≈	4.8910e−1 (1.01e−1)
CF8	3.1393e−1 (4.27e−2) ≈	3.0967e−1 (2.95e−2) ≈	3.0538e−1 (3.50e−2) ≈	3.0764e−1 (2.98e−2) ≈	3.0556e−1 (2.74e−2)
CF9	3.9848e−1 (1.73e−2) ≈	4.0345e−1 (1.59e−2) ≈	3.9965e−1 (2.04e−2) ≈	4.0053e−1 (2.28e−2) ≈	4.0291e−1 (1.59e−2)
CF10	1.5595e−1 (5.55e−2) ≈	1.6414e−1 (5.29e−2) ≈	1.7294e−1 (6.44e−2) ≈	1.6885e−1 (4.95e−2) ≈	1.6093e−1 (5.26e−2)
+/ − / ≈	0/0/10	0/1/9	0/1/9	0/0/10	

TABLE S-XX
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON CF
BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
CF1	2.4401e−3 (4.20e−4) ≈	2.3324e−3 (3.58e−4) ≈	2.3395e−3 (3.82e−4) ≈	2.3216e−3 (3.77e−4) ≈	2.2811e−3 (3.70e−4)
CF2	6.3114e−3 (2.44e−3) ≈	6.5549e−3 (2.61e−3) ≈	5.9054e−3 (1.74e−3) ≈	5.9451e−3 (1.93e−3) ≈	6.3466e−3 (1.96e−3)
CF3	1.9711e−1 (5.89e−2) ≈	2.1521e−1 (8.31e−2) ≈	1.8086e−1 (6.51e−2) ≈	1.7296e−1 (6.68e−2) ≈	1.7704e−1 (7.03e−2)
CF4	3.4523e−2 (9.24e−3) ≈	3.8861e−2 (7.70e−3) −	3.8486e−2 (8.91e−3) −	3.7709e−2 (9.26e−3) ≈	3.3520e−2 (8.10e−3)
CF5	2.2445e−1 (8.30e−2) −	1.9674e−1 (9.50e−2) ≈	1.7811e−1 (9.59e−2) ≈	1.8555e−1 (7.91e−2) ≈	1.8182e−1 (8.01e−2)
CF6	2.4944e−2 (2.99e−3) ≈	2.4869e−2 (3.14e−3) ≈	2.4370e−2 (3.10e−3) ≈	2.3615e−2 (2.89e−3) ≈	2.4233e−2 (3.99e−3)
CF7	1.2049e−1 (6.61e−2) ≈	1.5654e−1 (1.12e−1) ≈	1.1849e−1 (7.21e−2) ≈	1.5000e−1 (1.02e−1) ≈	1.5000e−1 (9.75e−2)
CF8	1.5428e−1 (3.81e−2) ≈	1.5034e−1 (1.79e−2) ≈	1.5019e−1 (2.09e−2) ≈	1.5129e−1 (2.33e−2) ≈	1.5084e−1 (2.12e−2)
CF9	8.0620e−2 (1.08e−2) ≈	7.6238e−2 (8.76e−3) ≈	7.9969e−2 (1.48e−2) ≈	8.2433e−2 (1.39e−2) ≈	7.7920e−2 (1.03e−2)
CF10	2.8053e−1 (1.16e−1) ≈	2.5240e−1 (9.50e−2) ≈	2.5593e−1 (7.98e−2) ≈	2.4273e−1 (8.67e−2) ≈	2.7362e−1 (6.37e−2)
+/ − / ≈	0/1/9	0/1/9	0/1/9	0/0/10	

TABLE S-XXI
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
DASCMOP1	2.1124e−1 (7.89e−4) ≈	2.1129e−1 (8.92e−4) ≈	2.1141e−1 (7.29e−4) ≈	2.1115e−1 (6.40e−4) ≈	2.1129e−1 (8.92e−4)
DASCMOP2	3.5429e−1 (2.18e−4) ≈	3.5430e−1 (2.45e−4) ≈	3.5424e−1 (2.60e−4) ≈	3.5424e−1 (2.47e−4) ≈	3.5432e−1 (2.42e−4)
DASCMOP3	3.0450e−1 (2.26e−2) ≈	3.1035e−1 (1.57e−3) ≈	3.1026e−1 (2.15e−3) ≈	3.0951e−1 (3.78e−3) ≈	3.1042e−1 (1.00e−3)
DASCMOP4	1.4628e−1 (6.33e−2) ≈	1.9108e−1 (1.95e−2) +	1.7079e−1 (5.16e−2) ≈	1.6561e−1 (5.41e−2) ≈	1.5188e−1 (6.24e−2)
DASCMOP5	3.1633e−1 (7.35e−2) −	3.1278e−1 (6.79e−2) ≈	3.0629e−1 (8.09e−2) ≈	3.0721e−1 (8.19e−2) ≈	3.1731e−1 (5.25e−2)
DASCMOP6	2.0425e−1 (1.11e−1) ≈	2.5745e−1 (8.18e−2) ≈	2.3598e−1 (9.61e−2) ≈	2.3209e−1 (1.02e−1) ≈	2.4675e−1 (9.47e−2)
DASCMOP7	1.9169e−1 (9.04e−2) −	2.2271e−1 (8.07e−2) ≈	2.4862e−1 (6.12e−2) ≈	2.1926e−1 (7.87e−2) ≈	2.4177e−1 (7.17e−2)
DASCMOP8	1.6252e−1 (6.50e−2) ≈	1.6380e−1 (7.02e−2) ≈	1.6645e−1 (5.67e−2) ≈	1.6713e−1 (5.35e−2) ≈	1.6314e−1 (5.34e−2)
DASCMOP9	2.0478e−1 (5.25e−4) ≈	2.0485e−1 (4.49e−4) ≈	2.0480e−1 (6.30e−4) ≈	2.0478e−1 (4.47e−4) ≈	2.0480e−1 (4.20e−4)
+/ − / ≈	0/2/7	1/0/8	0/0/9	0/0/9	

TABLE S-XXII
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
DASCMOP1	2.5568e−3 (2.22e−4) ≈	2.5116e−3 (2.52e−4) ≈	2.5069e−3 (1.93e−4) ≈	2.5644e−3 (1.69e−4) ≈	2.6347e−3 (8.06e−4)
DASCMOP2	4.3532e−3 (2.44e−4) ≈	4.3195e−3 (2.47e−4) ≈	4.3355e−3 (2.78e−4) ≈	4.3281e−3 (2.64e−4) ≈	4.3054e−3 (2.53e−4)
DASCMOP3	1.8564e−2 (4.42e−2) ≈	7.0518e−3 (1.39e−3) ≈	6.9911e−3 (1.58e−3) ≈	7.7017e−3 (2.82e−3) ≈	6.8896e−3 (8.38e−4)
DASCMOP4	1.2132e−1 (1.72e−1) ≈	1.2068e−2 (2.50e−2) +	6.3115e−2 (1.34e−1) ≈	7.5748e−2 (1.39e−1) ≈	1.1334e−1 (1.76e−1)
DASCMOP5	5.9108e−2 (1.32e−1) −	6.1598e−2 (1.11e−1) ≈	7.3702e−2 (1.37e−1) ≈	7.8455e−2 (1.65e−1) ≈	5.3014e−2 (8.29e−2)
DASCMOP6	2.1139e−1 (2.20e−1) ≈	1.0503e−1 (1.59e−1) ≈	1.5722e−1 (2.03e−1) ≈	1.6308e−1 (2.12e−1) ≈	1.3004e−1 (1.85e−1)
DASCMOP7	2.6576e−1 (2.87e−1) −	1.7207e−1 (1.99e−1) ≈	1.0974e−1 (1.43e−1) ≈	1.8514e−1 (2.17e−1) ≈	1.3052e−1 (1.84e−1)
DASCMOP8	1.2565e−1 (2.10e−1) ≈	1.2471e−1 (2.04e−1) ≈	9.4223e−2 (1.19e−1) ≈	9.0579e−2 (1.06e−1) ≈	9.6590e−2 (1.02e−1)
DASCMOP9	2.1502e−2 (1.07e−3) ≈	2.1311e−2 (8.70e−4) ≈	2.1438e−2 (1.14e−3) ≈	2.1456e−2 (9.36e−4) ≈	2.1548e−2 (7.80e−4)
+/ − / ≈	0/2/7	1/0/8	0/0/9	0/0/9	

TABLE S-XXIII
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
DOC1	3.4563e−1 (4.85e−4) ≈	3.4557e−1 (4.84e−4) ≈	3.4554e−1 (5.16e−4) ≈	3.4586e−1 (4.36e−4) ≈	3.4576e−1 (4.36e−4)
DOC2	4.8454e−1 (1.58e−1) ≈	5.1711e−1 (1.32e−1) ≈	4.6022e−1 (1.49e−1) ≈	5.0939e−1 (1.29e−1) ≈	5.1686e−1 (1.32e−1)
DOC3	2.1010e−2 (6.29e−2) ≈	1.1231e−2 (3.68e−2) ≈	2.5183e−2 (7.35e−2) ≈	3.7161e−2 (8.46e−2) ≈	1.9884e−2 (6.11e−2)
DOC4	5.1972e−1 (9.80e−3) ≈	5.2182e−1 (1.08e−2) ≈	5.1389e−1 (4.03e−2) ≈	5.1266e−1 (1.86e−2) ≈	5.1928e−1 (1.37e−2)
DOC5	4.1305e−1 (1.29e−1) ≈	3.4975e−1 (2.11e−1) ≈	4.0815e−1 (1.41e−1) ≈	3.9771e−1 (1.56e−1) ≈	3.9768e−1 (1.38e−1)
DOC6	4.7918e−1 (9.57e−2) ≈	4.9937e−1 (4.66e−2) ≈	4.9928e−1 (6.68e−2) ≈	4.9513e−1 (5.03e−2) ≈	5.1129e−1 (1.80e−2)
DOC7	2.2082e−1 (2.15e−1) ≈	2.0725e−1 (2.13e−1) ≈	2.6182e−1 (2.19e−1) ≈	3.3434e−1 (2.08e−1) ≈	2.5829e−1 (2.29e−1)
DOC8	5.4803e−1 (1.03e−1) ≈	5.6129e−1 (1.05e−1) ≈	5.8642e−1 (8.24e−2) ≈	5.7848e−1 (1.01e−1) ≈	5.8168e−1 (1.00e−1)
DOC9	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
+/ − / ≈	0/0/8	0/0/8	0/0/8	0/0/8	

TABLE S-XXIV
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
DOC1	2.6166e−3 (1.75e−4) ≈	2.6399e−3 (1.74e−4) ≈	2.7004e−3 (2.48e−4) ≈	2.5636e−3 (1.54e−4) ≈	2.6149e−3 (1.48e−4)
DOC2	1.2526e−1 (1.44e−1) ≈	9.5907e−2 (1.22e−1) ≈	1.4779e−1 (1.38e−1) ≈	1.0358e−1 (1.20e−1) ≈	9.8726e−2 (1.24e−1)
DOC3	5.5257e+2 (5.22e+2) ≈	5.9326e+2 (4.84e+2) ≈	4.9155e+2 (4.84e+2) ≈	4.4006e+2 (4.64e+2) ≈	4.4296e+2 (4.68e+2)
DOC4	3.7547e−2 (8.72e−3) ≈	3.5698e−2 (9.72e−3) ≈	4.3980e−2 (4.23e−2) ≈	4.3860e−2 (1.66e−2) ≈	3.7856e−2 (1.22e−2)
DOC5	1.0108e+1 (3.62e+1) ≈	3.2692e+1 (5.91e+1) ≈	1.1934e+1 (3.93e+1) ≈	1.4568e+1 (4.22e+1) ≈	1.1949e+1 (3.93e+1)
DOC6	2.7684e−2 (9.08e−2) ≈	1.1710e−2 (3.43e−2) ≈	1.4345e−2 (6.14e−2) ≈	1.2121e−2 (3.21e−2) ≈	3.9238e−3 (3.95e−3)
DOC7	4.9453e−1 (6.03e−1) ≈	5.0910e−1 (6.92e−1) ≈	4.9272e−1 (7.24e−1) ≈	2.9368e−1 (5.11e−1) ≈	5.1921e−1 (7.93e−1)
DOC8	2.5403e−1 (7.54e−2) ≈	2.4632e−1 (7.87e−2) ≈	2.2650e−1 (6.12e−2) ≈	2.3196e−1 (7.74e−2) ≈	2.2857e−1 (7.67e−2)
DOC9	6.0505e−2 (4.76e−2) ≈	6.1155e−2 (4.62e−2) ≈	4.9818e−2 (1.03e−2) ≈	6.1253e−2 (4.57e−2) ≈	7.5523e−2 (5.93e−2)
+/ − / ≈	0/0/9	0/0/9	0/0/9	0/0/9	

TABLE S-XXV
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
LIRCMOP1	1.3922e−1 (1.88e−2) ≈	1.3770e−1 (2.01e−2) ≈	1.4249e−1 (2.33e−2) ≈	1.4235e−1 (1.47e−2) ≈	1.4116e−1 (2.14e−2)
LIRCMOP2	2.7315e−1 (2.86e−2) ≈	2.7329e−1 (2.90e−2) ≈	2.5778e−1 (2.86e−2) −	2.6670e−1 (2.46e−2) ≈	2.7618e−1 (2.83e−2)
LIRCMOP3	1.1574e−1 (1.77e−2) ≈	1.2223e−1 (2.27e−2) ≈	1.2008e−1 (1.99e−2) ≈	1.1467e−1 (1.45e−2) ≈	1.1784e−1 (2.04e−2)
LIRCMOP4	2.1643e−1 (2.42e−2) ≈	2.1611e−1 (2.36e−2) ≈	2.1909e−1 (2.22e−2) ≈	2.0835e−1 (1.98e−2) ≈	2.1190e−1 (1.95e−2)
LIRCMOP5	2.8680e−1 (1.71e−3) ≈	2.8636e−1 (2.68e−3) ≈	2.8673e−1 (2.21e−3) ≈	2.8687e−1 (1.26e−3) ≈	2.8662e−1 (3.11e−3)
LIRCMOP6	1.9387e−1 (9.04e−4) ≈	1.9424e−1 (7.30e−4) ≈	1.9425e−1 (6.99e−4) ≈	1.9401e−1 (6.63e−4) ≈	1.9391e−1 (8.42e−4)
LIRCMOP7	2.9194e−1 (5.06e−3) ≈	2.9233e−1 (6.64e−3) ≈	2.9339e−1 (8.87e−4) ≈	2.9361e−1 (5.66e−4) ≈	2.9316e−1 (2.17e−3)
LIRCMOP8	2.9346e−1 (2.05e−3) ≈	2.9363e−1 (7.16e−4) ≈	2.9372e−1 (2.64e−4) ≈	2.9386e−1 (2.30e−4) ≈	2.9375e−1 (4.29e−4)
LIRCMOP9	4.5040e−1 (2.93e−2) ≈	4.5270e−1 (2.55e−2) ≈	4.6026e−1 (3.04e−2) ≈	4.5846e−1 (3.38e−2) ≈	4.5755e−1 (3.23e−2)
LIRCMOP10	6.9375e−1 (6.22e−3) ≈	6.9248e−1 (1.06e−2) ≈	6.9236e−1 (8.57e−3) ≈	6.9356e−1 (9.18e−3) ≈	6.8876e−1 (1.26e−2)
LIRCMOP11	6.8276e−1 (9.90e−3) −	6.8659e−1 (6.96e−3) ≈	6.8592e−1 (5.19e−3) ≈	6.8493e−1 (8.13e−3) ≈	6.8697e−1 (6.50e−3)
LIRCMOP12	5.7401e−1 (4.07e−2) ≈	5.8541e−1 (1.79e−2) ≈	5.8684e−1 (1.46e−2) ≈	5.8779e−1 (1.61e−2) ≈	5.8587e−1 (1.38e−2)
LIRCMOP13	5.2240e−1 (3.99e−3) ≈	5.2267e−1 (3.89e−3) ≈	5.2370e−1 (4.54e−3) ≈	5.2366e−1 (3.37e−3) ≈	5.2370e−1 (3.31e−3)
LIRCMOP14	5.4581e−1 (2.68e−3) ≈	5.4540e−1 (2.34e−3) ≈	5.4537e−1 (2.03e−3) ≈	5.4556e−1 (1.92e−3) ≈	5.4517e−1 (1.86e−3)
+/−/≈	0/1/13	0/0/14	0/1/13	0/0/14	

