Supplementary File for "A Two-stage Evolutionary Algorithm based on Global and Local Searches for Large-scale Constrained Multiobjective Optimization"

TABLE S-I
THE HV RESULTS OBTAINED BY TLCMEA AND SIX COMPARED ALGORITHMS ON MW TEST SUITE.

Problem	D	CCMO	MTCMO	C_LMEA	C_LMOCSO	DPSEA	POCEA	TLCMEA
MW1	100	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	4.9012e-1 (2.76e-5)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (83.33%)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (3.33%)
	1000	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%)
MW2	100	NaN (80.00%) -	NaN (66.67%) -	NaN (0.00%) -	NaN (0.00%) -	3.5721e-1 (8.80e-2) -	NaN (0.00%) -	5.8002e-1 (7.15e-4)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (26.67%) -	NaN (0.00%) -	5.7986e-1 (1.27e-3)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.7934e-1 (1.44e-3)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.7859e-1 (1.43e-3)
MW3	100	5.4010e-1 (1.44e-3) -	5.3866e-1 (1.94e-3) -	NaN (0.00%) -	5.3014e-1 (2.71e-3) -	5.4137e-1 (1.25e-3) -	5.2249e-1 (5.60e-3) -	5.4334e-1 (3.70e-4)
	200	5.3571e-1 (2.41e-3) -	5.3416e-1 (2.19e-3) -	NaN (0.00%) -	5.2722e-1 (2.59e-3) -	5.3846e-1 (1.58e-3) -	5.1781e-1 (5.83e-3) -	5.4139e-1 (5.44e-4)
	500	5.2325e-1 (2.89e-3) -	5.1545e-1 (1.39e-2) -	NaN (0.00%) -	5.2152e-1 (3.35e-3) -	5.2967e-1 (2.02e-3) -	4.8981e-1 (4.95e-3) -	5.3431e-1 (1.46e-3)
	1000	4.7621e-1 (4.77e-3) -	4.7344e-1 (6.27e-3) -	NaN (0.00%) -	5.0935e-1 (5.91e-3) -	5.0452e-1 (1.56e-2) -	4.7156e-1 (8.25e-3) -	5.2628e-1 (1.17e-3)
MW4	100	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	8.3514e-1 (1.56e-3)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	8.3555e-1 (1.83e-3)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (13.33%)
	1000	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%)
MW5	100	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (93.33%)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (73.33%)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (26.67%)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (6.67%)
MW6	100	NaN (93.33%) -	NaN (83.33%) -	NaN (0.00%) -	NaN (0.00%) -	6.2550e-2 (5.96e-2) -	NaN (0.00%) -	3.2851e-1 (1.85e-5)
	200	NaN (10.00%) -	NaN (10.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (40.00%) -	NaN (0.00%) -	3.2848e-1 (1.32e-4)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	3.2845e-1 (1.41e-4)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	3.2840e-1 (1.42e-4)
MW7	100	4.0960e-1 (1.07e-3) -	4.0654e-1 (1.16e-3) -	NaN (0.00%) -	4.0463e-1 (1.69e-3) -	4.1016e-1 (9.12e-4) -	3.9744e-1 (2.76e-3) -	4.1158e-1 (3.93e-4)
	200	4.0700e-1 (1.16e-3) -	4.0189e-1 (2.33e-3) -	NaN (0.00%) -	4.0023e-1 (1.88e-3) -	4.0728e-1 (8.89e-4) -	3.9684e-1 (3.76e-3) -	4.0923e-1 (6.65e-4)
	500	4.0088e-1 (1.78e-3) =	3.9095e-1 (1.89e-3) -	NaN (0.00%) -	3.9967e-1 (1.15e-3) -	4.0272e-1 (9.02e-4) +	3.9559e-1 (3.24e-3) -	4.0164e-1 (1.26e-3)
	1000	3.9406e-1 (1.42e-3) +	3.8161e-1 (1.18e-3) -	NaN (0.00%) -	3.9706e-1 (1.58e-3) +	3.9620e-1 (1.63e-3) +	3.9300e-1 (8.94e-3) +	3.8978e-1 (6.38e-3)
MW8	100	NaN (36.67%) -	NaN (40.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (73.33%) -	NaN (0.00%) -	5.5212e-1 (9.56e-4)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (10.00%) -	NaN (0.00%) -	5.5227e-1 (8.80e-4)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.5218e-1 (8.62e-4)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.5234e-1 (8.67e-4)
MW9	100	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (93.33%)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (50.00%)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (16.67%)
