Supplementary File of "A General Framework of Dynamic Constrained Multi-objective Evolutionary Algorithms for Constrained Optimization"

Sanyou Zeng, Ruwang Jiao, Changhe Li, Xi Li and Jawdat S. Alkasassbeh

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S. Zeng , R. Jiao and J. S. Alkasassbeh are with the School of Mechanical Engineering and Electronic Information, China University of Geosciences, Wuhan, China, 430074 (sanyouzeng@gmail.com, ruwangjiao@gmail.com, jawdat1983@yahoo.com).

C. Li is with the School of Automation, China University of Geosciences, Wuhan, China, 430074. C. Li is also with the Hubei key Laboratory of Advanced Control and Intelligent Automation for Complex Systems, Wuhan, China, 430074 (changhe.lw@gmail.com).

X. Li is with the School of Information Engineering, Hebei GEO University, Shijiazhuang, Hebei, China, 050031 (lixi_sjz@foxmail.com).

I. Results of the Peer Algorithms on the Test Suite $setG$

TABLE I
COMPARISON OF DCNSGA-II-DE, DCM2M-DE AND DCHYPE-DE WITH CMODE [2], εADE [3], DPDE[1], ECHT-ARMOR-DE1[4] AND ECHT-ARMOR-DE2[4] OVER 25 INDEPENDENT RUNS ON G01-G16