TABLE S-XXVI
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-CCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMOep1	DRLOS-CCMOep2	DRLOS-CCMOg1	DRLOS-CCMOg2	DRLOS-CCMO
LIRCMOP1	1.8426e−1 (4.38e−2) ≈	1.8993e−1 (4.45e−2) ≈	1.7677e−1 (5.81e−2) ≈	1.7829e−1 (3.38e−2) ≈	1.8166e−1 (4.80e−2)
LIRCMOP2	1.0002e−1 (3.35e−2) ≈	1.0283e−1 (3.56e−2) ≈	1.1940e−1 (3.62e−2) −	1.0929e−1 (2.87e−2) ≈	9.8504e−2 (3.06e−2)
LIRCMOP3	2.1503e−1 (4.44e−2) ≈	1.9886e−1 (6.12e−2) ≈	2.0144e−1 (5.08e−2) ≈	2.1695e−1 (3.72e−2) ≈	2.0504e−1 (5.76e−2)
LIRCMOP4	1.4692e−1 (3.63e−2) ≈	1.4584e−1 (3.83e−2) ≈	1.4323e−1 (3.49e−2) ≈	1.5622e−1 (3.43e−2) ≈	1.5243e−1 (3.14e−2)
LIRCMOP5	1.3944e−2 (2.90e−3) ≈	1.5013e−2 (4.01e−3) ≈	1.3721e−2 (3.28e−3) ≈	1.3920e−2 (1.95e−3) ≈	1.4657e−2 (6.31e−3)
LIRCMOP6	1.1166e−2 (1.81e−3) ≈	1.0527e−2 (1.50e−3) ≈	1.0649e−2 (1.54e−3) ≈	1.0945e−2 (1.24e−3) ≈	1.1160e−2 (1.55e−3)
LIRCMOP7	9.6390e−3 (7.62e−3) ≈	9.7052e−3 (1.32e−2) ≈	7.4972e−3 (1.51e−3) ≈	7.2467e−3 (1.06e−3) ≈	7.7800e−3 (3.10e−3)
LIRCMOP8	7.1910e−3 (2.59e−3) ≈	7.0776e−3 (9.97e−4) ≈	6.9092e−3 (5.22e−4) ≈	6.7466e−3 (3.60e−4) ≈	6.9280e−3 (6.95e−4)
LIRCMOP9	1.5606e−1 (3.19e−2) ≈	1.5377e−1 (2.75e−2) ≈	1.4496e−1 (3.24e−2) ≈	1.4747e−1 (3.61e−2) ≈	1.4893e−1 (3.47e−2)
LIRCMOP10	2.6086e−2 (1.23e−2) ≈	2.9537e−2 (2.12e−2) ≈	2.9048e−2 (1.70e−2) ≈	2.6909e−2 (1.83e−2) ≈	3.5973e−2 (2.44e−2)
LIRCMOP11	1.6591e−2 (1.46e−2) −	1.0833e−2 (1.00e−2) ≈	1.1812e−2 (7.41e−3) ≈	1.3521e−2 (1.19e−2) ≈	1.0432e−2 (9.45e−3)
LIRCMOP12	8.0698e−2 (5.87e−2) ≈	6.4820e−2 (2.64e−2) ≈	6.3786e−2 (2.37e−2) ≈	6.0376e−2 (2.59e−2) ≈	6.6395e−2 (2.30e−2)
LIRCMOP13	7.6265e−2 (3.97e−3) ≈	7.5759e−2 (3.69e−3) ≈	7.4953e−2 (4.50e−3) ≈	7.4833e−2 (3.48e−3) ≈	7.4755e−2 (3.32e−3)
LIRCMOP14	5.4360e−2 (2.54e−3) ≈	5.4721e−2 (2.30e−3) ≈	5.4644e−2 (2.13e−3) ≈	5.4483e−2 (1.81e−3) ≈	5.4903e−2 (1.88e−3)
+/−/≈	0/1/13	0/0/14	0/1/13	0/0/14	

TABLE S-XXVII
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
CF1	5.6102e−1 (1.69e−3) ≈	5.5916e−1 (3.07e−3) ≈	5.5935e−1 (4.60e−3) ≈	5.6041e−1 (2.55e−3) ≈	5.5940e−1 (3.40e−3)
CF2	6.2802e−1 (2.95e−2) ≈	6.3292e−1 (3.30e−2) ≈	6.2519e−1 (3.87e−2) ≈	6.2208e−1 (3.76e−2) ≈	6.1770e−1 (5.18e−2)
CF3	1.8799e−1 (5.56e−2) +	1.5868e−1 (4.84e−2) ≈	1.5567e−1 (5.42e−2) ≈	1.8065e−1 (4.86e−2) +	1.5111e−1 (5.15e−2)
CF4	4.1368e−1 (5.48e−2) ≈	4.0668e−1 (7.27e−2) ≈	4.0516e−1 (5.86e−2) ≈	4.1565e−1 (4.92e−2) ≈	4.0961e−1 (5.13e−2)
CF5	2.9135e−1 (5.86e−2) ≈	2.9254e−1 (4.78e−2) ≈	2.9242e−1 (6.00e−2) ≈	2.8688e−1 (5.70e−2) ≈	2.7342e−1 (5.30e−2)
CF6	6.5573e−1 (5.67e−2) ≈	6.5640e−1 (3.38e−2) ≈	6.6744e−1 (1.21e−2) ≈	6.6244e−1 (4.89e−2) ≈	6.7018e−1 (8.62e−3)
CF7	3.9977e−1 (1.20e−1) ≈	4.1322e−1 (1.07e−1) ≈	4.0635e−1 (7.63e−2) ≈	4.4279e−1 (1.02e−1) ≈	4.0649e−1 (1.24e−1)
CF8	4.0200e−1 (4.84e−2) ≈	4.1519e−1 (4.01e−2) ≈	3.9903e−1 (5.47e−2) ≈	4.1187e−1 (4.04e−2) ≈	4.0312e−1 (5.99e−2)

TABLE S-XXVII
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED (CONTINUED)

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
CF9	4.4752e−1 (3.22e−2) ≈	4.5460e−1 (2.28e−2) ≈	4.4730e−1 (3.83e−2) ≈	4.5703e−1 (5.79e−3) ≈	4.5692e−1 (6.15e−3)
CF10	2.2450e−1 (9.30e−2) ≈	2.8444e−1 (9.07e−2) ≈	2.7511e−1 (9.40e−2) ≈	2.4671e−1 (8.98e−2) ≈	2.6128e−1 (8.97e−2)
+/−/≈	1/0/9	0/0/10	0/0/10	1/0/9	

TABLE S-XXVIII
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
CF1	3.7863e−3 (1.30e−3) +	5.2574e−3 (2.40e−3) ≈	5.1606e−3 (3.68e−3) ≈	4.2844e−3 (1.96e−3) ≈	5.0790e−3 (2.70e−3)
CF2	2.0451e−2 (1.34e−2) ≈	2.1063e−2 (1.83e−2) ≈	2.2693e−2 (1.87e−2) ≈	2.4053e−2 (1.72e−2) ≈	2.5583e−2 (2.75e−2)
CF3	2.2850e−1 (1.23e−1) +	2.8546e−1 (1.22e−1) ≈	3.1259e−1 (1.48e−1) ≈	2.3751e−1 (1.24e−1) ≈	3.0487e−1 (1.39e−1)
CF4	8.6390e−2 (5.03e−2) ≈	9.9780e−2 (7.96e−2) ≈	9.9645e−2 (5.79e−2) ≈	8.9350e−2 (4.83e−2) ≈	9.3645e−2 (4.90e−2)
CF5	2.1784e−1 (7.48e−2) ≈	2.1370e−1 (5.86e−2) ≈	2.1417e−1 (7.71e−2) ≈	2.1633e−1 (6.68e−2) ≈	2.3798e−1 (6.80e−2)
CF6	3.1127e−2 (3.40e−2) ≈	3.0620e−2 (1.75e−2) ≈	2.5326e−2 (1.04e−2) ≈	2.7277e−2 (3.04e−2) ≈	2.2752e−2 (7.15e−3)
CF7	2.2236e−1 (1.13e−1) ≈	2.1129e−1 (1.03e−1) ≈	2.0338e−1 (6.86e−2) ≈	1.8043e−1 (9.18e−2) ≈	2.0546e−1 (1.19e−1)
CF8	1.0057e−1 (3.86e−2) ≈	9.0599e−2 (3.05e−2) ≈	1.0401e−1 (4.11e−2) ≈	9.3927e−2 (3.39e−2) ≈	9.9690e−2 (4.83e−2)
CF9	5.0374e−2 (1.39e−2) ≈	4.6980e−2 (9.65e−3) ≈	5.0327e−2 (1.60e−2) ≈	4.6380e−2 (2.56e−3) ≈	4.6378e−2 (2.88e−3)
CF10	2.2954e−1 (1.40e−1) ≈	1.6427e−1 (1.17e−1) ≈	1.7635e−1 (1.24e−1) ≈	1.9979e−1 (1.31e−1) ≈	1.9639e−1 (1.44e−1)
+/−/≈	2/0/8	0/0/10	0/0/10	0/0/10	

TABLE S-XXIX
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
DASCMOP1	9.9778e−2 (7.85e−2) −	1.7135e−1 (2.26e−3) ≈	1.7150e−1 (1.58e−3) ≈	1.6663e−1 (2.44e−2) ≈	1.7117e−1 (2.64e−3)
DASCMOP2	3.2461e−1 (2.72e−2) ≈	3.1217e−1 (2.20e−2) ≈	3.1464e−1 (2.35e−2) ≈	3.2145e−1 (2.16e−2) ≈	3.1747e−1 (2.65e−2)
DASCMOP3	2.3351e−1 (2.96e−2) ≈	2.2463e−1 (3.21e−2) ≈	2.3061e−1 (2.63e−2) ≈	2.2593e−1 (2.50e−2) ≈	2.2991e−1 (2.48e−2)
DASCMOP4	2.0289e−1 (3.58e−3) ≈	2.0009e−1 (8.83e−3) ≈	2.0321e−1 (2.77e−3) ≈	2.0075e−1 (6.50e−3) ≈	2.0230e−1 (4.32e−3)
DASCMOP5	3.4854e−1 (2.51e−3) ≈	3.4755e−1 (3.57e−3) ≈	3.4886e−1 (2.83e−3) ≈	3.4869e−1 (2.72e−3) ≈	3.4813e−1 (2.84e−3)
DASCMOP6	2.9887e−1 (2.53e−2) ≈	2.9787e−1 (2.55e−2) ≈	3.0450e−1 (1.64e−2) ≈	2.9801e−1 (2.44e−2) ≈	3.0820e−1 (9.23e−3)
DASCMOP7	2.8439e−1 (2.20e−3) +	2.8453e−1 (5.93e−4) ≈	2.8421e−1 (1.90e−3) ≈	2.8433e−1 (2.07e−3) ≈	2.8414e−1 (1.75e−3)
DASCMOP8	2.0283e−1 (3.40e−3) ≈	2.0126e−1 (5.00e−3) ≈	2.0134e−1 (4.24e−3) ≈	2.0117e−1 (5.12e−3) ≈	2.0279e−1 (3.26e−3)
DASCMOP9	1.2012e−1 (4.13e−2) ≈	1.4635e−1 (4.72e−2) +	1.3920e−1 (5.28e−2) ≈	1.3155e−1 (3.77e−2) ≈	1.2851e−1 (4.49e−2)
+/−/≈	1/1/7	1/0/8	0/0/9	0/0/9	

TABLE S-XXX
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
DASCMOP1	3.9368e−1 (2.61e−1) −	1.5894e−1 (3.53e−3) ≈	1.5881e−1 (2.69e−3) ≈	1.6934e−1 (5.64e−2) ≈	1.5920e−1 (3.90e−3)
DASCMOP2	4.6070e−2 (4.34e−2) ≈	3.7006e−2 (1.87e−2) ≈	3.5154e−2 (2.00e−2) ≈	3.7704e−2 (2.95e−2) ≈	3.7001e−2 (3.04e−2)
DASCMOP3	1.5476e−1 (5.95e−2) ≈	1.6894e−1 (6.11e−2) ≈	1.5879e−1 (4.95e−2) ≈	1.6597e−1 (4.81e−2) ≈	1.5792e−1 (4.59e−2)
DASCMOP4	1.3899e−3 (1.99e−3) ≈	8.7594e−3 (3.58e−2) ≈	1.3814e−3 (1.82e−3) ≈	2.5967e−3 (3.56e−3) ≈	1.5892e−3 (1.96e−3)
DASCMOP5	4.9583e−3 (2.36e−3) ≈	5.9234e−3 (3.67e−3) ≈	4.6635e−3 (2.79e−3) ≈	4.8731e−3 (2.65e−3) ≈	5.3318e−3 (2.65e−3)
DASCMOP6	2.7464e−2 (4.66e−2) ≈	2.9667e−2 (4.69e−2) ≈	1.7811e−2 (2.73e−2) ≈	3.0826e−2 (4.58e−2) −	1.2580e−2 (1.54e−2)
DASCMOP7	3.2016e−2 (4.76e−3) ≈	3.1414e−2 (1.72e−3) ≈	3.2371e−2 (4.23e−3) ≈	3.1613e−2 (4.45e−3) ≈	3.2002e−2 (3.71e−3)
DASCMOP8	2.6756e−2 (4.86e−3) ≈	2.9019e−2 (7.03e−3) ≈	2.8796e−2 (6.02e−3) ≈	2.9128e−2 (7.67e−3) ≈	2.6790e−2 (4.78e−3)
DASCMOP9	2.7522e−1 (1.36e−1) ≈	1.9259e−1 (1.56e−1) ≈	2.1806e−1 (1.73e−1) ≈	2.3681e−1 (1.25e−1) ≈	2.4978e−1 (1.49e−1)
+/−/≈	0/1/8	0/0/9	0/0/9	0/1/8	

TABLE S-XXXI
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
DOC1	2.2348e−1 (3.22e−2) ≈	2.1559e−1 (3.50e−2) ≈	2.0956e−1 (4.05e−2) ≈	2.2373e−1 (3.46e−2) ≈	2.1717e−1 (4.42e−2)
DOC2	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
DOC3	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
DOC4	4.2607e−2 (9.02e−2) ≈	4.5503e−2 (9.06e−2) ≈	4.2713e−2 (1.00e−1) ≈	2.9086e−2 (7.91e−2) ≈	5.8476e−2 (1.05e−1)
DOC5	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
DOC6	0.0000e+0 (0.00e+0) ≈	1.2056e−3 (5.01e−3) ≈	3.4966e−3 (1.92e−2) ≈	8.2177e−4 (4.50e−3) ≈	4.1556e−3 (1.72e−2)
DOC7	2.0380e−2 (5.83e−2) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	9.6361e−3 (4.20e−2) ≈	0.0000e+0 (0.00e+0)
DOC8	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0)
DOC9	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0)
+/−/≈	0/0/6	0/0/6	0/0/6	0/0/6	

TABLE S-XXXII
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
DOC1	8.5004e−2 (6.32e−2) ≈	9.2101e−2 (7.18e−2) ≈	1.0056e−1 (8.70e−2) ≈	6.9446e−2 (3.00e−2) ≈	9.0927e−2 (7.58e−2)
DOC2	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
DOC3	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
DOC4	1.5215e+0 (8.13e−1) −	1.3110e+0 (8.21e−1) ≈	1.1879e+0 (7.09e−1) ≈	1.4747e+0 (9.57e−1) ≈	1.0128e+0 (5.73e−1)
DOC5	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
DOC6	2.1850e+0 (7.37e−1) ≈	2.1668e+0 (7.97e−1) ≈	2.1464e+0 (8.53e−1) ≈	1.9289e+0 (6.03e−1) ≈	2.2171e+0 (1.04e+0)
DOC7	3.1948e+0 (1.94e+0) ≈	3.7120e+0 (2.07e+0) ≈	3.6006e+0 (1.81e+0) ≈	2.6530e+0 (1.54e+0) ≈	3.5655e+0 (2.53e+0)
DOC8	8.6286e+1 (6.58e+1) ≈	1.1160e+2 (8.74e+1) ≈	8.3924e+1 (6.34e+1) ≈	1.2267e+2 (9.46e+1) ≈	1.1700e+2 (8.66e+1)
DOC9	1.6829e−1 (1.43e−1) −	1.5026e−1 (1.46e−1) ≈	1.3650e−1 (1.21e−1) ≈	1.5781e−1 (1.30e−1) ≈	1.0490e−1 (1.10e−1)
+/−/≈	0/2/4	0/0/6	0/0/6	0/0/6	