	1000	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%) =	NaN (0.00%)
MW10	100	NaN (10.00%) -	NaN (3.33%) =	NaN (0.00%) -	NaN (0.00%) -	NaN (30.00%) -	NaN (0.00%) -	4.5492e-1 (2.89e-4)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	4.5499e-1 (2.16e-4)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (83.33%)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (63.33%)
MW11	100	4.4833e-1 (5.01e-5) +	4.4840e-1 (5.21e-5) +	NaN (0.00%) -	4.3857e-1 (2.57e-3) -	4.4831e-1 (5.17e-5) +	4.2628e-1 (5.32e-3) -	4.4823e-1 (9.15e-5)
	200	4.4841e-1 (3.86e-5) +	4.4845e-1 (3.60e-5) +	NaN (0.00%) -	4.3588e-1 (3.41e-3) -	4.4842e-1 (3.84e-5) +	4.2694e-1 (4.53e-3) -	4.4837e-1 (5.52e-5)
	500	4.4843e-1 (2.91e-5) =	4.4845e-1 (4.12e-5) +	NaN (0.00%) -	4.2966e-1 (3.03e-3) -	4.4845e-1 (4.84e-5) +	4.2695e-1 (5.02e-3) -	4.4841e-1 (4.50e-5)
	1000	4.4844e-1 (3.63e-5) =	4.4843e-1 (4.55e-5) =	NaN (0.00%) -	4.2546e-1 (2.54e-3) -	4.4846e-1 (3.72e-5) =	4.1178e-1 (1.05e-2) -	4.4845e-1 (3.22e-5)
MW12	100	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (93.33%)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (63.33%)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (33.33%)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (3.33%)
MW13	100	1.6228e-1 (7.01e-2) -	1.5393e-1 (9.00e-2) -	NaN (0.00%) -	0.0000e+0 (0.00e+0) -	2.9008e-1 (9.30e-2) -	3.6944e-3 (1.42e-2) -	4.7665e-1 (1.89e-4)
	200	9.3544e-3 (2.44e-2) -	1.6457e-2 (4.16e-2) -	NaN (0.00%) -	0.0000e+0 (0.00e+0) -	6.1535e-2 (6.11e-2) -	NaN (96.67%) -	4.7656e-1 (3.13e-4)
	500	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	NaN (0.00%) -	NaN (0.00%) -	0.0000e+0 (0.00e+0) -	NaN (0.00%) -	4.7643e-1 (6.12e-4)
	1000	NaN (30.00%) -	NaN (3.33%) =	NaN (0.00%) -	NaN (0.00%) -	NaN (83.33%) -	NaN (0.00%) -	4.7642e-1 (3.45e-4)
MW14	100	3.8477e-1 (5.61e-2) -	3.9052e-1 (5.16e-2) -	3.4988e-2 (5.15e-3) -	5.5107e-2 (7.04e-2) -	3.8952e-1 (5.29e-2) -	3.3031e-1 (6.77e-2) -	4.7232e-1 (1.53e-3)
	200	2.5228e-1 (2.37e-2) -	2.8674e-1 (3.06e-2) -	2.4322e-2 (7.46e-3) -	1.8964e-2 (1.55e-2) -	2.2898e-1 (2.36e-2) -	1.6133e-1 (8.38e-2) -	4.6980e-1 (1.99e-3)
	500	1.5783e-1 (1.92e-2) -	1.7736e-1 (1.57e-2) -	NaN (93.33%) -	1.7245e-2 (1.52e-2) -	1.5495e-1 (1.85e-2) -	1.1996e-1 (7.53e-2) -	4.4728e-1 (1.76e-2)
	1000	6.7415e-2 (3.26e-2) -	4.7315e-2 (2.04e-2) -	NaN (0.00%) -	1.6203e-2 (1.43e-2) -	8.2841e-2 (2.13e-2) -	1.0272e-1 (6.86e-2) -	3.7763e-1 (5.05e-2)
+/-/=		3/47/6	3/47/6	0/53/3	1/52/3	5/47/4	1/52/3	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-II
THE IGD RESULTS OBTAINED BY TLCMEA AND SIX COMPARED ALGORITHMS ON DTLZ TEST SUITE.

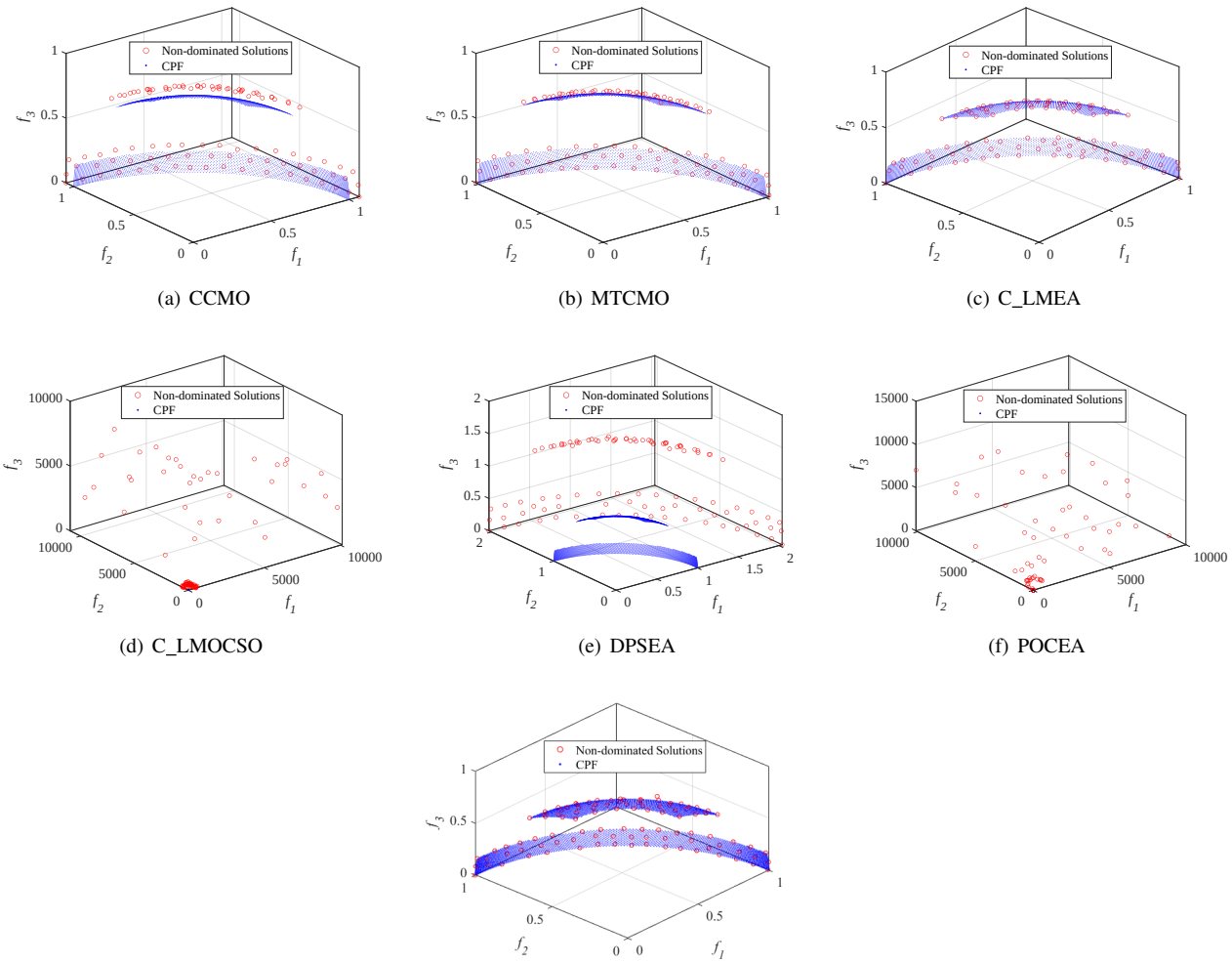
Problem	D	CCMO	MTCMO	C_LMEA	C_LMOCSO	DPSEA	POCEA	TLCMEA
C1_DTLZ1	100	4.8380e-2 (1.46e-2) -	3.2521e-2 (7.76e-3) -	NaN (0.00%) -	NaN (0.00%) -	9.0319e-2 (3.06e-2) -	NaN (0.00%) -	2.1656e-2 (7.64e-4)
	200	5.2708e-2 (1.31e-2) -	3.9471e-2 (8.62e-3) -	NaN (0.00%) -	NaN (0.00%) -	1.2211e-1 (2.75e-2) -	NaN (0.00%) -	2.1434e-2 (1.44e-3)
	500	8.8865e-2 (2.54e-2) -	6.7772e-2 (1.11e-2) -	NaN (0.00%) -	NaN (0.00%) -	2.1184e-1 (2.58e-2) -	NaN (0.00%) -	3.5113e-2 (6.74e-3)
	1000	6.9024e-2 (1.75e-2) =	7.3195e-2 (9.41e-3) -	NaN (0.00%) -	NaN (0.00%) -	1.4962e-1 (1.99e-2) -	NaN (0.00%) -	6.3585e-2 (1.69e-2)
C1_DTLZ3	100	5.4839e-2 (2.02e-3) -	8.0063e+0 (1.74e-3) -	5.4655e-2 (1.02e-3) -	5.6286e+1 (1.44e+1) -	1.0948e-1 (7.37e-2) -	8.0712e+0 (6.40e-2) -	5.3401e-2 (8.39e-4)