		Fcn/opt					Fcn/opt			
Alg.s	FEs	b	Mn	w	sd	FEs	b	Mn	w	sd
		g01/-15.0000					g02/-0.803619			
DCNSGAII-DE	240,116	-15.0000	**-15.0000**	-15.0000	5.52E-10	240,208	-0.803619	**-0.803619**	-0.803619	1.44E-07
DCM2M-DE	240,000	-15.0000	**-15.0000**	-15.0000	8.52E-07	240,000	-0.803619	-0.803618	-0.803617	5.48E-07
DCHypE-DE	240,000	-15.0000	**-15.0000**	-15.0000	7.89E-07	240,000	-0.803619	**-0.803619**	-0.803619	2.65E-08
CMODE	240,000	-15.0000	**-15.0000**	-15.0000	1.93E-07	240,000	-0.803608	-0.803178	-0.792608	2.20E-03
εADE	240,000	-15.0000	**-15.0000**	-15.0000	0.0E+00	240,000	-0.803617	-0.803604	-0.803542	4.45E-05
DPDE	240,000	-15.0000	**-15.0000**	-15.0000	0.0E+00	240,000	-0.803619	-0.802350	-0.795326	1.18E-03
ECHT-ARMOR-DE1	240,000	–	**-15.0000**	–	0.0E+00	240,000	–	-0.790034	–	1.23E-02
ECHT-ARMOR-DE2	240,000	–	**-15.0000**	–	0.0E+00	240,000	–	-0.795264	–	8.10E-03
		g03/-1.0005					g04/-30665.5387			
DCNSGAII-DE	240,000	-1.0005	**-1.0005**	-1.0005	8.99E-08	240,040	-30665.539	**-30665.539**	-30665.539	1.94E-07
DCM2M-DE	240,020	-1.0005	**-1.0005**	-1.0005	1.23E-07	240,008	-30665.539	**-30665.539**	-30665.539	1.04E-06
DCHypE-DE	240,000	-1.0005	**-1.0005**	-1.0005	4.02E-07	240,100	-30665.539	**-30665.539**	-30665.538	5.17E-05
CMODE	240,000	-1.0005	**-1.0005**	-1.0005	3.51E-08	240,000	-30665.539	**-30665.539**	-30665.539	1.11E-11
εADE	240,000	-1.0005	**-1.0005**	-1.0005	1.34E-10	240,000	-30665.539	**-30665.539**	-30665.539	3.71E-12
DPDE	240,000	-1.0005	**-1.0005**	-1.0005	0.0E+00	240,000	-30665.539	**-30665.539**	-30665.539	0.0E+00
ECHT-ARMOR-DE1	240,000	–	**-1.0005**	–	0.00E+00	240,000	–	**-30665.539**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**-1.0005**	–	0.00E+00	240,000	–	**-30665.539**	–	0.00E+00
		g05/5126.4967					g06/-6961.8139			
DCNSGAII-DE	240,556	5126.497	**5126.497**	5126.497	8.94E-11	240,000	-6961.814	**-6961.814**	-6961.814	3.13E-05
DCM2M-DE	240,116	5126.497	**5126.497**	5126.497	6.00E-10	240,124	-6961.814	**-6961.814**	-6961.814	6.22E-05
DCHypE-DE	240,000	5126.497	**5126.497**	5126.497	9.33E-07	240,012	-6961.814	**-6961.814**	-6961.814	6.38E-05
CMODE	240,000	5126.497	**5126.497**	5126.497	9.25E-13	240,000	-6961.814	**-6961.814**	-6961.814	1.85E-12
εADE	240,000	5126.497	**5126.497**	5126.497	1.46E-12	240,000	-6961.814	**-6961.814**	-6961.814	4.89E-13
DPDE	240,000	5126.497	**5126.497**	5126.497	0.0E+00	240,000	-6961.814	**-6961.814**	-6961.814	0.00E+00
ECHT-ARMOR-DE1	240,000	–	**5126.497**	–	0.00E+00	240,000	–	**-6961.814**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**5126.497**	–	0.00E+00	240,000	–	**-6961.814**	–	0.0E+00
		g07/24.306					g08/-0.095825			
DCNSGAII-DE	240,004	24.306	**24.306**	24.306	1.34E-05	240,068	-0.095825	**-0.095825**	-0.095825	4.54E-17
DCM2M-DE	240,004	24.306	**24.306**	24.306	4.67E-06	240,000	-0.095825	**-0.095825**	-0.095825	4.33E-16
DCHypE-DE	240,000	24.306	**24.306**	24.307	2.57E-04	240,028	-0.095825	**-0.095825**	-0.095825	9.27E-16
CMODE	240,000	24.306	**24.306**	24.306	1.21E-14	240,000	-0.095825	**-0.095825**	-0.095825	1.10E-17
εADE	240,000	24.306	**24.306**	24.306	4.07E-05	240,000	-0.095825	**-0.095825**	-0.095825	0.0E+00
DPDE	240,000	24.306	**24.306**	24.306	6.25E-09	240,000	-0.095825	**-0.095825**	-0.095825	0.0E+00
ECHT-ARMOR-DE1	240,000	–	**24.306**	–	0.00E+00	240,000	–	**-0.095825**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**24.306**	–	0.00E+00	240,000	–	**-0.095825**	–	0.0E+00