TABLE S-XXXIII
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
LIRCMOP1	1.8685e−1 (8.68e−3) ≈	1.7829e−1 (1.94e−2) ≈	1.8061e−1 (1.89e−2) ≈	1.8091e−1 (1.72e−2) ≈	1.8646e−1 (9.22e−3)
LIRCMOP2	2.7353e−1 (2.64e−2) ≈	2.7706e−1 (3.17e−2) ≈	2.7975e−1 (2.17e−2) ≈	2.7634e−1 (2.36e−2) ≈	2.7347e−1 (2.65e−2)
LIRCMOP3	1.5733e−1 (7.72e−3) ≈	1.6010e−1 (7.23e−3) ≈	1.5824e−1 (1.12e−2) ≈	1.5664e−1 (7.97e−3) ≈	1.5824e−1 (1.51e−2)
LIRCMOP4	2.3272e−1 (1.44e−2) ≈	2.2445e−1 (1.67e−2) ≈	2.3467e−1 (1.06e−2) ≈	2.3475e−1 (1.56e−2) ≈	2.3061e−1 (1.41e−2)
LIRCMOP5	1.4314e−1 (2.71e−2) ≈	1.4877e−1 (2.43e−2) ≈	1.4237e−1 (2.24e−2) ≈	1.4744e−1 (2.85e−2) ≈	1.4556e−1 (1.87e−2)
LIRCMOP6	1.2323e−1 (1.52e−2) ≈	1.2135e−1 (1.94e−2) ≈	1.2249e−1 (1.65e−2) ≈	1.1813e−1 (1.36e−2) ≈	1.1840e−1 (1.77e−2)
LIRCMOP7	2.4276e−1 (1.08e−2) ≈	2.4606e−1 (7.38e−3) ≈	2.3986e−1 (1.14e−2) ≈	2.4505e−1 (8.74e−3) ≈	2.4143e−1 (1.15e−2)
LIRCMOP8	2.4158e−1 (9.26e−3) ≈	2.3899e−1 (1.18e−2) ≈	2.4383e−1 (1.36e−2) ≈	2.4332e−1 (9.02e−3) ≈	2.4105e−1 (1.13e−2)
LIRCMOP9	4.2959e−1 (1.06e−1) ≈	4.6819e−1 (7.93e−2) ≈	4.4844e−1 (9.34e−2) ≈	4.3062e−1 (1.14e−1) ≈	4.5037e−1 (8.45e−2)
LIRCMOP10	6.1164e−1 (1.05e−1) ≈	6.2300e−1 (1.24e−1) ≈	6.4119e−1 (8.26e−2) ≈	5.7037e−1 (1.45e−1) ≈	6.1235e−1 (1.53e−1)
LIRCMOP11	6.5816e−1 (6.06e−2) ≈	6.3407e−1 (1.25e−1) ≈	6.0649e−1 (1.48e−1) ≈	6.6835e−1 (4.44e−2) ≈	6.2257e−1 (1.44e−1)
LIRCMOP12	5.3943e−1 (4.76e−2) ≈	5.3907e−1 (4.86e−2) ≈	5.4959e−1 (3.26e−2) ≈	5.5400e−1 (2.82e−2) ≈	5.5036e−1 (3.26e−2)
LIRCMOP13	5.5546e−1 (1.31e−3) ≈	5.5551e−1 (1.33e−3) ≈	5.5595e−1 (1.32e−3) ≈	5.5554e−1 (1.28e−3) ≈	5.5605e−1 (1.34e−3)
LIRCMOP14	5.5099e−1 (1.19e−3) ≈	5.5116e−1 (1.39e−3) ≈	5.5120e−1 (9.20e−4) ≈	5.5112e−1 (1.24e−3) ≈	5.5097e−1 (1.17e−3)
+/−/≈	0/0/14	0/0/14	0/0/14	0/0/14	

TABLE S-XXXIV
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-MOEADDAE AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-MOEADDAEep1	DRLOS-MOEADDAEep2	DRLOS-MOEADDAEg1	DRLOS-MOEADDAEg2	DRLOS-MOEADDAE
LIRCMOP1	1.0577e−1 (1.93e−2) ≈	1.1999e−1 (5.12e−2) −	1.1482e−1 (4.27e−2) ≈	1.1657e−1 (3.26e−2) ≈	1.0514e−1 (1.66e−2)
LIRCMOP2	9.3696e−2 (4.08e−2) ≈	9.0296e−2 (5.34e−2) ≈	8.6141e−2 (3.20e−2) ≈	8.9113e−2 (3.55e−2) ≈	9.4115e−2 (3.87e−2)
LIRCMOP3	1.4513e−1 (2.76e−2) ≈	1.3419e−1 (2.90e−2) ≈	1.3574e−1 (3.84e−2) ≈	1.3931e−1 (2.88e−2) ≈	1.4124e−1 (4.18e−2)
LIRCMOP4	1.1539e−1 (2.31e−2) ≈	1.2859e−1 (2.75e−2) ≈	1.1163e−1 (1.75e−2) ≈	1.1147e−1 (2.58e−2) ≈	1.1815e−1 (2.28e−2)
LIRCMOP5	2.6372e−1 (6.71e−2) ≈	2.4932e−1 (5.96e−2) ≈	2.6483e−1 (5.60e−2) ≈	2.5338e−1 (6.96e−2) ≈	2.5638e−1 (4.66e−2)
LIRCMOP6	2.7802e−1 (5.54e−2) ≈	2.8395e−1 (7.14e−2) ≈	2.8035e−1 (6.13e−2) ≈	2.9726e−1 (4.93e−2) ≈	2.9540e−1 (6.39e−2)
LIRCMOP7	1.1675e−1 (2.88e−2) ≈	1.0817e−1 (1.91e−2) ≈	1.2474e−1 (3.02e−2) ≈	1.1081e−1 (2.28e−2) ≈	1.2048e−1 (3.04e−2)
LIRCMOP8	1.2057e−1 (2.42e−2) ≈	1.2732e−1 (3.12e−2) ≈	1.1491e−1 (3.54e−2) ≈	1.1597e−1 (2.36e−2) ≈	1.2194e−1 (2.96e−2)
LIRCMOP9	2.8368e−1 (2.57e−1) ≈	1.9111e−1 (1.93e−1) ≈	2.3803e−1 (2.27e−1) ≈	2.8546e−1 (2.77e−1) ≈	2.3429e−1 (2.05e−1)
LIRCMOP10	1.0484e−1 (1.16e−1) ≈	1.0002e−1 (1.62e−1) ≈	7.3121e−2 (8.55e−2) ≈	1.5730e−1 (1.79e−1) ≈	1.1618e−1 (2.09e−1)
LIRCMOP11	5.6929e−2 (1.01e−1) ≈	1.0536e−1 (2.26e−1) ≈	1.5434e−1 (2.68e−1) ≈	4.2089e−2 (7.43e−2) ≈	1.2628e−1 (2.63e−1)
LIRCMOP12	1.6908e−1 (1.42e−1) ≈	1.6421e−1 (1.34e−1) ≈	1.3573e−1 (9.01e−2) ≈	1.3511e−1 (8.94e−2) ≈	1.3288e−1 (8.04e−2)
LIRCMOP13	4.3174e−2 (1.28e−3) ≈	4.3137e−2 (1.19e−3) ≈	4.2829e−2 (1.23e−3) ≈	4.3231e−2 (1.23e−3) ≈	4.2671e−2 (1.20e−3)
LIRCMOP14	4.8743e−2 (1.23e−3) ≈	4.8577e−2 (1.26e−3) ≈	4.8521e−2 (1.01e−3) ≈	4.8532e−2 (1.14e−3) ≈	4.8875e−2 (1.13e−3)
+/ − / ≈	0/0/14	0/1/13	0/0/14	0/0/14	

TABLE S-XXXV
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED.

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
CF1	5.6311e−1 (5.09e−4) −	5.6349e−1 (4.42e−4) ≈	5.6345e−1 (4.32e−4) ≈	5.6341e−1 (4.71e−4) ≈	5.6343e−1 (4.18e−4)
CF2	6.7165e−1 (2.95e−3) ≈	6.7202e−1 (3.03e−3) ≈	6.7145e−1 (3.52e−3) ≈	6.7127e−1 (3.24e−3) ≈	6.7170e−1 (3.41e−3)
CF3	1.9373e−1 (6.00e−2) ≈	1.9946e−1 (5.84e−2) ≈	1.8916e−1 (5.83e−2) ≈	2.1131e−1 (5.99e−2) ≈	2.0155e−1 (4.98e−2)
CF4	4.7158e−1 (1.01e−2) ≈	4.7417e−1 (1.34e−2) ≈	4.7446e−1 (1.32e−2) ≈	4.7554e−1 (1.82e−2) ≈	4.7513e−1 (1.12e−2)
CF5	3.1586e−1 (7.97e−2) ≈	2.8549e−1 (9.17e−2) ≈	2.9251e−1 (8.58e−2) ≈	2.6773e−1 (7.64e−2) −	3.3080e−1 (8.71e−2)
CF6	6.6831e−1 (4.67e−3) ≈	6.6358e−1 (1.23e−2) ≈	6.6880e−1 (4.30e−3) ≈	6.6593e−1 (8.49e−3) ≈	6.6654e−1 (6.98e−3)
CF7	5.1444e−1 (1.09e−1) ≈	5.1679e−1 (8.20e−2) ≈	5.1846e−1 (7.69e−2) ≈	5.2158e−1 (5.41e−2) ≈	4.9553e−1 (1.21e−1)
CF8	2.8976e−1 (4.05e−2) ≈	2.9021e−1 (3.20e−2) ≈	2.8860e−1 (3.57e−2) ≈	2.8354e−1 (3.19e−2) ≈	2.9022e−1 (2.70e−2)
CF9	3.8965e−1 (2.02e−2) ≈	3.9044e−1 (1.91e−2) ≈	3.8885e−1 (1.69e−2) ≈	3.9346e−1 (1.94e−2) ≈	3.9006e−1 (2.07e−2)
CF10	1.4703e−1 (5.63e−2) ≈	1.5399e−1 (4.63e−2) ≈	1.5419e−1 (4.24e−2) ≈	1.4929e−1 (3.90e−2) ≈	1.4939e−1 (5.13e−2)
+/ − / ≈	0/1/9	0/0/10	0/0/10	0/1/9	

TABLE S-XXXVI
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
CF1	2.4580e−3 (4.19e−4) −	2.1440e−3 (3.63e−4) ≈	2.1788e−3 (3.54e−4) ≈	2.2112e−3 (3.87e−4) ≈	2.1957e−3 (3.45e−4)
CF2	7.0414e−3 (2.50e−3) ≈	7.1175e−3 (2.75e−3) ≈	7.3630e−3 (3.16e−3) ≈	7.6700e−3 (2.75e−3) ≈	6.7656e−3 (2.69e−3)
CF3	1.9360e−1 (6.71e−2) ≈	1.8307e−1 (6.77e−2) ≈	1.9194e−1 (6.69e−2) ≈	1.7160e−1 (7.09e−2) ≈	1.8764e−1 (6.02e−2)
CF4	4.2656e−2 (6.16e−3) ≈	4.0947e−2 (8.95e−3) ≈	4.1207e−2 (8.41e−3) ≈	3.9970e−2 (1.18e−2) ≈	4.0393e−2 (7.07e−3)
CF5	1.9023e−1 (8.93e−2) ≈	2.1212e−1 (1.01e−1) ≈	1.9442e−1 (8.41e−2) ≈	2.2512e−1 (8.76e−2) −	1.6987e−1 (9.96e−2)
CF6	2.6653e−2 (3.41e−3) ≈	3.0766e−2 (1.03e−2) ≈	2.6683e−2 (2.67e−3) ≈	2.8468e−2 (6.60e−3) ≈	2.8311e−2 (5.73e−3)
CF7	1.2342e−1 (1.01e−1) ≈	1.2765e−1 (9.51e−2) ≈	1.1662e−1 (5.25e−2) ≈	1.2276e−1 (5.22e−2) ≈	1.4147e−1 (1.10e−1)
CF8	1.6994e−1 (3.23e−2) ≈	1.5980e−1 (2.59e−2) ≈	1.6571e−1 (2.91e−2) ≈	1.7173e−1 (3.28e−2) ≈	1.6727e−1 (2.80e−2)
CF9	8.4570e−2 (1.23e−2) ≈	8.5716e−2 (1.35e−2) ≈	8.8788e−2 (1.22e−2) ≈	8.4003e−2 (1.35e−2) ≈	8.4547e−2 (1.32e−2)
CF10	2.7420e−1 (8.50e−2) ≈	2.6708e−1 (8.09e−2) ≈	2.5401e−1 (8.44e−2) ≈	2.5370e−1 (6.62e−2) ≈	2.6734e−1 (7.38e−2)
+/ − / ≈	0/1/9	0/0/10	0/0/10	0/1/9	

TABLE S-XXXVII

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
DASCMOP1	2.1115e−1 (7.76e−4) ≈	2.1116e−1 (5.62e−4) ≈	2.1109e−1 (8.90e−4) ≈	2.1130e−1 (7.27e−4) ≈	2.1122e−1 (7.81e−4)
DASCMOP2	3.5423e−1 (3.10e−4) +	3.5408e−1 (3.23e−4) ≈	3.5414e−1 (3.39e−4) ≈	3.5407e−1 (3.84e−4) ≈	3.5405e−1 (2.67e−4)
DASCMOP3	3.0985e−1 (2.90e−3) ≈	3.0976e−1 (3.90e−3) ≈	3.1036e−1 (1.21e−3) ≈	3.0942e−1 (2.61e−3) ≈	3.0916e−1 (2.89e−3)
DASCMOP4	1.9155e−1 (2.55e−2) ≈	1.9165e−1 (2.49e−2) ≈	1.9439e−1 (1.58e−2) ≈	1.9987e−1 (8.27e−3) +	1.7883e−1 (4.36e−2)
DASCMOP5	3.2051e−1 (6.64e−2) ≈	3.4446e−1 (1.55e−2) ≈	3.4563e−1 (1.85e−2) ≈	3.4583e−1 (1.35e−2) ≈	3.4533e−1 (1.26e−2)
DASCMOP6	2.9716e−1 (4.46e−2) ≈	2.9525e−1 (4.56e−2) ≈	2.6313e−1 (8.32e−2) ≈	2.9451e−1 (4.58e−2) ≈	2.9414e−1 (3.54e−2)
DASCMOP7	2.3711e−1 (4.65e−2) ≈	2.3971e−1 (5.24e−2) ≈	2.6935e−1 (3.57e−2) +	2.5162e−1 (4.97e−2) ≈	2.3065e−1 (6.40e−2)
DASCMOP8	1.7746e−1 (4.23e−2) ≈	1.8183e−1 (4.99e−2) ≈	1.8326e−1 (4.10e−2) ≈	1.7477e−1 (5.34e−2) ≈	1.9030e−1 (2.98e−2)
DASCMOP9	2.0481e−1 (5.54e−4) ≈	2.0482e−1 (5.18e−4) ≈	2.0468e−1 (4.44e−4) ≈	2.0478e−1 (4.78e−4) ≈	2.0477e−1 (4.38e−4)
+/−/≈	1/0/8	0/0/9	1/0/8	1/0/8	

TABLE S-XXXVIII

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON DAS-CMOP
BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
DASCMOP1	2.5319e−3 (2.08e−4) ≈	2.5194e−3 (1.84e−4) ≈	2.5347e−3 (2.75e−4) ≈	2.4889e−3 (2.11e−4) ≈	2.5278e−3 (2.52e−4)
DASCMOP2	4.3746e−3 (2.97e−4) ≈	4.4119e−3 (3.04e−4) ≈	4.3926e−3 (2.61e−4) ≈	4.4188e−3 (3.41e−4) ≈	4.5000e−3 (2.92e−4)
DASCMOP3	9.1729e−3 (9.11e−3) ≈	7.5525e−3 (3.26e−3) +	7.5964e−3 (2.65e−3) +	9.2676e−3 (6.62e−3) ≈	9.2764e−3 (5.89e−3)
DASCMOP4	1.6759e−2 (6.25e−2) ≈	1.6850e−2 (5.45e−2) ≈	8.4762e−3 (1.80e−2) ≈	3.3917e−3 (6.98e−3) +	4.5370e−2 (1.05e−1)
DASCMOP5	5.0726e−2 (1.13e−1) ≈	1.1131e−2 (2.31e−2) ≈	8.9423e−3 (2.53e−2) ≈	8.8942e−3 (1.92e−2) ≈	9.7416e−3 (1.92e−2)
DASCMOP6	3.1469e−2 (8.32e−2) ≈	3.2825e−2 (8.33e−2) ≈	9.7329e−2 (1.58e−1) ≈	3.6245e−2 (8.60e−2) ≈	3.8780e−2 (7.10e−2)
DASCMOP7	1.2583e−1 (9.52e−2) ≈	1.2128e−1 (1.13e−1) ≈	6.3953e−2 (8.62e−2) +	9.9100e−2 (1.10e−1) ≈	1.4519e−1 (1.45e−1)
DASCMOP8	7.1919e−2 (8.58e−2) ≈	6.5374e−2 (9.99e−2) ≈	6.0863e−2 (8.33e−2) ≈	8.1704e−2 (1.25e−1) ≈	4.6088e−2 (5.16e−2)
DASCMOP9	2.1557e−2 (9.71e−4) ≈	2.1496e−2 (1.11e−3) ≈	2.1641e−2 (8.39e−4) ≈	2.1608e−2 (9.20e−4) ≈	2.1323e−2 (1.10e−3)
+/−/≈	0/0/9	1/0/8	2/0/7	1/0/8	

TABLE S-XXXIX

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
DOC1	3.4541e−1 (5.47e−4) ≈	3.4586e−1 (4.63e−4) +	3.4565e−1 (3.64e−4) ≈	3.4551e−1 (5.01e−4) ≈	3.4550e−1 (5.73e−4)
DOC2	5.1716e−1 (1.23e−1) ≈	5.5928e−1 (1.04e−1) ≈	5.5821e−1 (1.04e−1) ≈	5.5334e−1 (1.19e−1) ≈	5.7595e−1 (7.72e−2)
DOC3	6.7798e−3 (3.49e−2) ≈	2.0956e−2 (6.41e−2) ≈	7.8289e−3 (3.84e−2) ≈	2.7810e−3 (1.44e−2) ≈	9.1084e−3 (3.06e−2)
DOC4	5.2455e−1 (5.59e−3) ≈	5.2236e−1 (8.76e−3) ≈	5.2349e−1 (7.60e−3) ≈	5.2001e−1 (1.71e−2) ≈	5.1684e−1 (4.06e−2)
DOC5	4.0583e−1 (1.47e−1) ≈	4.0168e−1 (1.50e−1) ≈	3.7337e−1 (1.75e−1) ≈	4.0888e−1 (1.27e−1) ≈	3.8120e−1 (1.79e−1)
DOC6	5.1231e−1 (1.13e−2) ≈	5.0474e−1 (2.80e−2) ≈	5.0626e−1 (4.57e−2) ≈	5.1087e−1 (8.85e−3) ≈	5.0181e−1 (4.65e−2)
DOC7	3.8101e−1 (1.64e−1) ≈	4.0934e−1 (1.57e−1) ≈	3.8901e−1 (1.68e−1) ≈	3.9383e−1 (1.75e−1) ≈	3.9080e−1 (1.88e−1)
DOC8	4.7632e−1 (1.67e−1) ≈	5.5190e−1 (1.07e−1) ≈	5.4429e−1 (1.15e−1) ≈	5.0395e−1 (1.43e−1) ≈	5.2609e−1 (1.17e−1)
DOC9	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
+/−/≈	0/0/8	1/0/7	0/0/8	0/0/8	