	200	5.5669e-2 (1.03e-3) -	8.0051e+0 (1.18e-3) -	5.5442e-2 (1.94e-3) -	9.5789e+1 (2.24e+1) -	7.9755e-2 (4.27e-2) -	8.0772e+0 (5.80e-2) -	5.3179e-2 (4.90e-4)
	500	1.6942e-1 (1.03e-1) -	8.0040e+0 (6.05e-4) -	5.5173e-2 (1.53e-3) -	2.0815e+2 (6.25e+1) -	4.8261e-1 (3.01e-1) -	8.1531e+0 (1.01e-1) -	5.3299e-2 (5.48e-4)
	1000	1.5511e-1 (1.04e-1) -	8.0036e+0 (6.52e-4) -	5.5117e-2 (1.19e-3) -	3.9325e+2 (8.42e+1) -	6.0027e-1 (5.04e-1) -	8.1251e+0 (7.17e-2) -	5.3515e-2 (5.97e-4)
C2_DTLZ2	100	4.2972e-2 (6.02e-4) -	4.2625e-2 (5.94e-4) =	NaN (13.33%) -	5.0247e-2 (4.92e-4) -	4.3173e-2 (5.60e-4) -	5.1179e-2 (1.77e-3) -	4.2478e-2 (3.72e-4)
	200	4.2938e-2 (4.80e-4) =	4.2487e-2 (5.43e-4) =	NaN (0.00%) -	4.9934e-2 (4.45e-4) -	4.3026e-2 (5.38e-4) =	5.0682e-2 (9.58e-4) -	4.2751e-2 (6.37e-4)
	500	4.2787e-2 (5.54e-4) =	4.2721e-2 (4.86e-4) =	NaN (0.00%) -	4.9938e-2 (4.17e-4) -	4.3085e-2 (5.02e-4) -	5.1508e-2 (1.16e-3) -	4.2707e-2 (7.36e-4)
	1000	4.3175e-2 (6.31e-4) -	4.2513e-2 (5.60e-4) =	NaN (0.00%) -	4.9715e-2 (1.37e-5) -	4.3209e-2 (5.48e-4) -	5.1174e-2 (1.18e-3) -	4.2555e-2 (4.91e-4)
C3_DTLZ4	100	2.1883e-1 (2.83e-1) =	1.4424e-1 (1.89e-1) =	5.9380e-1 (1.96e-1) -	1.2434e-1 (9.97e-2) -	1.1966e-1 (1.36e-1) =	1.0771e-1 (3.49e-3) +	1.1941e-1 (1.36e-1)
	200	2.1841e-1 (2.83e-1) =	1.4381e-1 (1.90e-1) =	4.6771e-1 (1.65e-1) -	9.1358e-2 (1.72e-4) +	9.4409e-2 (1.29e-3) =	1.3030e-1 (1.36e-1) -	9.4402e-2 (1.69e-3)
	500	1.4355e-1 (1.90e-1) -	1.4419e-1 (1.89e-1) =	2.9512e-1 (1.20e-1) -	1.4180e-1 (1.92e-1) -	1.6928e-1 (2.28e-1) =	1.0317e-1 (4.13e-3) -	9.4733e-2 (1.11e-3)
	1000	1.1870e-1 (1.36e-1) +	1.1961e-1 (1.36e-1) =	2.6308e-1 (2.07e-1) -	9.1303e-2 (2.81e-6) +	9.4928e-2 (1.63e-3) =	1.2501e-1 (1.36e-1) +	1.4473e-1 (1.89e-1)
DC1_DTLZ1	100	6.5956e-2 (7.58e-2) -	2.8166e-2 (4.89e-3) -	1.2184e-2 (3.37e-4) -	3.1874e+2 (1.02e+2) -	4.8184e-2 (1.01e-2) -	1.5082e+1 (6.08e+0) -	1.1516e-2 (1.60e-4)
	200	1.2111e-1 (9.52e-2) -	4.7926e-2 (8.07e-3) -	1.2475e-2 (4.85e-4) -	6.6111e+2 (1.81e+2) -	4.1254e-1 (5.45e-1) -	2.6997e+1 (1.12e+1) -	1.1974e-2 (3.84e-4)
	500	8.0617e+0 (3.71e+0) -	1.5092e-1 (5.74e-2) -	1.3573e-2 (7.45e-4) +	1.1473e+3 (5.33e+2) -	3.9372e+1 (5.37e+0) -	5.7459e+1 (2.83e+1) -	1.4393e-2 (1.19e-3)
	1000	2.7221e+1 (7.96e+0) -	2.2840e-1 (1.26e-1) -	1.5282e-2 (8.57e-4) +	9.5067e+2 (9.48e+2) -	1.5054e+2 (1.38e+1) -	1.8237e+2 (2.14e+2) -	1.7596e-2 (2.36e-3)
DC1_DTLZ3	100	3.5138e-2 (6.71e-4) -	3.4453e-2 (4.35e-4) -	3.3810e-2 (5.22e-4) =	5.9933e+1 (1.66e+1) -	3.5993e-2 (9.79e-4) -	2.0374e+0 (8.18e-1) -	3.3915e-2 (4.04e-4)
	200	3.6939e-2 (8.63e-4) -	3.5170e-2 (4.55e-4) -	3.3919e-2 (5.90e-4) =	1.2332e+2 (2.49e+1) -	3.8642e-2 (1.21e-3) -	2.2421e+0 (9.68e-1) -	3.3790e-2 (2.46e-4)
	500	7.0257e-2 (2.89e-2) -	4.0591e-2 (1.33e-3) -	3.4039e-2 (7.17e-4) =	2.4231e+2 (5.82e+1) -	2.1153e-1 (1.36e-1) -	3.3708e+0 (1.34e+0) -	3.3864e-2 (3.60e-4)
	1000	9.7723e-2 (4.22e-2) -	3.9980e-2 (1.03e-3) -	3.4180e-2 (7.57e-4) =	4.1627e+2 (8.21e+1) -	1.0892e+0 (5.51e-1) -	1.9359e+0 (8.47e-1) -	3.3846e-2 (3.68e-4)
DC2_DTLZ1	100	NaN (20.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	2.0216e-2 (1.84e-4)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	2.0603e-2 (3.21e-4)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	1.2141e-1 (6.62e-2)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	1.6398e-1 (1.94e-4)
DC2_DTLZ3	100	4.1283e-1 (2.32e-1) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.2633e-2 (3.42e-4)
	200	NaN (33.33%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.2674e-2 (4.44e-4)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.2804e-2 (4.45e-4)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.2837e-2 (4.12e-4)