		g09/680.630057					g10/7049.248			
DCNSGAII-DE	240,032	680.630	**680.630**	680.630	3.90E-05	240,420	7049.248	7049.250	7049.266	3.56E-03
DCM2M-DE	240,064	680.630	**680.630**	680.630	4.05E-09	240,124	7049.248	7049.253	7049.265	4.39E-03
DCHypE-DE	240,084	680.630	**680.630**	680.630	1.16E-06	240,132	7049.249	7049.259	7049.302	1.25E-02
CMODE	240,000	680.630	**680.630**	680.630	1.46E-11	240,000	7049.248	**7049.248**	7049.248	3.65E-12
εADE	240,000	680.630	**680.630**	680.630	7.21E-12	240,000	7049.248	**7049.248**	7049.248	4.46E-05
DPDE	240,000	680.630	**680.630**	680.630	3.65E-14	240,000	7049.248	**7049.248**	7049.248	8.36E-08
ECHT-ARMOR-DE1	240,000	–	**680.630**	–	0.00E+00	240,000	–	**7049.248**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**680.630**	–	0.00E+00	240,000	–	**7049.248**	–	0.00E+00
		g11/0.749900					g12/-1.000			
DCNSGAII-DE	240,260	0.7499	**0.7499**	0.7499	2.34E-10	240,000	-1.0000	**-1.0000**	-1.0000	0.00E+00
DCM2M-DE	240,104	0.7499	**0.7499**	0.7499	3.32E-12	240,000	-1.0000	**-1.0000**	-1.0000	0.00E+00
DCHypE-DE	240,000	0.7499	**0.7499**	0.7499	1.34E-08	240,000	-1.0000	**-1.0000**	-1.0000	0.00E+00
CMODE	240,000	0.7499	**0.7499**	0.7499	1.13E-16	240,000	-1.0000	**-1.0000**	-1.0000	0.0E+00
εADE	240,000	0.7499	**0.7499**	0.7499	1.11E-16	240,000	-1.0000	**-1.0000**	-1.0000	0.0E+00
DPDE	240,000	0.7499	**0.7499**	0.7499	0.0E+00	240,000	-1.0000	**-1.0000**	-1.0000	0.0E+00
ECHT-ARMOR-DE1	240,000	–	**0.7499**	–	0.00E+00	240,000	–	**-1.0000**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**0.7499**	–	0.0E+00	240,000	–	**-1.0000**	–	0.0E+00
		g13/0.0539415					g14/-47.7649			
DCNSGAII-DE	240,316	0.05394	**0.05394**	0.05394	3.40E-09	240,036	-47.7649	**-47.7649**	-47.7649	3.58E-06
DCM2M-DE	240,064	0.05394	**0.05394**	0.05394	2.68E-12	240,068	-47.7649	**-47.7649**	-47.7649	6.44E-06
DCHypE-DE	240,100	0.05394	**0.05394**	0.05394	4.53E-09	240,100	-47.7649	**-47.7649**	-47.7647	1.03E-05
CMODE	240,000	0.05394	**0.05394**	0.05394	1.13E-16	240,000	-47.7649	**-47.7649**	-47.7649	2.29E-14
εADE	240,000	0.05394	**0.05394**	0.05394	0.0E+00	240,000	-47.7649	**-47.7649**	-47.7648	9.84E-06
DPDE	240,000	0.05394	**0.05394**	0.05394	1.16E-17	240,000	-47.7649	**-47.7649**	-47.7649	2.56E-09
ECHT-ARMOR-DE1	240,000	–	**0.05394**	–	0.00E+00	240,000	–	**-47.7649**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**0.05394**	–	0.00E+00	240,000	–	**-47.7649**	–	0.00E+00
		g15/ 961.715022					g16/-1.905155			
DCNSGAII-DE	240,196	961.71502	**961.71502**	961.71502	3.39E-11	240,064	-1.905155	**-1.905155**	-1.905155	4.40E-11
DCM2M-DE	240,044	961.71502	**961.71502**	961.71502	3.30E-11	240,000	-1.905155	**-1.905155**	-1.905155	8.71E-10
DCHypE-DE	240,080	961.71502	**961.71502**	961.71502	4.50E-08	240,000	-1.905155	**-1.905155**	-1.905155	1.32E-09
CMODE	240,000	961.71502	**961.71502**	961.71502	6.94E-13	240,000	-1.905155	**-1.905155**	-1.905155	6.78E-16
εADE	240,000	961.71502	**961.71502**	961.71502	5.68E-13	240,000	-1.905155	**-1.905155**	-1.905155	1.33E-15
DPDE	240,000	961.71502	**961.71502**	961.71502	0.0E+00	240,000	-1.905155	**-1.905155**	-1.905155	0.0E+00
ECHT-ARMOR-DE1	240,000	–	**961.71502**	–	0.00E+00	240,000	–	**-1.905155**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**961.71502**	–	0.0E+00	240,000	–	**-1.905155**	–	0.00E+00