TABLE S-XXXX

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
DOC1	2.6486e−3 (1.57e−4) ≈	2.5866e−3 (1.39e−4) ≈	2.5980e−3 (1.21e−4) ≈	2.6627e−3 (1.60e−4) ≈	2.6377e−3 (1.82e−4)
DOC2	9.7373e−2 (1.15e−1) ≈	5.6909e−2 (9.33e−2) ≈	6.0250e−2 (9.75e−2) ≈	6.3638e−2 (1.09e−1) ≈	4.3113e−2 (7.17e−2)
DOC3	6.4261e+2 (4.48e+2) ≈	5.2478e+2 (4.16e+2) ≈	6.4525e+2 (4.87e+2) ≈	4.9604e+2 (3.89e+2) ≈	6.0270e+2 (4.85e+2)

TABLE S-XXXX
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED (CONTINUED)

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
DOC4	3.3165e−2 (4.76e−3) ≈	3.5156e−2 (7.82e−3) ≈	3.4028e−2 (6.70e−3) ≈	3.7475e−2 (1.64e−2) ≈	4.1216e−2 (4.26e−2)
DOC5	1.8448e+1 (5.70e+1) ≈	1.4567e+1 (4.22e+1) ≈	2.1818e+1 (5.00e+1) ≈	9.4032e+0 (3.49e+1) ≈	2.1808e+1 (5.00e+1)
DOC6	3.3438e−3 (1.23e−3) ≈	5.8470e−3 (1.27e−2) ≈	9.7802e−3 (3.47e−2) ≈	2.9102e−3 (3.72e−4) ≈	9.4061e−3 (3.24e−2)
DOC7	1.4689e−1 (2.73e−1) ≈	1.1095e−1 (2.47e−1) ≈	1.2196e−1 (2.37e−1) ≈	1.3284e−1 (2.73e−1) ≈	1.4072e−1 (2.67e−1)
DOC8	3.2658e−1 (1.89e−1) ≈	2.5195e−1 (8.02e−2) ≈	2.5905e−1 (8.76e−2) ≈	2.9399e−1 (1.19e−1) ≈	2.7264e−1 (8.88e−2)
DOC9	5.2847e−2 (9.25e−3) ≈	5.4259e−2 (1.12e−2) ≈	5.0402e−2 (1.15e−2) ≈	5.2657e−2 (1.25e−2) ≈	5.0283e−2 (9.22e−3)
+/ − / ≈	0/0/9	0/0/9	0/0/9	0/0/9	

TABLE S-XXXXI
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
LIRCMOP1	1.4207e−1 (1.67e−2) ≈	1.4126e−1 (2.29e−2) ≈	1.4345e−1 (2.58e−2) ≈	1.4368e−1 (1.65e−2) ≈	1.4210e−1 (1.90e−2)
LIRCMOP2	2.6567e−1 (2.86e−2) ≈	2.6620e−1 (2.40e−2) ≈	2.7132e−1 (2.79e−2) ≈	2.6784e−1 (2.69e−2) ≈	2.6388e−1 (2.75e−2)
LIRCMOP3	1.2214e−1 (1.46e−2) ≈	1.2084e−1 (1.57e−2) ≈	1.1658e−1 (1.22e−2) ≈	1.1530e−1 (1.39e−2) ≈	1.1822e−1 (1.61e−2)
LIRCMOP4	2.1489e−1 (1.26e−2) ≈	2.1786e−1 (1.93e−2) ≈	2.1172e−1 (1.71e−2) ≈	2.1658e−1 (2.17e−2) ≈	2.1807e−1 (1.98e−2)
LIRCMOP5	2.8607e−1 (2.30e−3) ≈	2.8553e−1 (2.02e−3) ≈	2.8564e−1 (3.98e−3) ≈	2.8549e−1 (2.63e−3) ≈	2.8301e−1 (1.38e−2)
LIRCMOP6	1.9385e−1 (8.51e−4) ≈	1.9391e−1 (8.45e−4) ≈	1.9353e−1 (1.26e−3) ≈	1.9381e−1 (8.86e−4) ≈	1.9379e−1 (1.07e−3)
LIRCMOP7	2.9324e−1 (1.50e−3) ≈	2.9316e−1 (1.58e−3) ≈	2.9239e−1 (6.78e−3) ≈	2.9135e−1 (8.87e−3) ≈	2.9240e−1 (4.63e−3)
LIRCMOP8	2.9344e−1 (2.31e−3) ≈	2.9387e−1 (3.02e−4) ≈	2.9391e−1 (2.14e−4) +	2.9309e−1 (3.68e−3) ≈	2.9365e−1 (9.30e−4)
LIRCMOP9	4.4374e−1 (1.44e−2) ≈	4.4164e−1 (1.76e−2) ≈	4.4041e−1 (1.60e−2) ≈	4.4277e−1 (1.91e−2) ≈	4.4138e−1 (2.17e−2)
LIRCMOP10	6.8891e−1 (1.09e−2) ≈	6.8922e−1 (1.06e−2) ≈	6.8877e−1 (8.86e−3) ≈	6.8564e−1 (1.28e−2) ≈	6.8631e−1 (1.23e−2)
LIRCMOP11	6.7983e−1 (8.19e−3) ≈	6.8241e−1 (8.74e−3) ≈	6.8180e−1 (9.88e−3) ≈	6.7845e−1 (8.38e−3) −	6.8144e−1 (9.55e−3)
LIRCMOP12	5.7212e−1 (2.78e−2) ≈	5.8210e−1 (1.73e−2) ≈	5.8028e−1 (1.36e−2) ≈	5.8517e−1 (1.72e−2) +	5.7470e−1 (1.69e−2)
LIRCMOP13	5.3282e−1 (4.47e−3) ≈	5.3271e−1 (4.02e−3) ≈	5.3363e−1 (3.22e−3) ≈	5.3357e−1 (4.08e−3) ≈	5.3441e−1 (3.20e−3)
LIRCMOP14	5.4871e−1 (1.90e−3) ≈	5.4860e−1 (2.02e−3) ≈	5.4941e−1 (1.87e−3) +	5.4879e−1 (1.79e−3) ≈	5.4856e−1 (1.82e−3)
+/ − / ≈	0/0/14	0/0/14	2/0/12	1/1/12	

TABLE S-XXXXII
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMOep1	DRLOS-EMCMOep2	DRLOS-EMCMOg1	DRLOS-EMCMOg2	DRLOS-EMCMO
LIRCMOP1	1.7652e−1 (3.63e−2) ≈	1.7906e−1 (4.76e−2) ≈	1.7067e−1 (5.53e−2) ≈	1.7658e−1 (3.40e−2) ≈	1.7898e−1 (3.70e−2)
LIRCMOP2	1.1024e−1 (3.49e−2) ≈	1.1181e−1 (2.69e−2) ≈	1.0172e−1 (3.29e−2) ≈	1.0604e−1 (3.34e−2) ≈	1.1141e−1 (3.32e−2)
LIRCMOP3	2.0040e−1 (3.13e−2) ≈	1.9869e−1 (4.11e−2) ≈	2.1842e−1 (3.38e−2) ≈	2.1426e−1 (3.83e−2) ≈	2.0513e−1 (4.35e−2)
LIRCMOP4	1.4629e−1 (1.96e−2) ≈	1.4195e−1 (3.03e−2) ≈	1.5053e−1 (2.89e−2) ≈	1.4443e−1 (3.37e−2) ≈	1.4234e−1 (3.22e−2)
LIRCMOP5	1.5245e−2 (3.55e−3) ≈	1.6229e−2 (3.16e−3) ≈	1.6277e−2 (7.66e−3) ≈	1.6028e−2 (4.34e−3) ≈	1.9500e−2 (1.83e−2)
LIRCMOP6	1.1394e−2 (1.92e−3) ≈	1.1329e−2 (1.77e−3) ≈	1.1821e−2 (1.90e−3) ≈	1.1548e−2 (1.99e−3) ≈	1.1651e−2 (2.33e−3)
LIRCMOP7	7.8992e−3 (2.62e−3) ≈	7.9106e−3 (2.55e−3) ≈	9.7260e−3 (1.36e−2) ≈	1.1682e−2 (1.74e−2) ≈	9.5164e−3 (8.30e−3)
LIRCMOP8	7.2139e−3 (2.88e−3) −	6.7247e−3 (3.71e−4) +	6.6932e−3 (3.34e−4) +	8.1107e−3 (6.05e−3) ≈	7.0347e−3 (7.57e−4)
LIRCMOP9	1.6351e−1 (1.65e−2) ≈	1.6571e−1 (1.97e−2) ≈	1.6692e−1 (1.86e−2) ≈	1.6462e−1 (2.09e−2) ≈	1.6668e−1 (2.37e−2)
LIRCMOP10	3.5169e−2 (2.18e−2) ≈	3.5013e−2 (2.06e−2) ≈	3.5506e−2 (1.80e−2) ≈	4.2314e−2 (2.60e−2) ≈	4.0278e−2 (2.44e−2)
LIRCMOP11	2.0557e−2 (1.21e−2) ≈	1.6764e−2 (1.30e−2) ≈	1.7708e−2 (1.47e−2) ≈	2.2651e−2 (1.25e−2) −	1.8288e−2 (1.42e−2)
LIRCMOP12	8.5478e−2 (4.19e−2) ≈	6.9747e−2 (2.56e−2) ≈	7.3536e−2 (1.97e−2) ≈	6.5373e−2 (2.67e−2) +	8.1841e−2 (2.49e−2)
LIRCMOP13	6.5706e−2 (4.28e−3) ≈	6.5842e−2 (3.64e−3) ≈	6.4974e−2 (3.32e−3) ≈	6.4938e−2 (3.92e−3) ≈	6.4215e−2 (3.36e−3)
LIRCMOP14	5.1745e−2 (2.07e−3) ≈	5.1801e−2 (2.03e−3) ≈	5.0905e−2 (1.86e−3) +	5.1711e−2 (1.84e−3) ≈	5.1796e−2 (1.80e−3)
+/ − / ≈	0/1/13	1/0/13	2/0/12	1/1/12	

TABLE S-XXXXIII
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
CF1	5.5282e−1 (2.63e−3) ≈	5.5197e−1 (1.90e−3) ≈	5.5257e−1 (1.77e−3) ≈	5.5204e−1 (2.07e−3) ≈	5.5141e−1 (2.83e−3)
CF2	6.7438e−1 (3.36e−3) ≈	6.7425e−1 (3.59e−3) ≈	6.7407e−1 (2.84e−3) ≈	6.7477e−1 (3.38e−3) ≈	6.7513e−1 (2.70e−3)
CF3	1.9732e−1 (5.61e−2) ≈	1.8489e−1 (4.51e−2) ≈	1.8706e−1 (5.41e−2) ≈	1.8280e−1 (4.86e−2) ≈	1.8023e−1 (5.01e−2)
CF4	4.6337e−1 (3.33e−2) ≈	4.6071e−1 (4.22e−2) ≈	4.5668e−1 (5.39e−2) ≈	4.7862e−1 (3.46e−2) +	4.5494e−1 (4.37e−2)
CF5	3.1199e−1 (5.96e−2) ≈	2.9986e−1 (7.74e−2) ≈	3.0123e−1 (8.60e−2) ≈	3.2042e−1 (6.76e−2) ≈	2.9866e−1 (6.83e−2)
CF6	6.4871e−1 (1.38e−2) ≈	6.4616e−1 (9.88e−3) ≈	6.4860e−1 (1.20e−2) ≈	6.5096e−1 (1.29e−2) ≈	6.5293e−1 (1.44e−2)
CF7	4.1240e−1 (1.07e−1) ≈	4.1741e−1 (1.04e−1) ≈	3.9969e−1 (1.17e−1) ≈	4.1032e−1 (1.10e−1) ≈	4.0432e−1 (1.07e−1)
CF8	3.6826e−1 (2.14e−2) ≈	3.6474e−1 (2.37e−2) ≈	3.6985e−1 (2.45e−2) ≈	3.6935e−1 (2.19e−2) ≈	3.7286e−1 (2.08e−2)
CF9	4.5576e−1 (1.34e−2) ≈	4.5371e−1 (1.14e−2) ≈	4.5600e−1 (1.41e−2) ≈	4.5816e−1 (1.27e−2) ≈	4.5425e−1 (1.36e−2)
CF10	2.6474e−1 (7.56e−2) ≈	2.5741e−1 (6.77e−2) ≈	2.7143e−1 (8.18e−2) ≈	2.4618e−1 (8.41e−2) ≈	2.5890e−1 (7.19e−2)
+/−/≈	0/0/10	0/0/10	0/0/10	1/0/9	

TABLE S-XXXXIV
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
CF1	1.1002e−2 (2.18e−3) ≈	1.1731e−2 (1.56e−3) ≈	1.1180e−2 (1.40e−3) ≈	1.1582e−2 (1.71e−3) ≈	1.2193e−2 (2.35e−3)
CF2	4.0039e−3 (1.35e−3) ≈	3.9408e−3 (8.36e−4) ≈	3.7707e−3 (3.08e−4) ≈	3.7530e−3 (3.21e−4) ≈	3.7240e−3 (5.11e−4)
CF3	2.4020e−1 (1.41e−1) ≈	2.3375e−1 (1.22e−1) ≈	2.4935e−1 (1.29e−1) ≈	2.3879e−1 (1.18e−1) ≈	2.6365e−1 (1.39e−1)
CF4	5.3226e−2 (2.92e−2) ≈	5.5797e−2 (3.59e−2) ≈	5.9139e−2 (4.98e−2) ≈	4.0665e−2 (3.07e−2) +	5.9749e−2 (3.73e−2)
CF5	1.9499e−1 (7.21e−2) ≈	2.1015e−1 (9.01e−2) ≈	2.0993e−1 (1.02e−1) ≈	1.8674e−1 (7.87e−2) ≈	2.1211e−1 (7.99e−2)
CF6	4.2159e−2 (1.28e−2) ≈	4.4416e−2 (9.69e−3) ≈	4.2159e−2 (1.14e−2) ≈	3.9925e−2 (1.23e−2) ≈	3.8197e−2 (1.33e−2)
CF7	2.1327e−1 (1.15e−1) ≈	1.8829e−1 (7.84e−2) ≈	2.0433e−1 (9.44e−2) ≈	2.0031e−1 (9.66e−2) ≈	2.0739e−1 (9.18e−2)
CF8	1.1283e−1 (9.10e−3) ≈	1.1464e−1 (1.15e−2) ≈	1.1354e−1 (1.25e−2) ≈	1.1193e−1 (1.03e−2) ≈	1.1099e−1 (1.06e−2)
CF9	5.5052e−2 (7.91e−3) ≈	5.4300e−2 (8.22e−3) ≈	5.3368e−2 (7.68e−3) ≈	5.2881e−2 (7.01e−3) ≈	5.3836e−2 (9.90e−3)
CF10	1.9623e−1 (1.22e−1) ≈	1.8982e−1 (8.96e−2) ≈	1.8778e−1 (1.44e−1) ≈	2.2207e−1 (1.39e−1) ≈	1.9201e−1 (1.13e−1)
+/−/≈	0/0/10	0/0/10	0/0/10	1/0/9	

TABLE S-XXXXV
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
DASCMOP1	1.8058e−1 (5.26e−2) ≈	1.9247e−1 (3.60e−2) ≈	1.7451e−1 (5.84e−2) ≈	1.8386e−1 (5.48e−2) ≈	1.7781e−1 (5.19e−2)
DASCMOP2	3.5477e−1 (8.89e−5) ≈	3.5477e−1 (9.91e−5) ≈	3.5458e−1 (1.28e−3) ≈	3.5475e−1 (1.29e−4) ≈	3.5398e−1 (4.37e−3)
DASCMOP3	2.1311e−1 (1.92e−2) ≈	2.1009e−1 (4.88e−3) ≈	2.0865e−1 (6.30e−5) ≈	2.1208e−1 (1.89e−2) ≈	2.1174e−1 (9.34e−3)
DASCMOP4	1.9212e−1 (2.27e−2) ≈	1.8416e−1 (3.96e−2) ≈	1.8397e−1 (3.49e−2) ≈	1.9247e−1 (2.01e−2) ≈	1.8867e−1 (2.62e−2)
DASCMOP5	3.4156e−1 (3.45e−2) ≈	3.4938e−1 (5.58e−3) ≈	3.3274e−1 (5.14e−2) ≈	3.4931e−1 (7.57e−3) ≈	3.5005e−1 (2.90e−3)
DASCMOP6	1.0429e−1 (1.36e−1) ≈	1.5262e−1 (1.38e−1) +	1.1689e−1 (1.31e−1) ≈	1.0813e−1 (1.08e−1) ≈	7.8552e−2 (1.13e−1)
DASCMOP7	2.8358e−1 (1.02e−3) ≈	2.8353e−1 (8.71e−4) ≈	2.8355e−1 (8.08e−4) ≈	2.8357e−1 (7.82e−4) ≈	2.8378e−1 (7.33e−4)
DASCMOP8	2.0240e−1 (1.17e−3) ≈	2.0172e−1 (1.50e−3) ≈	2.0211e−1 (1.13e−3) ≈	2.0206e−1 (1.52e−3) ≈	2.0223e−1 (1.06e−3)
DASCMOP9	1.6657e−1 (3.53e−2) ≈	1.6791e−1 (2.08e−2) ≈	1.7049e−1 (2.63e−2) ≈	1.6236e−1 (3.00e−2) ≈	1.5384e−1 (4.20e−2)
+/−/≈	0/0/9	1/0/8	0/0/9	0/0/9	