DC3_DTLZ1	100	4.5814e+0 (2.36e+0) -	1.7307e+1 (3.60e+0) -	5.6079e+2 (5.95e+1) -	5.4316e+2 (9.94e+1) -	2.1387e+0 (1.78e+0) -	2.2074e+2 (6.19e+1) -	6.9864e-3 (1.65e-4)
	200	1.4855e+1 (3.34e+0) -	4.3550e+1 (5.81e+0) -	1.4169e+3 (1.33e+2) -	8.8930e+2 (1.45e+2) -	1.8206e+1 (3.58e+0) -	4.7231e+2 (1.09e+2) -	7.8867e-3 (5.85e-4)
	500	9.9467e+1 (1.51e+1) -	1.6255e+2 (1.64e+1) -	4.3200e+3 (1.60e+2) -	1.9999e+3 (4.37e+2) -	2.0972e+2 (2.76e+1) -	1.6911e+3 (6.17e+2) -	1.2158e-2 (1.70e-3)
	1000	3.2620e+2 (2.72e+1) -	3.0403e+2 (1.82e+1) -	9.3868e+3 (2.52e+2) -	3.8449e+3 (8.26e+2) -	8.4392e+2 (5.67e+1) -	6.6872e+3 (1.70e+3) -	7.1628e-2 (7.53e-2)
DC3_DTLZ3	100	7.9799e-1 (4.26e-1) -	1.9068e+1 (1.62e+0) -	1.7100e+2 (2.44e+1) -	1.6583e+2 (2.74e+1) -	7.9077e-1 (3.94e-1) -	7.6898e+1 (2.33e+1) -	1.9924e-2 (2.12e-4)
	200	2.4942e+0 (9.34e-1) -	3.9659e+1 (2.84e+0) -	4.7417e+2 (3.48e+1) -	2.7107e+2 (4.61e+1) -	1.8708e+0 (6.40e-1) -	1.6271e+2 (3.62e+1) -	1.9921e-2 (2.22e-4)
	500	2.2277e+1 (2.45e+0) -	1.0119e+2 (3.81e+0) -	1.4057e+3 (6.88e+1) -	5.8381e+2 (7.72e+1) -	2.7447e+1 (2.18e+0) -	5.7897e+2 (2.63e+2) -	2.0060e-2 (2.21e-4)
	1000	6.7820e+1 (5.22e+0) -	2.0480e+2 (6.99e+0) -	3.1090e+3 (1.02e+2) -	1.0893e+3 (1.69e+2) -	1.0555e+2 (7.05e+0) -	2.0081e+3 (5.26e+2) -	2.0343e-2 (2.77e-4)
+/-/=		1/34/5	0/32/8	2/34/4	2/38/0	0/35/5	2/38/0	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-III
THE HV RESULTS OBTAINED BY TLCMEA AND SIX COMPARED ALGORITHMS ON DTLZ TEST SUITE.

Problem	D	CCMO	MTCMO	C_LMEA	C_LMOCSO	DPSEA	POCEA	TLCMEA
C1_DTLZ1	100	6.9274e-1 (4.22e-2) -	7.4228e-1 (2.91e-2) -	NaN (0.00%) -	NaN (0.00%) -	5.9356e-1 (6.24e-2) -	NaN (0.00%) -	8.0829e-1 (8.19e-3)
	200	6.7855e-1 (3.35e-2) -	7.1666e-1 (2.76e-2) -	NaN (0.00%) -	NaN (0.00%) -	5.2786e-1 (5.23e-2) -	NaN (0.00%) -	8.0191e-1 (1.40e-2)
	500	5.9413e-1 (5.23e-2) -	6.3908e-1 (2.61e-2) -	NaN (0.00%) -	NaN (0.00%) -	3.6835e-1 (4.22e-2) -	NaN (0.00%) -	7.3110e-1 (2.41e-2)
	1000	6.3699e-1 (3.91e-2) =	6.2589e-1 (2.14e-2) -	NaN (0.00%) -	NaN (0.00%) -	4.7455e-1 (3.57e-2) -	NaN (0.00%) -	6.5063e-1 (4.25e-2)
C1_DTLZ3	100	5.4992e-1 (3.61e-3) -	0.0000e+0 (0.00e+0) -	5.5996e-1 (7.71e-4) -	0.0000e+0 (0.00e+0) -	4.4578e-1 (1.20e-1) -	0.0000e+0 (0.00e+0) -	5.6085e-1 (1.04e-3)
	200	5.4436e-1 (3.57e-3) -	0.0000e+0 (0.00e+0) -	5.5966e-1 (1.01e-3) -	0.0000e+0 (0.00e+0) -	4.9356e-1 (7.46e-2) -	0.0000e+0 (0.00e+0) -	5.6128e-1 (8.10e-4)
	500	3.5571e-1 (1.46e-1) -	0.0000e+0 (0.00e+0) -	5.5888e-1 (8.74e-4) -	0.0000e+0 (0.00e+0) -	1.2258e-1 (1.44e-1) -	0.0000e+0 (0.00e+0) -	5.6084e-1 (8.57e-4)
	1000	3.7705e-1 (1.44e-1) -	0.0000e+0 (0.00e+0) -	5.5777e-1 (8.60e-4) -	0.0000e+0 (0.00e+0) -	1.2917e-1 (1.84e-1) -	0.0000e+0 (0.00e+0) -	5.6040e-1 (1.14e-3)
C2_DTLZ2	100	5.1581e-1 (1.44e-3) -	5.1732e-1 (1.54e-3) =	NaN (13.33%) -	5.1260e-1 (1.16e-4) -	5.1609e-1 (1.30e-3) =	5.0110e-1 (5.89e-3) -	5.1665e-1 (1.62e-3)
	200	5.1402e-1 (1.63e-3) -	5.1684e-1 (1.14e-3) =	NaN (0.00%) -	5.1273e-1 (9.69e-5) -	5.1522e-1 (1.82e-3) -	5.0287e-1 (4.10e-3) -	5.1683e-1 (1.69e-3)
	500	5.1403e-1 (1.93e-3) -	5.1650e-1 (1.40e-3) =	NaN (0.00%) -	5.1252e-1 (8.92e-5) -	5.1474e-1 (1.80e-3) -	4.9977e-1 (3.83e-3) -	5.1607e-1 (1.68e-3)
	1000	5.1244e-1 (2.17e-3) -	5.1574e-1 (1.35e-3) =	NaN (0.00%) -	5.1275e-1 (7.66e-5) -	5.1353e-1 (1.32e-3) -	5.0119e-1 (3.19e-3) -	5.1607e-1 (1.44e-3)
C3_DTLZ4	100	7.4864e-1 (9.55e-2) =	7.7376e-1 (6.39e-2) =	6.0206e-1 (1.15e-1) -	7.8432e-1 (3.58e-2) +	7.8162e-1 (4.59e-2) =	7.8221e-1 (2.22e-3) +	7.8187e-1 (4.60e-2)