b, Mn, w, and sd represent the best, mean, worst, and standard deviation, respectively, of results over all runs; FEs represents the function evaluations for CMODE, εADE, DPDE, ECHT-ARMOR-DE1, and ECHT-ARMOR-DE2; For DCNSGAII-DE, DCM2M-DE, and DCHypE-DE, FEs represents the average evaluations.

TABLE II
COMPARISON OF DCNSGA-II-DE, DCM2M-DE AND DCHYPE-DE WITH CMODE [2], εADE [3], DPDE[1], ECHT-ARMOR-DE1[4] AND ECHT-ARMOR-DE2[4] OVER 25 INDEPENDENT RUNS ON G17-G24

		Fcn/opt					Fcn/opt			
Alg.s	FEs	b	Mn	w	sd	FEs	b	Mn	w	sd
		g17/8853.5339					g18/-0.86602540			
DCNSGAII-DE	240,116	8853.5339	**8853.5339**	8853.5339	3.38E-08	240,188	-0.866025	**-0.866025**	-0.866025	7.48E-08
DCM2M-DE	240,000	8853.5339	**8853.5339**	8853.5339	7.44E-06	240,148	-0.866025	**-0.866025**	-0.866025	1.29E-07
DCHypE-DE	240,100	8853.5339	8853.5340	8853.5340	2.85E-05	240,100	-0.866025	-0.866024	-0.866021	9.79E-07
CMODE	240,000	8853.5339	**8853.5339**	8853.5339	0.0E+00	240,000	-0.866025	**-0.866025**	-0.866025	5.16E-08
εADE	240,000	8863.6985	8893.6240	8964.3240	3.31E+01	240,000	-0.865967	-0.865731	-0.865047	2.21E-04
DPDE	240,000	8853.5339	**8853.5339**	8853.5339	2.34E-12	240,000	-0.866025	**-0.866025**	-0.866025	1.65E-12
ECHT-ARMOR-DE1	240,000	–	8853.5397	–	0.00E+00	240,000	–	**-0.866025**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	8853.5397	–	0.00E+00	240,000	–	**-0.866025**	–	0.00E+00
		g19/32.6556					g20/NA			
DCNSGAII-DE	240,000	32.6556	32.6684	32.8414	3.79E-02	1,000,000	0.2676	0.3223*	0.3752	2.29E-02
DCM2M-DE	240,004	32.6557	32.6824	32.7908	4.12E-02	1,000,000	0.2689	0.3383*	0.4572	2.59E-02
DCHypE-DE	240,100	32.6558	32.6785	32.7899	3.24E-02	1,000,000	0.2793	0.3298*	0.4507	9.47E-02
CMODE	240,000	32.6556	**32.6556**	32.6556	7.87E-11	–	–	–	–	–
εADE	240,000	32.6556	32.6605	32.6958	8.55E-03	–	–	–	–	–
DPDE	240,000	32.6556	**32.6556**	32.6556	6.17E-08	–	–	–	–	–
ECHT-ARMOR-DE1	240,000	–	**32.6556**	–	8.39E-06	–	–	–	–	–
ECHT-ARMOR-DE2	240,000	–	**32.6556**	–	1.90E-05	–	–	–	–	–
		g21/193.7245					g22/236.43098			
DCNSGAII-DE	240,036	193.7245	**193.7245**	193.7245	1.11E-06	468,320	238.978	268.670	320.275	2.22E+01
DCM2M-DE	240,000	193.7245	**193.7245**	193.7245	1.03E-06	493,152	240.762	3300.306*	17837.055	5.86E+03
DCHypE-DE	240,684	193.7245	**193.7245**	193.7245	2.35E-06	504,784	245.258	268.706	305.515	1.46E+01
CMODE	240,000	193.7245	230.3984	324.7028	6.00E+01	–	–	–	–	–
εADE	240,000	193.7245	**193.7245**	193.7245	4.09E-11	–	–	–	–	–
DPDE	240,000	193.7245	193.7262	193.7536	8.36E-04	–	–	–	–	–
ECHT-ARMOR-DE1	240,000	–	**193.7245**	–	0.00E+00	–	–	–	–	–
ECHT-ARMOR-DE2	240,000	–	**193.7245**	–	0.00E+00	–	–	–	–	–
		g23/-400.0551					g24 /-5.5080			
DCNSGAII-DE	240,228	-400.0551	**-400.0551**	-400.0551	4.10E-06	240,000	-5.5080	**5.5080**	-5.5080	1.52E-10
DCM2M-DE	240,044	-400.0550	-400.0511	-400.0063	1.06E-02	240,000	-5.5080	**-5.5080**	-5.5080	3.36E-09
DCHypE-DE	240,100	-400.0548	-400.0532	-400.0515	8.93E-04	240,000	-5.5080	**-5.5080**	-5.5080	2.41E-08
CMODE	240,000	-400.0549	-399.9532	-397.4744	4.69E-02	240,000	-5.5080	**-5.5080**	-5.5080	1.81E-15
εADE	240,000	-400.0551	-382.8252	-100.0465	6.01E+01	240,000	-5.5080	**-5.5080**	-5.5080	8.88E-16
DPDE	240,000	-400.0551	-399.2752	-396.9405	1.52E+00	240,000	-5.5080	**-5.5080**	-5.5080	0.0E+00
ECHT-ARMOR-DE1	240,000	–	**-400.0551**	–	2.68E-09	240,000	–	**-5.5080**	–	0.00E+00
ECHT-ARMOR-DE2	240,000	–	**-400.0551**	–	1.76E-08	240,000	–	**-5.5080**	–	0.0E+00