TABLE S-XXXXVI

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
DASCMOP1	1.0884e−1 (1.83e−1) ≈	6.5728e−2 (1.27e−1) ≈	1.3407e−1 (2.05e−1) ≈	9.5914e−2 (1.94e−1) ≈	1.1914e−1 (1.80e−1)
DASCMOP2	4.0428e−3 (1.41e−4) ≈	4.0379e−3 (1.41e−4) ≈	4.3935e−3 (2.17e−3) ≈	4.0694e−3 (1.93e−4) ≈	4.4246e−3 (2.16e−3)
DASCMOP3	1.8191e−1 (3.43e−2) ≈	1.8677e−1 (1.12e−2) ≈	1.9010e−1 (9.88e−5) ≈	1.8395e−1 (3.37e−2) ≈	1.8414e−1 (1.66e−2)
DASCMOP4	3.6628e−2 (7.97e−2) ≈	5.2769e−2 (1.07e−1) ≈	6.0034e−2 (1.01e−1) ≈	4.0728e−2 (7.95e−2) ≈	4.3946e−2 (8.43e−2)
DASCMOP5	1.5402e−2 (4.84e−2) ≈	5.2712e−3 (8.03e−3) ≈	2.8598e−2 (7.62e−2) ≈	4.4993e−3 (6.18e−3) ≈	4.2004e−3 (3.50e−3)
DASCMOP6	5.0709e−1 (3.45e−1) ≈	3.7593e−1 (3.32e−1) +	4.6214e−1 (3.27e−1) ≈	4.5848e−1 (2.97e−1) ≈	5.5552e−1 (3.01e−1)
DASCMOP7	3.7186e−2 (2.25e−3) ≈	3.7872e−2 (3.16e−3) ≈	3.7543e−2 (2.05e−3) ≈	3.7585e−2 (1.97e−3) −	3.6732e−2 (2.29e−3)
DASCMOP8	2.6600e−2 (1.90e−3) ≈	2.7227e−2 (2.18e−3) ≈	2.7128e−2 (1.65e−3) ≈	2.7174e−2 (2.24e−3) ≈	2.6822e−2 (1.48e−3)
DASCMOP9	1.1887e−1 (1.20e−1) ≈	1.1131e−1 (6.97e−2) ≈	1.0339e−1 (8.66e−2) ≈	1.3211e−1 (1.01e−1) ≈	1.5930e−1 (1.43e−1)
+/ − / ≈	0/0/9	1/0/8	0/0/9	0/1/8	

TABLE S-XXXXVII

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
DOC1	2.9103e−1 (2.55e−2) ≈	2.8136e−1 (2.66e−2) ≈	2.8720e−1 (3.28e−2) ≈	2.7959e−1 (2.82e−2) ≈	2.8345e−1 (3.49e−2)
DOC2	1.7206e−1 (5.45e−2) −	1.5981e−1 (3.62e−2) ≈	2.7577e−1 (1.55e−1) ≈	3.9243e−1 (1.19e−1) ≈	3.4609e−1 (1.27e−1)
DOC3	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0)
DOC4	2.2025e−1 (4.49e−2) ≈	2.0189e−1 (5.38e−2) ≈	2.1984e−1 (4.87e−2) ≈	2.3331e−1 (4.95e−2) ≈	2.2468e−1 (5.77e−2)
DOC5	1.0803e−1 (1.48e−1) ≈	0.0000e+0 (0.00e+0) −	0.0000e+0 (0.00e+0) −	7.8176e−2 (1.29e−1) ≈	9.8382e−2 (1.16e−1)
DOC6	2.0311e−1 (1.19e−1) ≈	2.0563e−1 (1.24e−1) ≈	1.7847e−1 (1.21e−1) ≈	2.2991e−1 (9.57e−2) ≈	2.1140e−1 (1.20e−1)
DOC7	1.3975e−2 (2.56e−2) ≈	2.2018e−2 (5.38e−2) ≈	3.0873e−2 (6.40e−2) +	9.2873e−3 (1.73e−2) ≈	6.1536e−3 (8.58e−3)
DOC8	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0) ≈	0.0000e+0 (0.00e+0)
DOC9	0.0000e+0 (0.00e+0)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
+/ − / ≈	0/1/7	0/1/7	1/1/6	0/0/8	

TABLE S-XXXXVIII

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
DOC1	4.2652e−2 (2.98e−2) ≈	5.8242e−2 (3.57e−2) ≈	6.0457e−2 (5.32e−2) ≈	5.4437e−2 (3.29e−2) ≈	6.7505e−2 (5.93e−2)
DOC2	4.0236e−1 (4.91e−2) −	3.9688e−1 (1.02e−2) ≈	2.9075e−1 (1.59e−1) ≈	1.8475e−1 (1.23e−1) ≈	2.2576e−1 (1.30e−1)
DOC3	2.1719e+2 (1.85e+2) ≈	1.9648e+2 (1.89e+2) ≈	2.1369e+2 (1.63e+2) ≈	2.2038e+2 (1.80e+2) ≈	1.7225e+2 (1.63e+2)
DOC4	3.0953e−1 (5.20e−2) ≈	3.3452e−1 (6.89e−2) ≈	3.0550e−1 (6.09e−2) ≈	2.9656e−1 (6.59e−2) ≈	3.0175e−1 (6.70e−2)
DOC5	1.1628e+1 (3.02e+1) ≈	1.2540e+2 (2.14e+2) −	1.0621e+1 (2.41e+1) +	4.8834e+1 (1.00e+2) ≈	1.7248e+1 (5.25e+1)
DOC6	3.4591e−1 (1.87e−1) ≈	3.5338e−1 (1.94e−1) ≈	3.8651e−1 (1.86e−1) ≈	3.2579e−1 (1.69e−1) ≈	3.6204e−1 (1.85e−1)
DOC7	6.9756e−1 (1.62e−1) ≈	7.0439e−1 (1.87e−1) ≈	6.8467e−1 (1.99e−1) ≈	7.0958e−1 (1.21e−1) ≈	7.6541e−1 (2.05e−1)
DOC8	8.5144e+1 (2.75e+1) ≈	7.7462e+1 (2.63e+1) +	8.1866e+1 (3.05e+1) ≈	8.1493e+1 (3.24e+1) ≈	9.8266e+1 (3.26e+1)
DOC9	2.6702e−1 (2.54e−2) ≈	2.6502e−1 (2.46e−2) ≈	2.6678e−1 (2.17e−2) ≈	2.6546e−1 (2.82e−2) ≈	2.6181e−1 (2.13e−2)
+/ − / ≈	0/1/8	1/1/7	1/0/8	0/0/9	

TABLE S-XXXXIX

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
LIRCMOP1	2.0167e−1 (2.13e−2) ≈	2.0283e−1 (2.00e−2) ≈	1.9457e−1 (2.56e−2) ≈	2.0459e−1 (2.25e−2) ≈	2.0604e−1 (2.16e−2)
LIRCMOP2	3.2316e−1 (2.75e−2) ≈	3.3337e−1 (2.42e−2) ≈	3.2244e−1 (2.76e−2) ≈	3.2382e−1 (2.87e−2) ≈	3.3468e−1 (2.30e−2)
LIRCMOP3	1.7504e−1 (2.99e−2) ≈	1.6598e−1 (3.07e−2) ≈	1.7237e−1 (2.69e−2) ≈	1.6887e−1 (3.03e−2) ≈	1.7237e−1 (2.83e−2)

TABLE S-XXXXIX
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED (CONTINUED)

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
LIRCMOP4	2.7600e−1 (3.87e−2) ≈	2.6857e−1 (3.73e−2) ≈	2.6584e−1 (3.70e−2) ≈	2.5108e−1 (3.57e−2) ≈	2.6475e−1 (3.60e−2)
LIRCMOP5	2.8973e−1 (1.93e−3) ≈	2.9009e−1 (1.54e−3) ≈	2.9041e−1 (1.19e−3) ≈	2.9014e−1 (1.44e−3) ≈	2.8995e−1 (1.58e−3)
LIRCMOP6	1.9464e−1 (5.40e−3) ≈	1.9112e−1 (9.14e−3) ≈	1.9398e−1 (6.11e−3) ≈	1.9354e−1 (6.13e−3) ≈	1.8552e−1 (3.59e−2)
LIRCMOP7	2.4332e−1 (7.39e−3) ≈	2.4291e−1 (5.42e−3) ≈	2.4340e−1 (5.45e−3) ≈	2.4587e−1 (9.82e−3) ≈	2.4478e−1 (9.38e−3)
LIRCMOP8	2.3221e−1 (6.51e−3) ≈	2.3088e−1 (6.07e−3) ≈	2.3016e−1 (5.10e−3) ≈	2.3618e−1 (1.17e−2) +	2.2976e−1 (4.43e−3)
LIRCMOP9	4.5258e−1 (2.66e−2) ≈	4.3852e−1 (4.33e−2) ≈	4.4847e−1 (3.11e−2) ≈	4.4627e−1 (3.22e−2) ≈	4.4779e−1 (2.95e−2)
LIRCMOP10	5.8153e−1 (1.04e−1) ≈	5.9959e−1 (1.01e−1) ≈	5.5842e−1 (9.42e−2) ≈	5.6772e−1 (9.62e−2) ≈	5.7544e−1 (1.03e−1)
LIRCMOP11	6.0108e−1 (9.20e−2) ≈	5.9523e−1 (9.28e−2) ≈	5.5629e−1 (1.14e−1) ≈	5.9486e−1 (8.70e−2) ≈	5.8452e−1 (8.07e−2)
LIRCMOP12	5.2477e−1 (4.91e−2) ≈	5.3423e−1 (4.42e−2) ≈	5.2578e−1 (3.97e−2) ≈	5.2108e−1 (4.93e−2) ≈	5.2892e−1 (4.19e−2)
LIRCMOP13	5.2308e−1 (4.21e−3) −	5.2587e−1 (3.99e−3) ≈	5.2501e−1 (4.29e−3) ≈	5.2502e−1 (4.50e−3) ≈	5.2564e−1 (3.81e−3)
LIRCMOP14	5.3539e−1 (3.90e−3) ≈	5.3465e−1 (4.52e−3) ≈	5.3456e−1 (3.62e−3) ≈	5.3442e−1 (5.15e−3) ≈	5.3451e−1 (4.69e−3)
+/−/≈	0/1/13	0/0/14	0/0/14	1/0/13	

TABLE S-L
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-PPS AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS ON
LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-PPSep1	DRLOS-PPSep2	DRLOS-PPSg1	DRLOS-PPSg2	DRLOS-PPS
LIRCMOP1	5.8227e−2 (3.39e−2) ≈	6.0110e−2 (3.45e−2) ≈	7.5884e−2 (4.28e−2) −	5.7434e−2 (3.99e−2) ≈	5.0521e−2 (3.46e−2)
LIRCMOP2	4.2439e−2 (2.63e−2) ≈	3.5144e−2 (2.57e−2) ≈	4.2490e−2 (2.67e−2) ≈	4.1171e−2 (2.76e−2) ≈	3.1777e−2 (2.27e−2)
LIRCMOP3	6.9824e−2 (7.11e−2) ≈	8.7502e−2 (7.28e−2) ≈	7.1485e−2 (6.28e−2) ≈	8.2655e−2 (7.45e−2) ≈	7.0081e−2 (6.30e−2)
LIRCMOP4	5.7538e−2 (5.43e−2) ≈	6.7487e−2 (5.21e−2) ≈	7.1642e−2 (5.19e−2) ≈	9.3482e−2 (5.10e−2) −	7.2644e−2 (5.09e−2)
LIRCMOP5	7.5992e−3 (2.48e−3) ≈	7.2015e−3 (1.89e−3) ≈	6.7810e−3 (1.41e−3) ≈	7.0145e−3 (1.61e−3) ≈	7.2731e−3 (2.14e−3)
LIRCMOP6	1.1187e−2 (1.68e−2) ≈	2.1868e−2 (2.90e−2) ≈	1.3063e−2 (1.84e−2) ≈	1.3911e−2 (1.78e−2) ≈	6.2842e−2 (2.43e−1)
LIRCMOP7	1.1249e−1 (1.85e−2) ≈	1.1398e−1 (1.30e−2) ≈	1.1233e−1 (1.34e−2) ≈	1.0719e−1 (2.15e−2) ≈	1.0937e−1 (2.11e−2)
LIRCMOP8	1.5521e−1 (2.52e−2) ≈	1.6256e−1 (2.50e−2) ≈	1.6626e−1 (2.47e−2) ≈	1.4789e−1 (4.26e−2) ≈	1.6705e−1 (2.43e−2)
LIRCMOP9	1.9628e−1 (4.78e−2) ≈	2.1618e−1 (7.01e−2) ≈	2.0075e−1 (4.96e−2) ≈	2.0390e−1 (5.12e−2) ≈	2.0240e−1 (4.93e−2)
LIRCMOP10	1.8480e−1 (1.47e−1) ≈	1.6033e−1 (1.44e−1) ≈	2.1785e−1 (1.34e−1) ≈	2.0572e−1 (1.36e−1) ≈	1.9290e−1 (1.47e−1)
LIRCMOP11	1.1864e−1 (1.11e−1) ≈	1.2511e−1 (1.13e−1) ≈	1.7628e−1 (1.44e−1) ≈	1.2551e−1 (1.04e−1) ≈	1.3919e−1 (9.70e−2)
LIRCMOP12	1.5271e−1 (6.93e−2) ≈	1.3908e−1 (6.40e−2) ≈	1.5175e−1 (5.62e−2) ≈	1.5785e−1 (6.96e−2) ≈	1.4758e−1 (5.88e−2)
LIRCMOP13	6.5495e−2 (2.64e−3) −	6.3555e−2 (2.66e−3) ≈	6.3969e−2 (2.47e−3) ≈	6.4280e−2 (2.88e−3) ≈	6.3727e−2 (2.70e−3)
LIRCMOP14	5.7215e−2 (2.32e−3) ≈	5.7632e−2 (2.56e−3) ≈	5.7938e−2 (2.08e−3) ≈	5.7912e−2 (2.74e−3) ≈	5.7911e−2 (3.06e−3)
+/−/≈	0/1/13	0/0/14	0/1/13	0/1/13	

TABLE S-LI
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE
DQN ON CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
CF1	5.6341e−1 (5.33e−4) ≈	5.6319e−1 (6.17e−4) ≈	5.6319e−1 (6.17e−4) ≈	5.6330e−1 (4.39e−4) ≈	5.6343e−1 (4.18e−4)
CF2	6.6995e−1 (3.94e−3) ≈	6.7255e−1 (2.53e−3) ≈	6.7190e−1 (2.99e−3) ≈	6.7072e−1 (4.07e−3) ≈	6.7170e−1 (3.41e−3)
CF3	2.0134e−1 (5.28e−2) ≈	1.9080e−1 (5.60e−2) ≈	1.8923e−1 (6.19e−2) ≈	1.9375e−1 (5.55e−2) ≈	2.0155e−1 (4.98e−2)
CF4	4.7399e−1 (1.17e−2) ≈	4.7505e−1 (1.33e−2) ≈	4.7959e−1 (1.42e−2) ≈	4.7463e−1 (1.16e−2) ≈	4.7513e−1 (1.12e−2)
CF5	3.0502e−1 (9.03e−2) ≈	3.0696e−1 (8.75e−2) ≈	2.9655e−1 (7.70e−2) ≈	2.9894e−1 (8.23e−2) ≈	3.3080e−1 (8.71e−2)
CF6	6.6447e−1 (1.03e−2) ≈	6.6577e−1 (8.93e−3) ≈	6.6895e−1 (4.81e−3) ≈	6.6787e−1 (8.64e−3) ≈	6.6654e−1 (6.98e−3)
CF7	4.9285e−1 (1.11e−1) ≈	4.9134e−1 (8.95e−2) ≈	4.8737e−1 (1.40e−1) ≈	5.0406e−1 (1.00e−1) ≈	4.9553e−1 (1.21e−1)
CF8	2.8092e−1 (4.56e−2) ≈	2.8099e−1 (3.89e−2) ≈	2.8853e−1 (3.15e−2) ≈	2.9046e−1 (4.95e−2) ≈	2.9022e−1 (2.70e−2)
CF9	3.9489e−1 (1.88e−2) ≈	3.8714e−1 (2.89e−2) ≈	3.9101e−1 (2.17e−2) ≈	3.9595e−1 (1.38e−2) ≈	3.9006e−1 (2.07e−2)
CF10	1.5456e−1 (5.48e−2) ≈	1.5953e−1 (5.13e−2) ≈	1.6193e−1 (3.92e−2) ≈	1.4599e−1 (5.34e−2) ≈	1.4939e−1 (5.13e−2)
+/−/≈	0/0/10	0/0/10	0/0/10	0/0/10	