	200	7.4870e-1 (9.56e-2) =	7.7412e-1 (6.40e-2) =	6.7760e-1 (8.13e-2) -	7.9617e-1 (3.70e-5) +	7.9017e-1 (1.38e-3) =	7.7461e-1 (4.86e-2) -	7.9072e-1 (1.21e-3)
	500	7.7406e-1 (6.40e-2) =	7.7370e-1 (6.39e-2) =	7.1675e-1 (4.74e-2) -	7.7740e-1 (7.15e-2) -	7.6473e-1 (7.67e-2) -	7.8454e-1 (1.66e-3) -	7.9045e-1 (1.28e-3)
	1000	7.8278e-1 (4.61e-2) +	7.8136e-1 (4.58e-2) =	7.2646e-1 (8.28e-2) -	7.9622e-1 (6.91e-6) +	7.8982e-1 (1.69e-3) =	7.7738e-1 (4.86e-2) +	7.7328e-1 (6.38e-2)
DC1_DTLZ1	100	4.8560e-1 (1.27e-1) -	5.7072e-1 (1.43e-2) -	6.2468e-1 (4.37e-3) -	0.0000e+0 (0.00e+0) -	5.1241e-1 (3.01e-2) -	1.2698e-2 (6.96e-2) -	6.3044e-1 (2.01e-3)
	200	3.6143e-1 (1.31e-1) -	5.1224e-1 (2.36e-2) -	6.2121e-1 (7.08e-3) -	0.0000e+0 (0.00e+0) -	2.0427e-1 (1.73e-1) -	6.2132e-3 (3.40e-2) -	6.2670e-1 (3.07e-3)
	500	7.8289e-4 (4.29e-3) -	2.8187e-1 (6.08e-2) -	6.1458e-1 (6.88e-3) =	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	6.1456e-1 (5.36e-3)
	1000	0.0000e+0 (0.00e+0) -	1.8078e-1 (6.70e-2) -	6.0665e-1 (8.70e-3) +	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	6.0305e-1 (8.53e-3)
DC1_DTLZ3	100	4.6358e-1 (2.95e-3) -	4.6710e-1 (2.46e-3) -	4.7199e-1 (9.31e-4) -	0.0000e+0 (0.00e+0) -	4.6069e-1 (3.96e-3) -	0.0000e+0 (0.00e+0) -	4.7466e-1 (7.10e-4)
	200	4.5583e-1 (2.99e-3) -	4.6272e-1 (2.58e-3) -	4.7134e-1 (1.39e-3) -	0.0000e+0 (0.00e+0) -	4.5026e-1 (3.56e-3) -	3.2155e-4 (1.76e-3) -	4.7465e-1 (8.26e-4)
	500	3.8320e-1 (5.12e-2) -	4.4431e-1 (3.53e-3) -	4.7070e-1 (8.75e-4) -	0.0000e+0 (0.00e+0) -	2.0245e-1 (1.29e-1) -	0.0000e+0 (0.00e+0) -	4.7383e-1 (8.67e-4)
	1000	3.3438e-1 (7.12e-2) -	4.4573e-1 (2.87e-3) -	4.6906e-1 (9.08e-4) -	0.0000e+0 (0.00e+0) -	8.5612e-3 (2.71e-2) -	2.7269e-4 (1.42e-3) -	4.7292e-1 (9.38e-4)
DC2_DTLZ1	100	NaN (20.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	8.4095e-1 (1.17e-3)
	200	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	8.3799e-1 (1.72e-3)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.8544e-1 (1.64e-1)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	4.8013e-1 (9.96e-4)
DC2_DTLZ3	100	1.6713e-1 (2.38e-1) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.6149e-1 (5.74e-4)
	200	NaN (33.33%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.6125e-1 (9.73e-4)
	500	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.6033e-1 (1.10e-3)
	1000	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	NaN (0.00%) -	5.5913e-1 (1.03e-3)
DC3_DTLZ1	100	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	9.3985e-3 (2.88e-2) -	0.0000e+0 (0.00e+0) -	5.3353e-1 (2.29e-3)
	200	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) -	5.2664e-1 (3.94e-3)
	500	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) -	5.0734e-1 (6.79e-3)
	1000	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) -	3.5109e-1 (1.93e-1)
DC3_DTLZ3	100	9.8107e-3 (5.37e-2) -	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) -	3.6891e-1 (5.82e-4)
	200	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) -	3.6865e-1 (8.12e-4)
	500	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) -	3.6686e-1 (1.63e-3)
	1000	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) -	3.6429e-1 (1.76e-3)
+/-/=		1/35/4	0/32/8	1/38/1	3/37/0	0/36/4	2/38/0	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.



(a) CCMO (b) MTCMO (c) C_LMEA

(d) C_LMOCSO (e) DPSEA (f) POCEA

(g) TLCMEA

Fig. S-I. The population distribution of median IGD values obtained by seven algorithms on 1000-dimensional DC1-DTLZ3.