b, Mn, w, and sd represent the best, mean, worst and standard deviation, respectively, of the results over all runs; FEs represents the function evaluations for CMODE, εADE, DPDE, ECHT-ARMOR-DE1,ECHT-ARMOR-DE2; For DCNSGAII-DE, DCM2M-DE,DCHypE-DE, the FEs represents the average evaluations; Results with * means that there are infeasible solutions over 25 independent runs.

II. Results of the Peer Algorithms on the Test Suite $setC$

TABLE III
EXPERIMENTAL RESULT OF DCNSGA-II-DE, DCM2M-DE, DCHYPE-DE,CMODE [2],εADE [3], AIS[5] AND ECHT-ARMOR-DE[4] OVER 25 INDEPENDENT ON C01-C18 WITH 10 DIMENSIONS.

		Fcn					Fcn			
Alg.s	FEs	b	Mn	w	sd	FEs	b	Mn	w	sd
		c01-10D					c02-10D			
DCNSGAII-DE	200,300	-0.7473	-0.7389	-0.7285	5.36E-03	200,192	-2.2777	**-2.2777**	-2.2777	1.50E-06
DCM2M-DE	200,240	-0.7473	-0.7382	-0.7285	3.73E-03	200,108	-2.2777	**-2.2777**	-2.2777	4.32E-06
DCHypE-DE	200,100	-0.7473	-0.7366	-0.7202	4.95E-03	200,000	-2.2777	**-2.2777**	-2.2777	3.90E-07
CMODE	200,000	-0.7473	**-0.7473**	-0.7473	1.26E-13	200,000	-1.9273	-1.5459	-0.7219	3.05E-01
εADE	200,000	-0.7473	-0.7461	-0.7380	4.41E-03	200,000	-1.5884	-0.5859	2.0929	7.32E-01
AIS	200,000	-0.7473	-0.7471	-0.7436	1.30E-03	200,000	-2.2777	-2.2748	-2.2709	2.05E-03
ECHT-ARMOR-DE	200,000	-0.7473	-0.7470	-0.7406	1.45E-03	200,000	-2.2777	-2.2770	-2.2612	3.35E-03
		c03-10D					c04-10D			
DCNSGAII-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,056	-9.788E-06	-9.639E-06	-9.509E-06	6.58E-08
DCM2M-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,060	-9.927E-06	-9.769E-06	-9.462E-06	1.05E-07
DCHypE-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,000	-9.784E-06	-9.619E-06	-9.523E-06	6.90E-08
CMODE	200,000	0.00E+00	3.5502E+00	8.8756E+00	4.44E+00	200,000	-1.000E-05	**-9.980E-06**	-9.674E-06	6.98E-08
εADE	200,000	8.8756E+00	8.8756E+00	8.8756E+00	1.48E-10	200,000	-1.000E-05	-1.000E-05	-1.000E-05	0.00E+00
AIS	200,000	0.00E+00	3.7472E-09	2.1342E-08	4.81E-04	200,000	-1.000E-05	-9.971E-06	-9.932E-06	4.28E-03
ECHT-ARMOR-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,000	-1.000E-05	-1.000E-05	-1.000E-05	0.00E+00
		c05-10D					c06-10D			
DCNSGAII-DE	201,092	-4.8361E+02	**-4.8361E+02**	-4.8361E+02	3.39E-08	200,104	-5.7866E+02	-5.7866E+02	-5.7866E+02	1.42E-04
DCM2M-DE	200,564	-4.8361E+02	**-4.8361E+02**	-4.8361E+02	5.44E-08	200,124	-5.7866E+02	-5.7866E+02	-5.7866E+02	5.89E-06
DCHypE-DE	200,000	-4.8361E+02	**-4.8361E+02**	-4.8361E+02	4.43E-08	200,000	-5.7866E+02	-5.7866E+02	-5.7866E+02	7.01E-07
CMODE	200,000	-4.8357E+02	-4.5198E+02	2.9571E+02	1.56E+02	200,000	-5.7866E+02	-5.7863E+02	-5.7858E+02	2.27E-02
εADE	200,000	-2.2626E-02	1.7441E+02	4.8157E+02	1.74E+02	200,000	-1.4799E-02	1.2609E+01	4.4949E+02	1.76E+02
AIS	200,000	-4.8361E+02	-4.7996E+02	-4.6012E+02	6.35E+00	200,000	-5.8000E+02	**-5.7995E+02**	-5.7974E+02	7.35E-08
ECHT-ARMOR-DE	200,000	-4.8361E+02	**-4.8361E+02**	-4.8361E+02	0.00E+00	200,000	-5.7866E+02	-5.7866E+02	-5.7866E+02	4.05E-13
		c07-10D					c08-10D			
DCNSGAII-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,000	5.74E-12	3.04E+00	1.53E+01	4.22E+00
DCM2M-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,092	6.44E-13	9.39E+00	5.08E+01	1.47E+01
DCHypE-DE	200,100	2.5198E-08	3.7193E-03	9.2982E-02	1.82E-02	200,000	4.53E-12	3.98E+00	1.05E+01	4.02E+00
CMODE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,000	2.42E-13	8.11E+00	1.09E+01	4.65E+00
εADE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,000	1.11E-25	**2.99E+00**	1.09E+01	4.80E+00
AIS	200,000	0.00E+00	1.1735E-08	2.1778E-01	2.75E+00	200,000	5.55E-12	4.09E+00	9.48E+00	1.46E+00
ECHT-ARMOR-DE	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00	200,000	0.00E+00	7.53E+00	1.09E+01	5.05E+00
		c09-10D					c10-10D			
DCNSGAII-DE	200,000	0.00E+00	7.391E+00	1.0215E+02	2.18E+01	200,004	2.542E-06	3.190E+01	4.173E+01	1.75E+01