TABLE S-LII
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON CF BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
CF1	2.2168e−3 (4.37e−4) ≈	2.3949e−3 (5.09e−4) ≈	2.3949e−3 (5.09e−4) ≈	2.3073e−3 (3.61e−4) ≈	2.1957e−3 (3.45e−4)
CF2	8.2987e−3 (2.96e−3) −	6.8479e−3 (2.27e−3) ≈	6.5730e−3 (2.26e−3) ≈	7.1668e−3 (2.66e−3) ≈	6.7656e−3 (2.69e−3)
CF3	1.8888e−1 (6.52e−2) ≈	1.9362e−1 (6.75e−2) ≈	1.9157e−1 (7.09e−2) ≈	1.9275e−1 (6.35e−2) ≈	1.8764e−1 (6.02e−2)
CF4	4.1124e−2 (7.39e−3) ≈	4.0563e−2 (8.19e−3) ≈	3.7343e−2 (9.46e−3) ≈	4.0904e−2 (7.62e−3) ≈	4.0393e−2 (7.07e−3)
CF5	1.9725e−1 (1.03e−1) ≈	2.0303e−1 (1.03e−1) ≈	1.9634e−1 (8.38e−2) ≈	2.0144e−1 (9.17e−2) ≈	1.6987e−1 (9.96e−2)
CF6	2.9798e−2 (8.45e−3) ≈	2.8525e−2 (7.41e−3) ≈	2.5886e−2 (3.13e−3) +	2.6837e−2 (7.05e−3) ≈	2.8311e−2 (5.73e−3)
CF7	1.3670e−1 (7.60e−2) ≈	1.4148e−1 (6.63e−2) ≈	1.5310e−1 (1.43e−1) ≈	1.2987e−1 (7.24e−2) ≈	1.4147e−1 (1.10e−1)
CF8	1.7665e−1 (4.97e−2) ≈	1.7793e−1 (4.39e−2) ≈	1.6802e−1 (2.10e−2) ≈	1.6693e−1 (3.96e−2) ≈	1.6727e−1 (2.80e−2)
CF9	8.3686e−2 (1.24e−2) ≈	8.7803e−2 (1.58e−2) ≈	8.5876e−2 (1.22e−2) ≈	8.2732e−2 (9.53e−3) ≈	8.4547e−2 (1.32e−2)
CF10	2.7341e−1 (7.96e−2) ≈	2.5449e−1 (7.53e−2) ≈	2.5139e−1 (7.73e−2) ≈	2.8483e−1 (8.42e−2) ≈	2.6734e−1 (7.38e−2)
+/ − / ≈	0/1/9	0/0/10	1/0/9	0/0/10	

TABLE S-LIII
STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
DASCMOP1	2.1110e−1 (7.56e−4) ≈	2.1097e−1 (1.05e−3) ≈	2.1119e−1 (7.94e−4) ≈	2.1112e−1 (7.41e−4) ≈	2.1122e−1 (7.81e−4)
DASCMOP2	3.5410e−1 (4.50e−4) ≈	3.5420e−1 (3.00e−4) +	3.5414e−1 (2.68e−4) ≈	3.5415e−1 (3.96e−4) +	3.5405e−1 (2.67e−4)
DASCMOP3	3.1060e−1 (1.11e−3) +	3.0996e−1 (1.72e−3) ≈	3.1023e−1 (1.28e−3) ≈	3.0952e−1 (3.42e−3) ≈	3.0916e−1 (2.89e−3)
DASCMOP4	1.8803e−1 (3.53e−2) ≈	1.9819e−1 (1.33e−2) +	1.9204e−1 (2.65e−2) ≈	1.9672e−1 (8.36e−3) ≈	1.7883e−1 (4.36e−2)
DASCMOP5	3.3849e−1 (3.37e−2) ≈	3.4427e−1 (1.95e−2) ≈	3.4643e−1 (1.09e−2) ≈	3.4111e−1 (2.55e−2) ≈	3.4533e−1 (1.26e−2)
DASCMOP6	2.7561e−1 (8.02e−2) ≈	3.0184e−1 (4.50e−2) +	3.0166e−1 (2.32e−2) ≈	2.9399e−1 (4.89e−2) ≈	2.9414e−1 (3.54e−2)
DASCMOP7	2.6295e−1 (3.75e−2) ≈	2.6108e−1 (3.84e−2) +	2.4265e−1 (5.87e−2) ≈	2.4773e−1 (5.54e−2) ≈	2.3065e−1 (6.40e−2)
DASCMOP8	1.9296e−1 (3.11e−2) +	1.9187e−1 (2.48e−2) ≈	1.7963e−1 (4.21e−2) ≈	1.8501e−1 (3.93e−2) ≈	1.9030e−1 (2.98e−2)
DASCMOP9	2.0483e−1 (5.24e−4) ≈	2.0484e−1 (4.55e−4) ≈	2.0479e−1 (4.96e−4) ≈	2.0475e−1 (3.25e−4) ≈	2.0477e−1 (4.38e−4)
+/ − / ≈	2/0/7	4/0/5	0/0/9	1/0/8	

TABLE S-LIV
STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON DAS-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
DASCMOP1	2.5423e−3 (2.22e−4) ≈	2.5994e−3 (2.59e−4) ≈	2.5195e−3 (1.74e−4) ≈	2.5073e−3 (1.79e−4) ≈	2.5278e−3 (2.52e−4)
DASCMOP2	4.3409e−3 (2.82e−4) +	4.3686e−3 (3.22e−4) ≈	4.3881e−3 (2.60e−4) ≈	4.4256e−3 (3.29e−4) ≈	4.5000e−3 (2.92e−4)
DASCMOP3	6.9220e−3 (1.69e−3) +	7.6954e−3 (2.75e−3) ≈	7.2169e−3 (1.59e−3) ≈	7.7020e−3 (2.73e−3) ≈	9.2764e−3 (5.89e−3)
DASCMOP4	2.8667e−2 (7.81e−2) ≈	5.5014e−3 (1.46e−2) ≈	1.7187e−2 (6.14e−2) ≈	4.8169e−3 (6.49e−3) ≈	4.5370e−2 (1.05e−1)
DASCMOP5	2.0681e−2 (5.20e−2) ≈	1.1001e−2 (2.85e−2) ≈	8.0324e−3 (1.55e−2) ≈	1.6527e−2 (4.11e−2) ≈	9.7416e−3 (1.92e−2)
DASCMOP6	7.5432e−2 (1.56e−1) ≈	2.3813e−2 (8.74e−2) +	2.3268e−2 (4.32e−2) ≈	3.8715e−2 (9.48e−2) ≈	3.8780e−2 (7.10e−2)
DASCMOP7	7.4206e−2 (7.83e−2) ≈	7.8510e−2 (8.08e−2) +	1.2144e−1 (1.34e−1) ≈	1.0987e−1 (1.31e−1) ≈	1.4519e−1 (1.45e−1)
DASCMOP8	4.2326e−2 (5.64e−2) ≈	4.2445e−2 (4.20e−2) ≈	6.5380e−2 (7.61e−2) ≈	5.6260e−2 (7.17e−2) ≈	4.6088e−2 (5.16e−2)
DASCMOP9	2.1494e−2 (1.02e−3) ≈	2.1441e−2 (8.76e−4) ≈	2.1435e−2 (9.85e−4) ≈	2.1701e−2 (8.55e−4) ≈	2.1323e−2 (1.10e−3)
+/ − / ≈	2/0/7	2/0/7	0/0/9	0/0/9	

TABLE S-LV

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
DOC1	3.4547e−1 (5.12e−4) ≈	3.4563e−1 (6.47e−4) ≈	3.4553e−1 (6.08e−4) ≈	3.4559e−1 (5.36e−4) ≈	3.4550e−1 (5.73e−4)
DOC2	5.4898e−1 (1.01e−1) ≈	5.5076e−1 (9.88e−2) ≈	5.4684e−1 (1.08e−1) ≈	5.5692e−1 (1.02e−1) ≈	5.7595e−1 (7.72e−2)
DOC3	1.1974e−2 (3.67e−2) ≈	3.4724e−4 (1.90e−3) ≈	5.4678e−3 (2.34e−2) ≈	6.2108e−3 (2.45e−2) ≈	9.1084e−3 (3.06e−2)
DOC4	5.1885e−1 (2.39e−2) ≈	5.1869e−1 (1.81e−2) ≈	5.1422e−1 (3.86e−2) ≈	5.2385e−1 (7.85e−3) ≈	5.1684e−1 (4.06e−2)
DOC5	3.6574e−1 (1.78e−1) ≈	3.6007e−1 (1.83e−1) ≈	3.9905e−1 (1.52e−1) ≈	4.5950e−1 (2.63e−2) ≈	3.8120e−1 (1.79e−1)
DOC6	4.8268e−1 (8.02e−2) ≈	4.9308e−1 (6.79e−2) ≈	5.0997e−1 (1.29e−2) ≈	4.8636e−1 (8.74e−2) ≈	5.0181e−1 (4.65e−2)
DOC7	3.9582e−1 (1.65e−1) ≈	4.4944e−1 (1.02e−1) ≈	3.6326e−1 (1.82e−1) ≈	3.9264e−1 (1.35e−1) ≈	3.9080e−1 (1.88e−1)
DOC8	5.2160e−1 (1.08e−1) ≈	5.1891e−1 (1.13e−1) ≈	4.9331e−1 (1.42e−1) ≈	5.4053e−1 (9.15e−2) ≈	5.2609e−1 (1.17e−1)
DOC9	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)
+/−/≈	0/0/8	0/0/8	0/0/8	0/0/8	

TABLE S-LVI

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON DOC BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
DOC1	2.6671e−3 (2.10e−4) ≈	2.6007e−3 (1.96e−4) ≈	2.6573e−3 (1.91e−4) ≈	2.5981e−3 (1.65e−4) ≈	2.6377e−3 (1.82e−4)
DOC2	6.8042e−2 (9.51e−2) ≈	6.5249e−2 (9.20e−2) ≈	6.9694e−2 (1.02e−1) ≈	6.0811e−2 (9.60e−2) ≈	4.3113e−2 (7.17e−2)
DOC3	4.8250e+2 (3.99e+2) ≈	5.7498e+2 (4.03e+2) ≈	5.9239e+2 (4.93e+2) ≈	5.1568e+2 (4.22e+2) ≈	6.0270e+2 (4.85e+2)
DOC4	3.8730e−2 (2.41e−2) ≈	3.8515e−2 (1.70e−2) ≈	4.3538e−2 (4.00e−2) ≈	3.3784e−2 (6.95e−3) ≈	4.1216e−2 (4.26e−2)
DOC5	2.3123e+1 (5.13e+1) ≈	2.4544e+1 (5.26e+1) ≈	1.3807e+1 (4.11e+1) ≈	5.7167e−2 (3.75e−2) ≈	2.1808e+1 (5.00e+1)
DOC6	2.4497e−2 (6.38e−2) ≈	1.6963e−2 (5.77e−2) ≈	3.5604e−3 (2.51e−3) ≈	2.4453e−2 (7.95e−2) ≈	9.4061e−3 (3.24e−2)
DOC7	1.4202e−1 (3.11e−1) ≈	4.7630e−2 (9.55e−2) ≈	1.8989e−1 (3.79e−1) ≈	9.3678e−2 (1.35e−1) ≈	1.4072e−1 (2.67e−1)
DOC8	2.7740e−1 (8.58e−2) ≈	2.7711e−1 (9.13e−2) ≈	3.0207e−1 (1.26e−1) ≈	2.6235e−1 (6.85e−2) ≈	2.7264e−1 (8.88e−2)
DOC9	5.0235e−2 (8.73e−3) ≈	5.4243e−2 (1.28e−2) ≈	6.1488e−2 (3.12e−2) −	5.7025e−2 (3.27e−2) ≈	5.0283e−2 (9.22e−3)
+/−/≈	0/0/9	0/0/9	0/1/8	0/0/9	

TABLE S-LVII

STATISTICAL RESULTS OF HV OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
LIRCMOP1	1.3849e−1 (1.68e−2) ≈	1.4019e−1 (1.90e−2) ≈	1.3683e−1 (1.89e−2) ≈	1.3945e−1 (1.83e−2) ≈	1.4210e−1 (1.90e−2)
LIRCMOP2	2.7170e−1 (2.40e−2) ≈	2.6183e−1 (2.50e−2) ≈	2.6524e−1 (2.43e−2) ≈	2.6146e−1 (1.80e−2) ≈	2.6388e−1 (2.75e−2)
LIRCMOP3	1.1521e−1 (1.41e−2) ≈	1.1909e−1 (1.29e−2) ≈	1.2392e−1 (1.54e−2) ≈	1.2564e−1 (1.73e−2) ≈	1.1822e−1 (1.61e−2)
LIRCMOP4	2.1486e−1 (1.87e−2) ≈	2.0859e−1 (1.67e−2) −	2.1471e−1 (1.82e−2) ≈	2.1197e−1 (1.55e−2) ≈	2.1807e−1 (1.98e−2)
LIRCMOP5	2.8584e−1 (2.83e−3) ≈	2.8629e−1 (2.64e−3) ≈	2.8540e−1 (3.45e−3) ≈	2.8272e−1 (1.27e−2) ≈	2.8301e−1 (1.38e−2)
LIRCMOP6	1.9282e−1 (5.65e−3) ≈	1.9361e−1 (1.30e−3) ≈	1.9327e−1 (2.26e−3) ≈	1.9213e−1 (1.07e−2) ≈	1.9379e−1 (1.07e−3)
LIRCMOP7	2.9353e−1 (5.91e−4) ≈	2.9372e−1 (2.01e−4) ≈	2.9343e−1 (1.24e−3) ≈	2.9228e−1 (5.55e−3) ≈	2.9240e−1 (4.63e−3)
LIRCMOP8	2.9384e−1 (2.08e−4) ≈	2.9348e−1 (2.09e−3) −	2.9386e−1 (1.73e−4) ≈	2.9385e−1 (3.27e−4) ≈	2.9365e−1 (9.30e−4)
LIRCMOP9	4.4196e−1 (1.50e−2) ≈	4.4494e−1 (1.43e−2) ≈	4.4653e−1 (1.95e−2) ≈	4.4885e−1 (2.02e−2) ≈	4.4138e−1 (2.17e−2)
LIRCMOP10	6.8966e−1 (9.68e−3) ≈	6.8991e−1 (8.72e−3) ≈	6.8822e−1 (1.05e−2) ≈	6.7906e−1 (1.60e−2) ≈	6.8631e−1 (1.23e−2)
LIRCMOP11	6.8159e−1 (8.54e−3) ≈	6.7824e−1 (1.03e−2) ≈	6.7853e−1 (1.05e−2) ≈	6.7932e−1 (9.70e−3) ≈	6.8144e−1 (9.55e−3)
LIRCMOP12	5.7870e−1 (1.52e−2) ≈	5.7735e−1 (2.84e−2) ≈	5.7125e−1 (2.52e−2) ≈	5.7448e−1 (1.86e−2) ≈	5.7470e−1 (1.69e−2)
LIRCMOP13	5.3419e−1 (4.49e−3) ≈	5.3284e−1 (3.59e−3) ≈	5.3435e−1 (3.50e−3) ≈	5.3313e−1 (4.22e−3) ≈	5.3441e−1 (3.20e−3)
LIRCMOP14	5.4749e−1 (1.85e−3) ≈	5.4833e−1 (1.55e−3) ≈	5.4886e−1 (2.33e−3) ≈	5.4784e−1 (2.08e−3) ≈	5.4856e−1 (1.82e−3)
+/−/≈	0/0/14	0/2/12	0/0/14	0/0/14	