TABLE S-IV
THE IGD RESULTS OBTAINED BY TLCMEA AND SIX COMPARED ALGORITHMS ON LIRCMOP TEST SUITE.

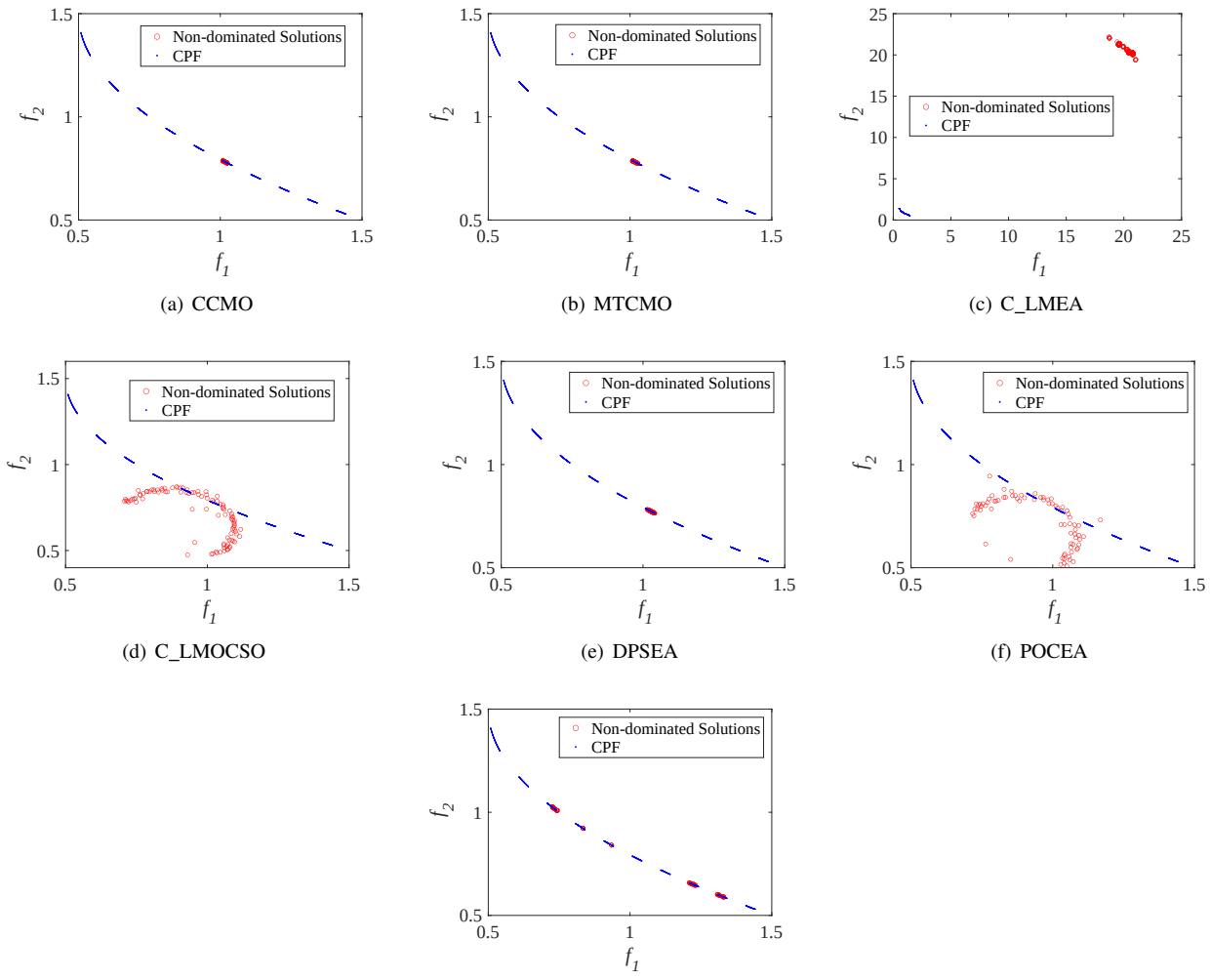
Problem	D	CCMO	MTCMO	C_LMEA	C_LMOCSO	DPSEA	POCEA	TLCMEA
LIRCMOP1	100	3.1383e-1 (2.40e-2) -	2.5271e-1 (3.93e-3) -	3.4685e-1 (7.87e-3) -	1.3440e-2 (1.14e-3) +	3.0249e-1 (1.80e-2) -	4.9748e-2 (1.83e-2) =	4.9450e-2 (9.58e-3)
	200	3.2046e-1 (1.73e-2) -	2.8792e-1 (3.50e-3) -	NaN (0.00%) -	1.3867e-2 (1.10e-3) +	3.1636e-1 (1.36e-2) -	5.2148e-2 (2.81e-2) +	7.3324e-2 (1.59e-2)
	500	3.2950e-1 (9.60e-3) -	3.1574e-1 (1.89e-3) -	NaN (0.00%) -	2.6215e-2 (3.67e-2) +	3.2082e-1 (1.13e-2) -	1.7252e-1 (9.24e-2) -	1.3319e-1 (3.34e-2)
	1000	3.3847e-1 (7.17e-3) -	3.3054e-1 (1.06e-3) -	NaN (0.00%) -	1.3581e-1 (1.05e-1) =	3.2775e-1 (8.62e-3) -	3.4755e-1 (7.57e-3) -	1.8303e-1 (4.53e-2)
LIRCMOP2	100	2.3702e-1 (2.69e-2) -	2.1987e-1 (3.11e-3) -	3.0652e-1 (5.42e-3) -	1.5217e-2 (9.79e-4) +	2.6222e-1 (1.74e-2) -	5.7454e-2 (2.18e-2) -	3.0733e-2 (4.39e-3)
	200	2.6288e-1 (1.68e-2) -	2.5035e-1 (2.33e-3) -	NaN (0.00%) -	1.5545e-2 (1.37e-3) +	2.7866e-1 (1.39e-2) -	5.0823e-2 (1.77e-2) -	3.9048e-2 (5.96e-3)
	500	2.8846e-1 (1.17e-2) -	2.7735e-1 (1.40e-3) -	NaN (0.00%) -	1.5886e-2 (1.30e-3) +	2.7912e-1 (9.55e-3) -	7.9303e-2 (5.29e-2) =	6.6126e-2 (1.78e-2)
	1000	2.8913e-1 (7.13e-3) -	2.9092e-1 (1.25e-3) -	NaN (0.00%) -	2.7834e-1 (1.10e-2) -	2.8730e-1 (7.65e-3) -	3.1309e-1 (9.64e-3) -	7.7415e-2 (2.08e-2)
LIRCMOP3	100	3.0266e-1 (2.83e-2) -	2.4517e-1 (2.09e-2) -	3.4134e-1 (4.35e-3) -	1.6854e-1 (1.22e-1) -	3.1835e-1 (2.31e-2) -	NaN (96.67%) -	2.4964e-2 (1.01e-2)
	200	3.2079e-1 (2.14e-2) -	3.2890e-1 (6.60e-4) -	NaN (0.00%) -	3.3130e-1 (1.73e-3) -	3.3063e-1 (1.57e-2) -	NaN (96.67%) -	3.5257e-2 (1.23e-2)
	500	3.4013e-1 (1.04e-2) -	3.2979e-1 (1.52e-3) -	NaN (0.00%) -	3.3185e-1 (2.49e-3) -	3.3630e-1 (5.37e-3) -	NaN (96.67%) -	5.1600e-2 (1.52e-2)
	1000	3.4106e-1 (7.54e-3) -	3.3526e-1 (3.50e-3) -	NaN (0.00%) -	3.3213e-1 (2.30e-3) -	3.3614e-1 (6.24e-3) -	3.4231e-1 (7.06e-3) -	8.3270e-2 (4.54e-2)
LIRCMOP4	100	2.8471e-1 (3.19e-2) -	2.3394e-1 (1.71e-2) -	3.1629e-1 (4.97e-3) -	2.1173e-1 (8.42e-2) -	3.0051e-1 (1.93e-2) -	NaN (93.33%) -	2.4573e-2 (7.63e-3)
	200	3.0092e-1 (2.08e-2) -	2.9755e-1 (1.90e-2) -	NaN (0.00%) -	3.0756e-1 (2.32e-3) -	3.0765e-1 (1.11e-2) -	NaN (96.67%) -	4.0084e-2 (1.63e-2)
	500	3.1079e-1 (1.63e-2) -	3.0788e-1 (1.71e-3) -	NaN (0.00%) -	3.0812e-1 (2.15e-3) -	3.0937e-1 (9.40e-3) -	NaN (86.67%) -	7.3788e-2 (3.10e-2)
	1000	3.1518e-1 (5.83e-3) -	3.1329e-1 (3.61e-3) -	NaN (0.00%) -	3.0874e-1 (2.22e-3) -	3.1147e-1 (4.80e-3) -	3.1845e-1 (6.15e-3) -	8.2616e-2 (2.71e-2)