DCM2M-DE	200,012	0.00E+00	6.167E-01	7.7084E+00	2.09E+00	200,000	2.541E-06	2.837E+01	4.173E+01	1.94E+01
DCHypE-DE	200,000	0.00E+00	3.083E-01	7.7084E+00	1.51E+00	200,000	2.541E-06	2.503E+01	4.172E+01	2.04E+01
CMODE	200,000	2.043E+03	1.3370E+06*	3.0800E+07	6.15E+06	200,000	1.439E+02	7.094E+03*	6.326E+04	1.59E+04
εADE	200,000	1.493E+05	2.868E+09*	3.8323E+10	8.08E+08	200,000	2.421E+05	2.613E+09*	2.539E+10	6.23E+09
AIS	200,000	5.201E-08	2.698E+01	2.9953E+02	7.50E+01	200,000	2.684E-17	1.620E+03	2.574E+03	5.05E+02
ECHT-ARMOR-DE	200,000	0.00E+00	**1.76E-01**	4.4082E+00	8.85E-01	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
		c11-10D					c12-10D			
DCNSGAII-DE	632,932	-4.4617E-03	2.1245E-04*	2.2584E-02	***5.02E-03!!!***	1,000,000	-9.1845E+02	-3.1098E+02*	6.8353E+00	4.93E+02
DCM2M-DE	814,752	-1.5227E-03	3.5459E-04*	2.1637E-03	1.54E-03	644,836	-5.5435E+02	-2.8832E+02*	-1.9924E-01	2.76E+02
DCHypE-DE	568,508	-1.5228E-03	-4.0592E-04*	1.3116E-03	1.19E-03	371,760	-5.5435E+02	-1.1099E+02*	-1.9924E-01	2.21E+02
CMODE	200,000	-8.7341E-02	-8.3908E-02*	-1.5227E-03	1.72E-02	200,000	-8.8703E+02	-6.4753E+02*	-1.9924E-01	2.01E+02
εADE	200,000	-1.7812E+00	-3.0092E-01*	3.9047E-01	6.94E-01	200,000	-8.8704E+02	-8.8704E+02*	-8.8704E+02	2.40E-07
AIS	200,000	-1.5227E-03	**-9.1995E-04**	1.3972E-03	8.23E-04	200,000	-5.7019E+02	**-4.3577E+02**	-2.5535E+02	6.02E+01
ECHT-ARMOR-DE	200,000	-1.5227E-03	-4.2716E-02*	-8.7342E-02	4.45E-02	200,000	-1.9925E-01	-1.9925E-01	-1.9925E-01	1.65E-13
		c13-10D					c14-10D			
DCNSGAII-DE	200,000	-6.8429E+01	-6.6849E+01	-6.2490E+01	2.55E+00	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
DCM2M-DE	200,012	-6.8429E+01	**-6.8429E+01**	6.8429E+01	7.39E-08	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
DCHypE-DE	200,100	-6.8429E+01	-6.6819E+01	-6.24900E+01	2.36E+00	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
CMODE	200,000	-6.8426E+01	-5.9162E+01	-5.1546E+01	4.42E+00	200,000	1.0553E-10	6.7798E-09	3.3036E-08	8.57E-09
εADE	200,000	-6.8429E+01	**-6.8429E+01**	-6.8429E+01	2.30E-07	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
AIS	200,000	-6.8430E+01	-6.7874E+01	-6.7071E+01	3.11E-01	200,000	1.5314E-14	1.2213E-04	2.2116E-04	2.95E-08
ECHT-ARMOR-DE	200,000	-6.8429E+01	-6.7169E+01	-6.2276E+01	2.15E+00	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
		c15-10D					c16-10D			
DCNSGAII-DE	200,000	3.3266E-10	2.0900E+00	4.4974E+00	1.86E+00	200,072	0.00E+00	1.4022E-03	1.9146E-02	4.78E-03
DCM2M-DE	200,024	1.0944E-10	1.1754E+00	3.6732E+00	1.71E+00	200,076	0.00E+00	1.3417E-03	1.9146E-02	4.60E-03
DCHypE-DE	200,100	1.0152E-06	1.3224E+00	3.6732E+00	1.76E+00	200,100	2.1538E-06	3.3640E-03	5.3054E-02	1.18E-02
CMODE	200,000	3.7527E-01	1.0878E+02	1.4696E+03	2.89E+02	200,000	8.6718E-08	6.1158E-05	5.3984E-02	1.47E-04
εADE	200,000	3.7819E-11	7.9284E+06	6.5892E+07	1.73E+07	200,000	0.00E+00	1.5391E-01	1.0279E+00	2.86E-01
AIS	200,000	2.5265E-20	**5.1855E-09**	2.8151E-08	1.15E-08	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
ECHT-ARMOR-DE	200,000	0.00E+00	2.8246E+00	4.4974E+00	1.65E+00	200,000	0.00E+00	2.8478E-02	2.3426E-01	5.05E-02
		c17-10D					c18-10D			
DCNSGAII-DE	200,100	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
DCM2M-DE	200,344	4.1422E-18	1.3219E-02	3.2708E-01	6.40E-02	200,056	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
DCHypE-DE	200,040	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00
CMODE	200,000	4.0071E-04	6.6913E-03	3.9624E-02	8.28E-02	200,000	9.3501E+01	7.7049E+03	1.7485E+04	4.48E+03
εADE	200,000	4.1376E-18	4.2061E-01	1.3177E+00	3.14E-01	200000	2.1084E-01	6.9830E+02	1.3055E+04	2.54E+03
AIS	200,000	1.4250E-09	2.9340E+00	4.7120E+00	2.29E+00	200,000	1.2521E-18	1.6590E+00	6.6334E+00	1.27E+00
ECHT-ARMOR-DE	200,000	0.00E+00	**0.00E+00**	0.000E+00	0.00E+00	200,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00