TABLE S-LVIII

STATISTICAL RESULTS OF IGD+ OBTAINED BY DRLOS-EMCMO AND VARIANTS WITH DIFFERENT PARAMETER SETTINGS FOR THE DQN ON LIR-CMOP BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-EMCMO-Decay	DRLOS-EMCMO-LearningRate	DRLOS-EMCMO-NumIte	DRLOS-EMCMO-NumNeu	DRLOS-EMCMO
LIRCMOP1	1.8484e−1 (3.62e−2) ≈	1.8484e−1 (3.99e−2) ≈	1.9059e−1 (3.91e−2) ≈	1.8086e−1 (3.76e−2) ≈	1.7898e−1 (3.70e−2)
LIRCMOP2	1.0287e−1 (2.86e−2) ≈	1.1701e−1 (3.25e−2) ≈	1.0910e−1 (3.30e−2) ≈	1.1461e−1 (2.38e−2) ≈	1.1141e−1 (3.32e−2)
LIRCMOP3	2.1128e−1 (3.61e−2) ≈	2.0284e−1 (3.39e−2) ≈	1.9463e−1 (4.08e−2) ≈	1.9191e−1 (4.29e−2) ≈	2.0513e−1 (4.35e−2)
LIRCMOP4	1.4644e−1 (3.01e−2) ≈	1.5693e−1 (2.74e−2) −	1.4808e−1 (3.08e−2) ≈	1.5176e−1 (2.58e−2) ≈	1.4234e−1 (3.22e−2)
LIRCMOP5	1.5676e−2 (4.52e−3) ≈	1.4945e−2 (3.96e−3) ≈	1.6307e−2 (5.81e−3) ≈	1.9911e−2 (1.62e−2) ≈	1.9500e−2 (1.83e−2)
LIRCMOP6	1.5192e−2 (2.00e−2) ≈	1.2089e−2 (3.35e−3) ≈	1.2294e−2 (3.19e−3) ≈	1.4481e−2 (1.93e−2) ≈	1.1651e−2 (2.33e−3)
LIRCMOP7	7.3386e−3 (9.62e−4) ≈	7.0545e−3 (3.25e−4) ≈	7.5797e−3 (2.09e−3) ≈	9.4783e−3 (9.35e−3) ≈	9.5164e−3 (8.30e−3)
LIRCMOP8	6.8441e−3 (3.85e−4) ≈	7.3611e−3 (2.59e−3) ≈	6.8737e−3 (3.00e−4) ≈	6.8188e−3 (5.92e−4) ≈	7.0347e−3 (7.57e−4)
LIRCMOP9	1.6538e−1 (1.70e−2) ≈	1.6236e−1 (1.56e−2) ≈	1.6047e−1 (2.14e−2) ≈	1.5807e−1 (2.19e−2) ≈	1.6668e−1 (2.37e−2)
LIRCMOP10	3.3790e−2 (1.93e−2) ≈	3.3047e−2 (1.81e−2) ≈	3.7047e−2 (2.12e−2) ≈	5.4137e−2 (3.07e−2) ≈	4.0278e−2 (2.44e−2)
LIRCMOP11	1.7974e−2 (1.29e−2) ≈	2.2847e−2 (1.54e−2) ≈	2.2802e−2 (1.56e−2) ≈	2.1433e−2 (1.46e−2) ≈	1.8288e−2 (1.42e−2)
LIRCMOP12	7.6973e−2 (2.17e−2) ≈	7.6959e−2 (4.35e−2) ≈	8.7176e−2 (3.71e−2) ≈	8.1477e−2 (2.63e−2) ≈	8.1841e−2 (2.49e−2)
LIRCMOP13	6.4462e−2 (4.38e−3) ≈	6.5644e−2 (3.22e−3) ≈	6.4383e−2 (3.47e−2) ≈	6.5412e−2 (4.22e−2) ≈	6.4215e−2 (3.36e−3)
LIRCMOP14	5.2828e−2 (1.98e−3) ≈	5.2092e−2 (1.57e−3) ≈	5.1387e−2 (1.93e−3) ≈	5.2669e−2 (2.35e−3) ≈	5.1796e−2 (1.80e−3)
+/−/≈	0/0/14	0/1/13	0/0/14	0/0/14	

TABLE S-LIX

STATISTICAL RESULTS OF HV OBTAINED BY THE METHODS OF SECTION-III AND VARIANTS THAT ADOPT HV AND SPACING INDICATORS FOR CALCULATING CONVERGENCE AND DIVERSITY ON ALL BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMO-Indi	DRLOS-CCMO	DRLOS-EMCMO-Indi	DRLOS-EMCMO	DRLOS-MOEAD-DAe-Indi	DRLOS-MOEADDAE	DRLOS-PPS-Indi	DRLOS-PPS
CF1	5.6329e−1 (4.89e−4) =	5.6333e−1 (4.50e−4)	5.6322e−1 (4.02e−4) =	5.6343e−1 (4.18e−4)	5.5948e−1 (2.64e−3)	5.5940e−1 (3.40e−3) =	5.4956e−1 (2.26e−3) −	5.5141e−1 (2.83e−3)
CF2	6.7281e−1 (3.39e−3) =	6.7309e−1 (1.88e−3)	6.7149e−1 (3.66e−3) =	6.7170e−1 (3.41e−2)	6.0473e−1 (5.31e−2)	6.1770e−1 (5.18e−2) =	6.7390e−1 (4.70e−3) =	6.7513e−1 (2.70e−3)
CF3	1.8621e−1 (5.21e−2) −	2.1030e−1 (5.76e−2)	1.8752e−1 (4.98e−2) =	2.0155e−1 (4.98e−2)	1.5815e−1 (5.33e−2)	1.5111e−1 (5.15e−2) =	1.7630e−1 (5.56e−2) =	1.8023e−1 (5.01e−2)
CF4	4.7956e−1 (1.55e−2) =	4.8483e−1 (1.28e−2)	4.7505e−1 (1.31e−2) =	4.7513e−1 (1.12e−2)	4.1253e−1 (5.57e−2)	4.0961e−1 (5.13e−2) =	4.5561e−1 (5.58e−2) =	4.5494e−1 (4.37e−2)
CF5	2.8039e−1 (9.17e−2) =	3.1494e−1 (7.42e−2)	2.9937e−1 (7.72e−2) =	3.3080e−1 (8.71e−2)	2.9082e−1 (3.95e−2)	2.7342e−1 (5.30e−2) =	3.1337e−1 (7.55e−2) =	2.9866e−1 (6.83e−2)
CF6	6.7238e−1 (4.73e−3) =	6.7057e−1 (5.86e−3)	6.6574e−1 (1.21e−2) =	6.6654e−1 (6.98e−3)	6.4692e−1 (6.94e−2)	6.7018e−1 (8.62e−3) =	6.4642e−1 (1.15e−2) =	6.5293e−1 (1.44e−2)
CF7	5.0138e−1 (1.13e−1) =	4.8910e−1 (1.01e−1)	5.3156e−1 (7.60e−2) =	4.9553e−1 (1.21e−1)	3.7045e−1 (1.41e−1)	4.0649e−1 (1.24e−1) =	3.9828e−1 (1.37e−1) =	4.0432e−1 (1.07e−1)
CF8	3.5382e−1 (1.86e−2) +	3.0556e−1 (2.74e−2)	3.3219e−1 (2.67e−2) +	2.9022e−1 (2.70e−2)	4.0987e−1 (3.59e−2)	4.0312e−1 (5.99e−2) =	3.7055e−1 (2.50e−2) =	3.7286e−1 (2.08e−2)
CF9	4.0028e−1 (1.89e−2) =	4.0291e−1 (1.59e−2)	3.9702e−1 (1.98e−2) =	3.9006e−1 (2.07e−2)	4.5519e−1 (2.33e−2)	4.5692e−1 (6.15e−3) =	4.5859e−1 (1.23e−2) =	4.5425e−1 (1.36e−2)
CF10	1.9714e−1 (6.18e−2) +	1.6093e−1 (5.26e−2)	1.6599e−1 (4.85e−2) =	1.4939e−1 (5.13e−2)	2.5924e−1 (1.00e−1)	2.6128e−1 (8.97e−2) =	2.0822e−1 (8.05e−2) −	2.5890e−1 (7.19e−2)
DASCMOP1	2.1134e−1 (8.95e−4) =	2.1129e−1 (8.92e−4)	2.1072e−1 (9.79e−4) =	2.1122e−1 (7.81e−4)	1.6636e−1 (2.69e−2)	1.7117e−1 (2.64e−3) =	3.6881e−2 (5.39e−2) −	1.7781e−1 (5.19e−2)
DASCMOP2	3.5429e−1 (2.66e−4) =	3.5432e−1 (2.42e−4)	3.5274e−1 (1.68e−3) −	3.5405e−1 (2.67e−2)	3.2534e−1 (2.74e−2)	3.1747e−1 (2.65e−2) =	2.7252e−1 (7.07e−3) −	3.5398e−1 (4.37e−3)

TABLE S-LIX
STATISTICAL RESULTS OF HV OBTAINED BY THE METHODS OF SECTION-III AND VARIANTS THAT ADOPT HV AND SPACING INDICATORS FOR CALCULATING CONVERGENCE AND DIVERSITY ON ALL BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED (CONTINUED)

Problem	DRLOS-CCMO-Indi	DRLOS-CCMO	DRLOS-EMCMO-Indi	DRLOS-EMCMO	DRLOS-MOEAD-DAe-Indi	DRLOS-MOEADDAE	DRLOS-PPS-Indi	DRLOS-PPS
DASCMOP3	3.0159e-1 (1.47e-2) −	**3.1042e-1 (1.00e-3)**	2.9849e-1 (1.45e-2) −	**3.0916e-1 (2.89e-3)**	2.2271e-1 (2.99e-2)	2.2991e-1 (2.48e-2) =	2.1423e-1 (2.02e-2) =	2.1174e-1 (9.34e-3)
DASCMOP4	2.0149e-1 (3.69e-3) +	1.5188e-1 (6.24e-2)	2.0207e-1 (3.54e-2) +	1.7883e-1 (4.36e-2)	2.0326e-1 (3.03e-3)	2.0230e-1 (4.32e-2) =	1.9946e-1 (1.18e-2) +	1.8867e-1 (2.62e-2)
DASCMOP5	**3.5103e-1 (2.86e-4)** +	3.1731e-1 (5.25e-2)	3.5088e-1 (5.90e-4) +	3.4533e-1 (1.26e-2)	**3.4840e-1 (2.85e-3)**	3.4813e-1 (2.84e-3) =	3.4875e-1 (6.89e-3) =	**3.5005e-1 (2.90e-3)**
DASCMOP6	**3.1190e-1 (3.77e-4)** +	2.4675e-1 (9.47e-2)	3.1184e-1 (3.69e-4) +	2.9414e-1 (3.54e-2)	2.9925e-1 (2.50e-2)	**3.0820e-1 (9.23e-3)** =	9.1977e-2 (1.22e-1) =	7.8552e-2 (1.13e-1)
DASCMOP7	**2.8783e-1 (6.39e-4)** +	2.4177e-1 (7.17e-2)	2.8816e-1 (6.07e-4) +	2.3065e-1 (6.40e-2)	**2.8430e-1 (2.22e-3)**	2.8414e-1 (1.75e-3) =	2.8497e-1 (7.32e-4) +	2.8378e-1 (7.33e-4)
DASCMOP8	**2.0646e-1 (1.06e-3)** +	1.6314e-1 (5.34e-2)	2.0685e-1 (1.35e-3) +	1.9030e-1 (2.98e-2)	2.0147e-1 (4.75e-3)	2.0279e-1 (3.26e-3) =	2.0250e-1 (1.21e-3) =	2.0223e-1 (1.06e-3)
DASCMOP9	**2.0559e-1 (3.48e-4)** +	2.0480e-1 (4.20e-4)	2.0569e-1 (3.87e-4) +	2.0477e-1 (4.38e-4)	1.4271e-1 (3.95e-2)	1.2851e-1 (4.49e-2) =	1.3873e-1 (3.39e-2) −	**1.5384e-1 (4.20e-2)**
DOC1	3.3223e-1 (6.35e-2) =	**3.4576e-1 (4.36e-4)**	3.4526e-1 (1.79e-3) =	**3.4550e-1 (5.73e-2)**	2.1836e-1 (5.94e-2)	2.1717e-1 (4.42e-2) =	6.3431e-2 (7.40e-2) −	2.8345e-1 (3.49e-2)
DOC2	2.8690e-1 (1.73e-1) =	**5.1686e-1 (1.32e-1)**	3.2467e-1 (1.52e-1) −	**5.7595e-1 (7.72e-2)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	3.4609e-1 (1.27e-1)
DOC3	0.0000e+0 (0.00e+0) =	**1.9884e-2 (6.11e-2)**	0.0000e+0 (0.00e+0) =	**9.1084e-3 (3.06e-2)**	NaN (NaN)	NaN (NaN)	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0)
DOC4	4.5838e-1 (8.73e-2) −	**5.1928e-1 (1.37e-2)**	4.4200e-1 (1.05e-1) −	**5.1684e-1 (4.06e-2)**	5.7924e-2 (1.10e-1)	**5.8476e-2 (1.05e-1)** =	1.3946e-1 (5.58e-2) −	2.2468e-1 (5.77e-2)
DOC5	3.9590e-1 (6.66e-2) =	**3.9768e-1 (1.38e-1)**	3.3639e-1 (1.10e-1) −	**3.8120e-1 (1.79e-1)**	NaN (NaN)	NaN (NaN)	NaN (NaN)	9.8382e-2 (1.16e-1)
DOC6	1.8273e-1 (1.86e-1) =	**5.1129e-1 (1.80e-2)**	2.4295e-1 (1.70e-1) −	**5.0181e-1 (4.65e-2)**	1.4461e-4 (7.92e-4)	4.1556e-3 (1.72e-2) =	8.1111e-2 (9.13e-2) −	2.1140e-1 (1.20e-1)
DOC7	8.8809e-3 (2.93e-2) −	**2.5829e-1 (2.29e-1)**	0.0000e+0 (0.00e+0) −	**3.9080e-1 (1.88e-1)**	1.3668e-2 (4.15e-2)	0.0000e+0 (0.00e+0) =	5.2232e-3 (2.67e-2) −	6.1536e-3 (8.58e-3)
DOC8	1.8237e-6 (9.99e-6) −	**5.8168e-1 (1.00e-1)**	2.7991e-3 (8.67e-3) −	**5.2609e-1 (1.17e-1)**	0.0000e+0 (0.00e+0)	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0) =	0.0000e+0 (0.00e+0)
DOC9	NaN (NaN)	NaN (NaN)	NaN (NaN)	NaN (NaN)	0.0000e+0 (0.00e+0)	0.0000e+0 (0.00e+0) =	NaN (NaN)	NaN (NaN)
LIRCMOP1	1.3359e-1 (1.67e-2) =	**1.4116e-1 (2.14e-2)**	1.3408e-1 (1.45e-2) =	**1.4210e-1 (1.90e-2)**	1.8441e-1 (9.69e-3)	**1.8646e-1 (9.22e-3)** =	1.8249e-1 (2.09e-2) −	2.0604e-1 (2.16e-2)
LIRCMOP2	**2.8405e-1 (2.45e-2)** =	2.7618e-1 (2.83e-2)	2.6820e-1 (2.50e-2) =	2.6388e-1 (2.75e-2)	2.7376e-1 (2.40e-2)	2.7347e-1 (2.65e-2) =	3.0576e-1 (2.36e-2) −	**3.3468e-1 (2.30e-2)**
LIRCMOP3	**1.2677e-1 (2.19e-2)** +	1.1784e-1 (2.04e-2)	1.1824e-1 (1.50e-2) =	1.1822e-1 (1.61e-2)	1.5913e-1 (8.69e-3)	1.5824e-1 (1.51e-2) =	1.5813e-1 (2.21e-2) −	**1.7237e-1 (2.83e-2)**
LIRCMOP4	**2.2644e-1 (2.70e-2)** =	2.1190e-1 (1.95e-2)	2.1860e-1 (1.87e-2) =	2.1807e-1 (1.98e-2)	2.3192e-1 (1.45e-2)	2.3061e-1 (1.41e-2) =	2.5446e-1 (2.92e-2) =	**2.6475e-1 (3.60e-2)**
LIRCMOP5	2.8500e-1 (1.19e-2) =	**2.8662e-1 (3.11e-3)**	2.8499e-1 (3.93e-3) =	2.8301e-1 (1.38e-2)	1.4494e-1 (2.37e-2)	1.4556e-1 (1.87e-2) =	2.3860e-1 (2.95e-2) −	**2.8995e-1 (1.58e-2)**
LIRCMOP6	**1.9394e-1 (5.16e-4)** +	1.9391e-1 (8.42e-4)	1.9371e-1 (1.11e-3) =	1.9379e-1 (1.07e-2)	1.2134e-1 (1.58e-2)	1.1840e-1 (1.77e-2) =	1.4967e-1 (9.11e-3) −	1.8552e-1 (3.59e-2)
LIRCMOP7	2.9179e-1 (7.21e-3) =	**2.9316e-1 (2.17e-3)**	2.9258e-1 (4.36e-3) =	2.9240e-1 (4.63e-3)	2.4289e-1 (7.83e-3)	2.4143e-1 (1.15e-2) =	2.4131e-1 (6.10e-3) =	2.4478e-1 (9.38e-3)
LIRCMOP8	2.9366e-1 (1.25e-3) =	**2.9375e-1 (4.29e-4)**	2.9259e-1 (5.40e-3) =	2.9365e-1 (9.30e-4)	2.4053e-1 (1.04e-2)	2.4105e-1 (1.13e-2) =	2.2815e-1 (5.51e-3) =	2.2976e-1 (4.43e-3)
LIRCMOP9	4.4665e-1 (2.28e-2) =	**4.5755e-1 (3.23e-2)**	4.4407e-1 (1.48e-2) =	4.4138e-1 (2.17e-2)	4.4540e-1 (9.57e-2)	**4.5037e-1 (8.45e-2)** =	4.5121e-1 (3.05e-2) =	4.4779e-1 (2.95e-2)
LIRCMOP10	**6.9422e-1 (9.52e-2)** +	6.8876e-1 (1.26e-2)	6.9131e-1 (1.02e-2) =	6.8631e-1 (1.23e-2)	6.4956e-1 (1.13e-1)	6.1235e-1 (1.53e-1) −	5.4905e-1 (8.30e-2) −	5.7544e-1 (1.03e-1)
LIRCMOP11	**6.8805e-1 (6.26e-3)** =	6.8697e-1 (6.50e-3)	6.8477e-1 (7.86e-3) =	6.8144e-1 (9.55e-3)	6.3391e-1 (1.53e-1)	6.2257e-1 (1.44e-1) −	6.0467e-1 (8.15e-2) =	5.8452e-1 (8.07e-2)
LIRCMOP12	5.9303e-1 (1.36e-2) +	5.8587e-1 (1.38e-2)	5.9229e-1 (1.09e-2) +	5.7470e-1 (1.69e-2)	5.4015e-1 (5.85e-2)	5.5036e-1 (3.26e-2) =	5.2591e-1 (3.73e-2) =	5.2892e-1 (4.19e-2)
LIRCMOP13	5.2357e-1 (3.96e-2) =	**5.2370e-1 (3.31e-1)**	5.3415e-1 (3.00e-3) =	**5.3441e-1 (3.20e-3)**	5.5555e-1 (1.18e-3)	5.5605e-1 (1.34e-2) =	5.2359e-1 (4.70e-3) −	5.2564e-1 (3.81e-3)
LIRCMOP14	**5.4640e-1 (1.61e-3)** +	5.4517e-1 (1.86e-3)	5.4853e-1 (1.97e-3) =	5.4856e-1 (1.82e-3)	5.5147e-1 (1.34e-3)	5.5097e-1 (1.17e-3) =	5.3602e-1 (4.41e-3) =	5.3451e-1 (4.69e-3)
+/−/=	11/8/22		8/8/25		1/0/38		2/14/23	