LIRCMOP5	100	3.6569e-1 (3.35e-2) -	8.1975e-1 (4.35e-1) -	6.2762e-1 (4.79e-1) -	1.2184e+0 (2.53e-3) -	3.6505e-1 (2.42e-2) -	1.1973e+0 (1.61e-1) -	1.2488e-1 (3.96e-2)
	200	3.6360e-1 (1.94e-2) -	8.7818e-1 (4.23e-1) -	9.9926e-1 (7.21e-1) -	1.2172e+0 (1.97e-3) -	3.6306e-1 (1.99e-2) -	1.2256e+0 (4.61e-3) -	1.7798e-1 (7.96e-2)
	500	3.7236e-1 (1.79e-2) +	1.2236e+0 (1.91e-3) -	1.9444e+0 (7.33e-1) -	1.2186e+0 (1.04e-3) -	3.7403e-1 (1.37e-2) +	1.2252e+0 (3.07e-3) -	3.8259e-1 (3.45e-1)
	1000	3.7496e-1 (1.20e-2) +	1.2258e+0 (1.25e-3) =	1.8438e+0 (5.74e-1) -	1.2193e+0 (9.94e-4) -	3.7028e-1 (9.84e-3) +	1.2274e+0 (3.26e-3) =	9.8283e-1 (4.20e-1)
LIRCMOP6	100	4.2154e-1 (5.16e-2) -	7.7084e-1 (4.47e-1) -	7.4578e-1 (4.36e-1) -	1.3484e+0 (1.06e-3) -	4.1177e-1 (3.85e-2) -	1.3497e+0 (1.40e-3) -	1.2337e-1 (6.38e-2)
	200	4.2739e-1 (2.86e-2) -	9.5990e-1 (4.49e-1) -	1.0512e+0 (4.67e-1) -	1.3476e+0 (9.39e-4) -	4.3157e-1 (3.04e-2) -	1.3496e+0 (1.31e-3) -	2.2614e-1 (8.08e-2)
	500	4.2944e-1 (2.84e-2) +	1.3450e+0 (1.22e-4) -	1.4391e+0 (5.59e-1) -	1.3475e+0 (6.92e-4) -	4.3113e-1 (2.36e-2) +	1.3491e+0 (1.75e-3) -	7.4292e-1 (4.78e-1)
	1000	4.3440e-1 (1.91e-2) +	1.3451e+0 (1.12e-4) -	1.2979e+0 (5.06e-1) -	1.3470e+0 (5.66e-4) -	4.3489e-1 (1.74e-2) +	1.3488e+0 (1.52e-3) -	1.0514e+0 (4.66e-1)
LIRCMOP7	100	1.4738e-1 (1.82e-2) -	1.4684e-1 (1.85e-2) -	7.3518e-1 (5.77e-1) -	1.6854e+0 (1.41e-3) -	1.4576e-1 (1.25e-2) -	9.8008e-1 (7.70e-1) -	1.2624e-1 (4.81e-1)
	200	1.5314e-1 (1.56e-2) -	1.6055e-1 (1.17e-2) -	1.0512e+0 (5.83e-1) -	1.6844e+0 (1.00e-3) -	1.5013e-1 (1.09e-2) -	1.4386e+0 (5.67e-1) -	1.4850e-1 (4.42e-1)
	500	1.5341e-1 (7.68e-3) +	1.6928e-1 (7.72e-3) +	1.4771e+0 (5.29e-1) -	1.6844e+0 (8.54e-4) -	1.5248e-1 (1.01e-2) +	1.6382e+0 (2.75e-1) -	1.9604e-1 (4.84e-1)
	1000	1.5541e-1 (7.28e-3) -	1.7125e-1 (6.40e-3) -	1.9458e+0 (3.27e-1) -	1.6834e+0 (7.60e-4) -	1.5213e-1 (5.72e-3) -	1.6876e+0 (2.71e-3) -	1.1866e-1 (3.05e-2)
LIRCMOP8	100	2.5314e-1 (2.30e-2) -	2.5457e-1 (3.30e-2) -	9.5931e-1 (5.52e-1) -	1.6849e+0 (1.37e-3) -	2.4428e-1 (1.82e-2) -	1.4066e+0 (5.74e-1) -	7.2234e-2 (8.60e-2)
	200	2.4689e-1 (1.44e-2) -	2.6102e-1 (1.48e-2) -	1.0901e+0 (5.46e-1) -	1.6843e+0 (9.24e-4) -	2.5237e-1 (1.28e-2) -	1.6876e+0 (2.46e-3) -	8.7930e-2 (4.92e-2)
	500	2.5627e-1 (1.08e-2) -	2.7327e-1 (1.11e-2) -	1.7674e+0 (2.43e-1) -	1.6840e+0 (8.76e-4) -	2.5398e-1 (9.76e-3) -	1.6873e+0 (2.67e-3) -	1.4588e-1 (5.84e-2)
	1000	2.5626e-1 (8.55e-3) =	2.8308e-1 (7.58e-3) -	2.2202e+0 (6.91e-1) -	1.6831e+0 (5.99e-4) -	2.5531e-1 (8.68e-3) =	1.6867e+0 (2.41e-3) -	2.3934e-1 (8.75e-2)