b, Mn, w, and sd represent the best, mean, worst and standard deviation, respectively, of results over all runs; FEs represents the function evaluations for CMODE, εADE, AIS, and ECHT-ARMOR-DE; For DCNSGAII-DE, DCM2M-DE, and DCHypE-DE, the FEs represents the average evaluations; Results with * means that there are infeasible solutions over 25 independent runs.

TABLE IV
EXPERIMENTAL RESULTS OF DCNSGA-II-DE, DCM2M-DE,DCHYPE-DE WITH CMODE [2], εADE [3], AIS[5] AND ECHT-ARMOR-DE[4] OVER 25 INDEPENDENT RUNS ON C01-C18 WITH 30 DIMENSIONS.

		Fcn					Fcn			
Alg.s	FEs	b	Mn	w	sd	FEs	b	Mn	w	sd
		c01-30D					c02-30D			
DCNSGAII-DE	600,132	-0.82188	-0.82127	-0.81273	2.12E-03	600,120	-2.27759	-2.27099	-2.25878	4.43E-03
DCM2M-DE	600,356	-0.82188	-0.82068	-0.79704	4.93E-03	600,168	-2.28018	-2.27406	-2.25767	5.14E-03
DCHypE-DE	600,000	-0.82188	**-0.82188**	-0.82188	1.61E-08	600,000	-2.27768	**-2.27533**	-2.26819	3.66E-03
CMODE	600,000	-0.82188	-0.82079	-0.81794	1.48E-03	600,000	-0.15389	0.87004	3.2703	9.20E-01
εADE	600,000	-0.82188	-0.81924	-0.81425	2.35E-03	600,000	0.59233	1.6713	2.3253	3.95E-01
AIS	600,000	-0.82196	-0.82011	-0.75773	3.25E-04	600,000	-2.22444	-2.21252	-2.20280	2.84E-03
ECHT-ARMOR-DE	600,000	-0.81806	-0.78992	-0.73601	2.51E-02	600,000	-2.2607	-2.1706	-1.9746	7.36E-02
		c03-30D					c04-30D			
DCNSGAII-DE	600,012	2.8673E+01	2.8673E+01	2.8673E+01	4.63E-06	600,008	-2.95E-06	1.46E-05	4.00E-04	7.87E-05
DCM2M-DE	616,128	2.8674E+01	3.4053E+01	1.6316E+02	2.64E+01	600,108	-3.15E-06	1.12E-05	1.23E-04	2.93E-05
DCHypE-DE	600,000	2.8674E+01	2.8674E+01	2.8674E+01	6.11E-05	600,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
CMODE	600,000	0.00E+00	**2.4086E+01**	2.8674E+01	1.07E+01	600,000	1.49E-04	8.38E-04	1.49E-03	4.09E-04
εADE	600,000	2.8673E+01	2.8673E+01	2.8673E+01	4.61E-07	600,000	2.77E-03	2.29E-02	6.63E-02	1.40E-02
AIS	600,000	8.5374E-05	6.6758E+01	8.9201E+01	4.26E+02	600,000	-2.08E-02	1.98E-03	1.29E-02	1.61E-03
ECHT-ARMOR-DE	600,000	2.5801E-24	2.6380E+01	2.8673E+01	7.94E+00	600,000	-3.33E-06	8.37E-02	1.09E+00	2.89E-01
		c05-30D					c06-30D			
DCNSGAII-DE	647,940	-483.61	**-483.61**	-483.61	1.37E-07	600,004	-530.63	**-530.61**	-530.56	1.99E-02
DCM2M-DE	614,684	-483.61	**-483.61**	-483.61	7.09E-08	600,008	-530.64	**-530.61**	-530.49	3.30E-02
DCHypE-DE	600,000	-483.61	**-483.61**	-483.61	1.80E-07	600,000	-530.64	**-530.61**	-530.52	2.78E-02
CMODE	600,000	-79.98	293.25	554.42	1.94E+02	600,000	-516.83	-489.97	-418.63	2.99E+01
εADE	600,000	189.15	394.19	571.91	1.09E+02	600,000	253.50	419.11	594.65	8.29E+01
AIS	600,000	-483.34	-436.11	-425.01	2.51E+01	600,000	-530.33	-454.26	-424.54	4.79E+01
ECHT-ARMOR-DE	600,000	-481.22	-433.35	76.41	1.46E+02	600,000	-530.10	-489.31	124.54	1.32E+02
		c07-30D					c08-30D			
DCNSGAII-DE	600,000	5.7476E-11	4.2694E+01	7.6174E+01	3.20E+01	600,000	1.8371E+00	4.2709E+01	1.1876E+02	3.81E+01
DCM2M-DE	600,000	1.4772E-10	3.5572E+01	7.3709E+01	2.91E+01	600,000	1.3821E+01	5.6438E+01	1.2151E+01	3.79E+01
DCHypE-DE	600,000	1.2891E+01	5.4363E+01	7.4543E+01	2.62E+01	600,000	1.0896E+01	3.5865E+01	9.2078E+01	3.27E+01
CMODE	600,000	2.2367E-07	**2.3707E-04**	2.9979E-03	2.99E+01	600,000	4.1186E-02	**4.1699E-01**	1.0996E+00	2.93E-01
εADE	600,000	2.7570E-04	2.4723E+01	1.0207E+02	2.89E+01	600,000	1.4033E-17	1.0421E+01	2.1212E+01	1.06E+01
AIS	600,000	1.7096E-15	1.0730E+00	2.3370E+00	1.61E+00	600,000	9.7601E-17	1.6531E+00	3.5833E+00	6.41E-01
ECHT-ARMOR-DE	600,000	0.0000E+00	1.0789E-25	1.1045E-24	2.20E-25	600,000	0.0000E+00	2.0101E+01	1.5113E+02	4.70E+01
		c09-30D					c10-30D			
DCNSGAII-DE	600,068	4.59669E-10	4.1274E+01	1.2568E+02	3.71E+01	607,168	3.1309E+01	7.7447E+01	2.7340E+02	7.74E+01
DCM2M-DE	600,016	2.8922E-10	1.0777E+01	1.0109E+02	2.78E+01	602,968	9.0611E-08	7.6729E+01	2.0111E+02	5.77E+01
DCHypE-DE	600,000	5.8017E-10	6.4540E+00	9.8829E+01	1.98E+01	630,172	3.1309E+01	7.5328E+01	2.0300E+02	7.16E+01
CMODE	600,000	3.1701E+12	1.5175E+13*	3.6716E+13	8.84E+12	600,000	1.1336E+12	3.8653E+13*	3.5416E+13	1.04E+13