TABLE S-LX

STATISTICAL RESULTS OF IGD+ OBTAINED BY THE METHODS OF SECTION-III AND VARIANTS THAT ADOPT HV AND SPACING INDICATORS FOR CALCULATING CONVERGENCE AND DIVERSITY ON ALL BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED

Problem	DRLOS-CCMO-Indi	DRLOS-CCMO	DRLOS-EMCMO-Indi	DRLOS-EMCMO	DRLOS-MOEAD-DAe-Indi	DRLOS-MOEADDAE	DRLOS-PPS-Indi	DRLOS-PPS
CF1	2.3089e-3 (4.01e-4) =	2.2811e-3 (3.70e-4)	2.3658e-3 (3.31e-4) =	2.1957e-3 (3.45e-4)	5.0253e-3 (2.08e-3)	5.0790e-3 (2.70e-3) =	1.3818e-2 (1.88e-3) -	1.2193e-2 (2.35e-3)
CF2	6.2324e-3 (2.38e-3) =	6.3466e-3 (1.96e-3)	6.9101e-3 (2.73e-3) =	6.7656e-3 (2.69e-3)	3.2971e-2 (2.64e-2)	2.5583e-2 (2.75e-2) +	3.9548e-3 (4.71e-4) -	3.7240e-3 (5.11e-4)
CF3	1.9520e-1 (6.12e-2) =	1.7704e-1 (7.03e-2)	2.0052e-1 (5.90e-2) =	1.8764e-1 (6.02e-2)	2.5910e-1 (1.34e-1) =	3.0487e-1 (1.39e-1) =	2.6254e-1 (1.37e-1) =	2.6365e-1 (1.39e-1)
CF4	3.7647e-2 (9.79e-3) =	3.3520e-2 (8.10e-3)	4.0695e-2 (8.13e-3) =	4.0393e-2 (7.07e-3)	9.2098e-2 (5.76e-2)	9.3645e-2 (4.90e-2) =	5.9843e-2 (5.16e-2) =	5.9749e-2 (3.73e-2)
CF5	2.2171e-1 (1.05e-1) =	1.8182e-1 (8.01e-2)	1.9007e-1 (6.90e-2) =	1.6987e-1 (9.96e-2)	2.1614e-1 (4.86e-2)	2.3798e-1 (6.80e-2) =	1.9631e-1 (8.76e-2) =	2.1211e-1 (7.99e-2)
CF6	2.3522e-2 (2.84e-3) =	2.4233e-2 (3.99e-3)	2.9728e-2 (1.00e-2) =	2.8311e-2 (5.73e-3)	3.6240e-2 (4.18e-2)	2.2752e-2 (7.15e-3) =	4.3408e-2 (9.85e-3) =	3.8197e-2 (1.33e-2)
CF7	1.5041e-1 (1.34e-1) =	1.5000e-1 (9.75e-2)	1.0910e-1 (5.88e-2) =	1.4147e-1 (1.10e-1)	2.4417e-1 (1.45e-1)	2.0546e-1 (1.19e-1) =	2.1725e-1 (1.24e-1) =	2.0739e-1 (9.18e-2)
CF8	1.2143e-1 (1.07e-2) +	1.5084e-1 (2.12e-2)	1.3317e-1 (1.67e-2) +	1.6727e-1 (2.80e-2)	9.3565e-2 (2.87e-2)	9.9690e-2 (4.83e-2) =	1.1171e-1 (1.45e-2) =	1.1099e-1 (1.06e-2)
CF9	7.9287e-2 (9.69e-3) =	7.7920e-2 (1.03e-2)	8.3632e-2 (1.43e-2) =	8.4547e-2 (1.32e-2)	4.7366e-2 (9.70e-3)	4.6378e-2 (2.88e-3) =	5.2554e-2 (7.16e-3) =	5.3836e-2 (9.90e-3)
CF10	2.0824e-1 (7.12e-2) +	2.7362e-1 (6.37e-2)	2.3927e-1 (7.77e-2) =	2.6734e-1 (7.38e-2)	2.0734e-1 (1.55e-1)	1.9639e-1 (1.44e-1) =	2.5994e-1 (1.42e-1) =	1.9201e-1 (1.13e-1)
DASCMOP1	2.5486e-3 (2.67e-4) =	2.6347e-3 (8.06e-4)	2.7178e-3 (3.38e-4) -	2.5278e-3 (2.52e-4)	1.7470e-1 (8.61e-2)	1.5920e-1 (3.90e-3) =	6.0124e-1 (1.90e-1) -	1.1914e-1 (1.80e-1)
DASCMOP2	4.3436e-3 (3.02e-4) =	4.3054e-3 (2.53e-4)	5.5298e-3 (1.69e-3) -	4.5000e-3 (2.92e-4)	3.4086e-2 (3.40e-2)	3.7001e-2 (3.04e-2) =	1.1899e-1 (1.56e-2) -	4.4246e-3 (2.16e-3)
DASCMOP3	1.8006e-2 (2.50e-2) -	6.8896e-3 (8.38e-4)	2.0611e-2 (2.42e-2) -	9.2764e-3 (5.89e-3)	1.7183e-1 (5.88e-2)	1.5792e-1 (4.59e-2) =	1.8119e-1 (3.63e-2) =	1.8414e-1 (1.66e-2)
DASCMOP4	1.2831e-3 (8.20e-4) =	1.1334e-1 (1.76e-1)	1.0892e-3 (7.30e-4) +	4.5370e-2 (1.05e-1)	1.1959e-3 (1.70e-3)	1.5892e-3 (1.96e-3) =	1.3991e-2 (4.82e-2) +	4.3946e-2 (8.43e-2)
DASCMOP5	2.0962e-3 (2.65e-4) +	5.3014e-2 (8.29e-2)	2.2936e-3 (6.94e-4) +	9.7416e-3 (1.92e-2)	4.9776e-3 (2.61e-3)	5.3318e-3 (2.65e-3) =	4.9033e-3 (5.35e-3) =	4.2004e-3 (3.50e-3)
DASCMOP6	5.4992e-3 (2.08e-4) +	1.3004e-1 (1.85e-1)	5.7000e-3 (3.62e-4) +	3.8780e-2 (7.10e-2)	2.7234e-2 (4.56e-2)	1.2580e-2 (1.54e-2) =	5.2660e-1 (3.01e-1) =	5.5552e-1 (3.01e-1)
DASCMOP7	2.3591e-2 (1.09e-3) +	1.3052e-1 (1.84e-1)	2.3167e-2 (1.09e-3) +	1.4519e-1 (1.45e-1)	3.1822e-2 (4.85e-3)	3.2002e-2 (3.71e-3) =	3.4736e-2 (2.61e-3) +	3.6732e-2 (2.29e-3)
DASCMOP8	1.9296e-2 (1.47e-3) +	9.6590e-2 (1.02e-1)	1.9148e-2 (2.77e-3) +	4.6088e-2 (5.16e-2)	2.9027e-2 (6.86e-3)	2.6790e-2 (4.78e-3) =	2.6965e-2 (1.69e-3) =	2.6822e-2 (1.48e-3)
DASCMOP9	1.9852e-2 (6.14e-4) +	2.1548e-2 (7.80e-4)	1.9661e-2 (7.59e-4) +	2.1323e-2 (2.10e-3)	2.0271e-1 (1.31e-1)	2.4978e-1 (1.49e-1) =	1.9653e-1 (1.20e-1) -	1.5930e-1 (1.43e-1)
DOC1	1.3702e-1 (7.22e-1) =	2.6149e-3 (1.48e-4)	2.7854e-3 (9.75e-4) =	2.6377e-3 (1.82e-4)	9.4867e-2 (1.02e-1)	9.0927e-2 (7.58e-2) =	8.0752e-1 (7.02e-1) -	6.7505e-2 (5.93e-2)
DOC2	3.0097e-1 (1.58e-1) -	9.8726e-2 (1.24e-1)	2.6518e-1 (1.41e-1) -	4.3113e-1 (7.17e-2)	NaN (NaN)	NaN (NaN)	NaN (NaN)	2.2576e-1 (1.30e-1)
DOC3	5.3391e+2 (3.54e+2) =	4.4296e+2 (4.68e+2)	5.2513e+2 (2.82e+2) =	6.0270e+2 (4.85e+2)	NaN (NaN)	NaN (NaN)	3.9974e+2 (5.07e-1) -	1.7225e+2 (1.63e+2)
DOC4	9.8886e-1 (9.40e-2) -	3.7856e-1 (1.22e-2)	1.1753e-1 (1.12e-1) -	4.1216e-2 (4.26e-2)	1.1842e+0 (7.78e-1)	1.0128e+0 (5.73e-1) =	4.4754e-1 (1.29e-1) -	3.0175e-1 (6.70e-2)
DOC5	1.3403e-1 (8.14e-2) =	1.1949e+1 (3.93e+1)	2.0767e-1 (1.28e-1) +	2.1808e+1 (5.00e+1)	NaN (NaN)	NaN (NaN)	NaN (NaN)	1.7248e+1 (5.25e+1)
DOC6	5.7728e-1 (7.27e-1) -	3.9238e-3 (3.95e-3)	3.0602e-2 (3.11e-1) -	9.4061e-3 (3.24e-2)	2.4179e+0 (1.06e+0)	2.2171e+0 (1.04e+0) =	5.6340e-1 (2.05e-1) -	3.6204e-1 (1.85e-1)
DOC7	1.5652e+0 (8.21e-1) -	5.1921e-1 (7.93e-1)	2.0699e+0 (8.57e-1) -	1.4072e-1 (2.67e-1)	3.0522e+0 (1.91e+0)	3.5655e+0 (2.53e+0) =	1.1637e+0 (4.14e-1) -	7.6541e-1 (2.05e-1)

TABLE S-LX
STATISTICAL RESULTS OF IGD+ OBTAINED BY THE METHODS OF SECTION-III AND VARIANTS THAT ADOPT HV AND SPACING INDICATORS FOR CALCULATING CONVERGENCE AND DIVERSITY ON ALL BENCHMARK PROBLEMS. THE BEST RESULT IN EACH ROW IS HIGHLIGHTED (CONTINUED)

Problem	DRLOS-CCMO-Indi	DRLOS-CCMO	DRLOS-EMCMO-Indi	DRLOS-EMCMO	DRLOS-MOEAD-DAe-Indi	DRLOS-MOEADDAE	DRLOS-PPS-Indi	DRLOS-PPS
DOC8	7.6919e+0 (8.67e+0) -	**2.2857e-1 (7.67e-2)**	5.9712e+0 (6.22e+0) -	**2.7264e-1 (8.88e-2)**	**1.0351e+2 (7.53e+1)**	1.1700e+2 (8.66e+1) =	**5.6042e+1 (2.49e+1) +**	9.8266e+1 (3.26e+1)
DOC9	**5.2409e-2 (6.30e-2) +**	7.5523e-2 (5.93e-2)	**2.7527e-2 (5.98e-3) +**	5.0283e-2 (9.22e-3)	1.4581e-1 (1.42e-1)	**1.0490e-1 (1.10e-1) =**	**2.1831e-1 (2.68e-2) +**	2.6181e-1 (2.13e-2)
LIRCMOP1	1.9596e-1 (3.93e-2) =	**1.8166e-1 (4.80e-2)**	1.9847e-1 (3.25e-2) -	**1.7898e-1 (3.70e-2)**	1.0615e-1 (1.63e-2)	**1.0514e-1 (1.66e-2) =**	9.5528e-2 (4.41e-2) -	**5.0521e-2 (3.46e-2)**
LIRCMOP2	**8.8432e-2 (2.95e-2) =**	9.8504e-2 (3.06e-2)	1.0843e-1 (2.98e-2) =	1.1141e-1 (3.32e-2)	9.6380e-2 (4.18e-2)	**9.4115e-2 (3.87e-2) =**	6.3449e-2 (2.27e-2) -	**3.1777e-2 (2.27e-2)**
LIRCMOP3	**1.8039e-1 (5.87e-2) =**	2.0504e-1 (5.76e-2)	2.0350e-1 (3.97e-2) =	2.0513e-1 (4.35e-2)	**1.3820e-1 (2.97e-2)**	1.4124e-1 (4.18e-2) =	9.8935e-2 (5.93e-2) -	**7.0081e-2 (6.30e-2)**
LIRCMOP4	**1.3075e-1 (4.04e-2) =**	1.5243e-1 (3.14e-2)	1.4023e-1 (2.90e-2) =	1.4234e-1 (3.22e-2)	**1.1618e-1 (2.33e-2)**	1.1815e-1 (2.28e-2) =	8.8658e-2 (4.06e-2) =	**7.2644e-2 (5.09e-2)**
LIRCMOP5	1.6211e-2 (1.44e-2) =	**1.4657e-2 (6.31e-3)**	1.7084e-2 (5.60e-3) =	1.9500e-2 (1.83e-2)	2.5862e-1 (5.83e-2)	**2.5638e-1 (4.66e-2) =**	**6.8547e-2 (3.95e-2) -**	7.2731e-1 (2.14e-3)
LIRCMOP6	1.1187e-2 (1.07e-3) =	**1.1160e-2 (1.55e-3)**	1.1834e-2 (1.85e-3) =	**1.1651e-2 (2.33e-3)**	**2.8511e-1 (5.77e-2)**	2.9540e-1 (6.39e-2) -	1.7820e-1 (3.76e-2) -	**6.2842e-2 (2.43e-1)**
LIRCMOP7	1.0589e-2 (1.33e-2) =	**7.7800e-3 (3.10e-3)**	**8.7560e-3 (6.74e-3) =**	9.5164e-3 (8.30e-3)	**1.1668e-1 (2.05e-2)**	1.2048e-1 (3.04e-2) =	1.1792e-1 (1.50e-2) =	**1.0937e-1 (2.11e-2)**
LIRCMOP8	6.9383e-3 (1.28e-3) =	6.9280e-3 (6.95e-3)	8.9523e-3 (9.80e-3) =	**7.0347e-3 (7.57e-4)**	1.2330e-1 (2.72e-2)	**1.2194e-1 (2.96e-2) =**	1.7323e-1 (2.38e-2) =	**1.6705e-1 (2.43e-2)**
LIRCMOP9	1.5965e-1 (2.54e-2) =	**1.4893e-1 (3.47e-2)**	**1.6267e-1 (1.73e-2) =**	1.6668e-1 (2.37e-2)	2.5212e-1 (2.32e-1)	**2.3429e-1 (2.05e-1) =**	**1.9713e-1 (5.12e-2) =**	2.0240e-1 (4.93e-2)
LIRCMOP10	**2.6086e-2 (1.87e-2) +**	3.5973e-2 (2.44e-2)	**3.1139e-2 (2.04e-2) =**	4.0278e-2 (2.44e-2)	**6.9033e-2 (1.40e-1)**	1.1618e-1 (2.09e-1) =	2.3217e-1 (1.17e-1) =	**1.9290e-1 (1.47e-1)**
LIRCMOP11	**8.8989e-3 (9.20e-3) =**	1.0432e-2 (9.45e-3)	**1.3650e-2 (1.15e-2) =**	1.8288e-2 (1.42e-2)	**1.0813e-1 (2.81e-1)**	1.2628e-1 (2.63e-1) =	**1.1511e-1 (9.76e-2) =**	1.3919e-1 (9.70e-2)
LIRCMOP12	**5.2369e-2 (2.38e-2) +**	6.6395e-2 (2.30e-2)	**5.5293e-2 (1.98e-2) +**	8.1841e-2 (2.49e-2)	1.8337e-1 (1.73e-1)	**1.3288e-1 (8.04e-2) =**	1.5231e-1 (5.24e-2) =	**1.4758e-1 (5.88e-2)**
LIRCMOP13	7.4979e-2 (3.58e-3) =	**7.4755e-2 (3.32e-3)**	6.4555e-2 (2.87e-3) =	**6.4215e-2 (3.36e-3)**	4.3147e-2 (1.30e-3)	**4.2671e-2 (1.20e-3) =**	6.4947e-2 (2.87e-3) =	**6.3727e-2 (2.70e-3)**
LIRCMOP14	**5.3744e-2 (1.63e-3) +**	5.4903e-2 (1.88e-3)	**5.1793e-2 (1.91e-3) =**	5.1796e-2 (1.80e-3)	**4.8427e-2 (1.24e-3)**	4.8875e-2 (1.13e-3) =	**5.6769e-2 (2.74e-3) =**	5.7911e-2 (3.06e-3)
+/−/=	12/6/24		10/9/23		0/1/38		4/15/21	