εADE	600,000	6.5001E+11	4.6822E+12*	1.8320E+13	1.00E+13	600,000	1.6277E+12	1.4354E+13*	3.2413E+13	1.56E+13
AIS	600,000	8.9156E-20	**1.5654E+00**	2.4188E+01	1.96E+00	600,000	2.1834E-05	**1.7847E+01**	5.5992E+01	1.88E+01
ECHT-ARMOR-DE	600,000	0.00E+00	4.6110E+00	1.1527E+02	2.31E+01	600,000	6.0209E-13	6.5536E+01	5.3332E+02	1.07E+02
		c11-30D					c12-30D			
DCNSGAII-DE	1,000,000	-6.3433E-02	2.7021E-02*	3.8409E-01	1.06E-01	1,000,000	-9.1845E+02	-3.1098E+02*	6.8353E+02	4.93E+02
DCM2M-DE	1,000,000	-7.6071E-01	6.7184E-02*	4.4093E-01	2.36E-01	969,964	-9.1845E+02	-4.2261E+02*	7.3235E+02	4.91E+02
DCHypE-DE	1,000,000	-4.2382E-02	2.4829E-02*	2.1157E-01	6.10E-02	1,000,000	-9.1744E+02	-1.4637E+02*	2.0937E+02	2.77E+02
CMODE	600,000	-3.9234E-04	1.3333E-02*	1.8671E-02	8.74E-03	600,000	-1.9926E-01	1.3152E+01*	3.3358E+02	6.68E+01
εADE	600,000	-9.2021E-02	-4.026E-03*	3.2551E-01	8.51E-02	600,000	-4.9053E+02	1.8117E+00*	3.6840E+02	1.74E+02
AIS	600,000	-1.641E-04	**-1.579E-04**	-1.793E-04	4.67E-05	600,000	-1.9642E-01	4.2881E-06	6.1933E-06	4.52E-04
ECHT-ARMOR-DE	600,000	-3.9234E-04	1.1327E-03*	1.8671E-02	5.28E-03	600,000	-1.9926E-01	**-1.6076E-01**	7.6343E-01	1.93E-01
		c13-30D					c14-30D			
DCNSGAII-DE	600,000	-68.429	**-68.429**	-68.429	9.54E-08	600,000	8.1516E+00	2.8562E+01	7.5125E+01	2.27E+01
DCM2M-DE	600,000	-68.429	**-68.429**	-68.429	1.46E-07	600,000	2.3096E-02	4.2276E+01	7.5281E+01	2.92E+01
DCHypE-DE	600,000	-68.429	68.228	-67.709	3.23E-01	600,000	9.8184E+00	5.1435E+01	7.7232E+01	2.81E+01
CMODE	600,000	-43.561	-38.279	-34.445	2.28E+00	600,000	4.5341E+00	8.9621E+00	1.4388E+01	2.55E+00
εADE	600,000	-68.429	-67.453	-66.810	3.24E-01	600,000	5.4002E-08	4.3667E+00	1.5406E+01	4.73E+00
AIS	600,000	-68.429	-66.236	-66.002	2.27E-01	600,000	6.7351E-15	**8.6828E-07**	1.5555E-06	3.14E-07
ECHT-ARMOR-DE	600,000	-67.416	-64.646	-60.769	1.97E+00	600,000	1.5809E-27	6.6135E+02	1.1507E+04	2.47E+03
		c15-30D					c16-30D			
DCNSGAII-DE	600,000	1.2060E+01	2.7367E+01	7.4319E+01	1.69E+01	600,164	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
DCM2M-DE	600,000	1.0128E-01	**1.9982E+01**	7.2509E+01	1.28E+00	600,152	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
DCHypE-DE	600,100	4.6636E-06	2.5734E+01	7.4063E+01	1.84E+01	600,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
CMODE	600,000	5.6050E+12	1.6221E+13	3.1369E+13	7.39E+12	600,000	1.0529E-02	6.6305E-02	1.2098E-01	2.90E-02
εADE	600,000	5.3333E+12	2.2290E+13	4.6200E+12	2.07E+13	600,000	2.1523E-01	5.9221E-01	1.0178E+00	3.98E-01
AIS	600,000	1.9950E-09	3.4128E+01	7.2308E+01	3.82E+01	600,000	3.9634E-11	8.2062E-02	5.4746E-01	1.12E-01
ECHT-ARMOR-DE	600,000	1.1716E-04	3.1316E+08	5.9937E+09	1.20E+09	600,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
		c17-30D					c18-30D			
DCNSGAII-DE	663,864	9.7212E-05	2.1765E+00*	1.9164E+01	4.50E+00	600,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
DCM2M-DE	635,616	5.2263E-04	3.5238E+00*	2.6361E+01	7.47E+00	600,156	3.7912E-21	5.1814E-02	6.4906E-01	1.76E-01
DCHypE-DE	842,024	5.4585E-08	2.6095E+00*	2.4723E+01	5.64E+00	600,012	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00
CMODE	600,000	5.0557E+01	4.0933E+02*	1.2705E+03	3.35E+02	600,000	2.9940E+03	7.8684E+03	1.4559E+04	3.42E+03
εADE	600,000	1.3429E+02	5.0001E+02*	1.6112E+03	8.27E+02	600,000	5.3558E+05	1.8358E+06	4.3910E+06	2.02E+06
AIS	600,000	4.1942E-07	3.6051E+00	8.9452E+00	2.54E+00	600,000	1.9887E-08	4.0152E+01	6.2643E+01	1.80E+01
ECHT-ARMOR-DE	600,000	3.3564E-16	**4.0336E-01**	1.2633E+00	3.51E-01	600,000	0.00E+00	**0.00E+00**	0.00E+00	0.00E+00

b, Mn, w, and sd represent the best, mean, worst and standard deviation, respectively, of results over all runs; FEs represents the function evaluations for CMODE, εADE, AIS, and ECHT-ARMOR-DE; For DCNSGAII-DE, DCM2M-DE, and DCHypE-DE, the FEs represents the average evaluations; Results with * means that there are infeasible solutions over 25 independent runs.

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