LIRCMOP9	100	1.1733e+0 (1.35e-1) -	1.0410e+0 (1.32e-1) -	4.3870e-1 (9.33e-2) -	5.2134e-1 (9.36e-2) -	1.0449e+0 (2.53e-1) -	9.9688e-1 (3.10e-1) -	1.0477e-1 (2.91e-2)
	200	1.2838e+0 (1.37e-2) -	1.1947e+0 (1.33e-1) -	4.6378e-1 (9.76e-2) -	4.8488e-1 (4.76e-2) -	1.2831e+0 (6.04e-3) -	1.2671e+0 (6.81e-2) -	1.3141e-1 (4.32e-2)
	500	1.2938e+0 (7.13e-4) -	1.2891e+0 (1.56e-3) -	5.6564e-1 (1.78e-1) -	7.6122e-1 (3.36e-1) -	1.2914e+0 (4.40e-3) -	1.2985e+0 (2.46e-3) -	2.6483e-1 (1.05e-1)
	1000	1.2940e+0 (6.52e-4) -	1.2901e+0 (1.81e-3) -	6.6682e-1 (2.51e-1) -	1.2014e+0 (2.37e-1) -	1.2933e+0 (3.22e-3) -	1.2394e+0 (6.62e-2) -	4.4066e-1 (1.90e-1)
LIRCMOP10	100	2.8239e-1 (1.27e-2) -	4.1256e-1 (1.29e-1) -	3.4595e-1 (1.37e-1) -	6.3813e-1 (9.65e-2) -	4.1866e-1 (1.78e-1) -	8.1466e-1 (2.24e-1) -	2.9075e-2 (1.93e-2)
	200	4.5481e-1 (1.51e-1) -	4.7624e-1 (1.61e-1) -	4.7875e-1 (1.23e-1) -	9.0466e-1 (1.87e-1) -	6.4776e-1 (2.73e-1) -	8.0465e-1 (1.90e-1) -	5.9388e-2 (2.90e-2)
	500	5.1722e-1 (1.84e-1) -	5.6207e-1 (1.50e-1) -	6.4407e-1 (2.46e-1) -	1.0787e+0 (2.40e-2) -	9.6993e-1 (1.71e-1) -	7.9970e-1 (1.44e-1) -	1.7475e-1 (9.38e-2)
	1000	6.0599e-1 (1.98e-1) -	7.4029e-1 (1.52e-1) -	6.2525e-1 (1.07e-1) -	1.0698e+0 (3.46e-2) -	9.6363e-1 (1.66e-1) -	7.6487e-1 (9.94e-2) -	3.5842e-1 (1.61e-1)
LIRCMOP11	100	1.5742e-1 (7.78e-2) -	4.9603e-1 (3.24e-1) -	4.4562e-1 (1.40e-1) -	5.3729e-1 (1.22e-1) -	1.6132e-1 (1.06e-1) -	1.0297e+0 (1.06e-1) -	6.0970e-3 (2.36e-3)
	200	3.0988e-1 (2.60e-1) -	4.0089e-1 (2.69e-1) -	4.0096e-1 (1.11e-1) -	6.9534e-1 (2.32e-1) -	3.8169e-1 (3.23e-1) -	1.1080e+0 (9.30e-2) -	1.1437e-2 (6.44e-3)
	500	6.5255e-1 (3.20e-1) -	7.8102e-1 (3.12e-1) -	5.2153e-1 (1.94e-1) -	1.0947e+0 (4.93e-3) -	9.2085e-1 (2.70e-1) -	1.1472e+0 (8.60e-2) -	1.4396e-1 (2.51e-1)
	1000	6.8826e-1 (2.17e-1) -	8.3455e-1 (2.80e-1) -	5.9107e-1 (2.79e-1) -	1.1415e+0 (9.01e-2) -	9.9043e-1 (2.02e-1) -	1.1753e+0 (1.03e-1) -	1.6695e-1 (1.88e-1)
LIRCMOP12	100	8.5846e-1 (1.11e-1) -	7.3862e-1 (6.72e-2) -	4.5012e-1 (1.66e-1) -	2.6524e-1 (2.31e-2) -	8.5684e-1 (1.08e-1) -	7.4566e-1 (2.70e-1) -	4.5125e-2 (1.78e-1)
	200	9.5194e-1 (4.53e-3) -	8.2000e-1 (9.07e-2) -	4.6057e-1 (1.69e-1) -	2.7412e-1 (3.61e-2) -	9.4034e-1 (5.85e-3) -	9.5095e-1 (1.09e-1) -	6.0073e-2 (1.42e-1)
	500	9.5515e-1 (4.67e-3) -	9.4921e-1 (1.03e-3) -	5.2735e-1 (2.16e-1) -	4.5207e-1 (3.06e-1) -	9.5135e-1 (1.91e-3) -	9.7364e-1 (1.95e-2) -	1.1493e-1 (1.96e-1)
	1000	9.5586e-1 (2.04e-3) -	9.5052e-1 (8.20e-4) -	6.1676e-1 (2.40e-1) -	7.6967e-1 (3.04e-1) -	9.5193e-1 (1.04e-3) -	9.8014e-1 (2.00e-2) -	2.0543e-1 (1.40e-1)
LIRCMOP13	100	9.3070e-2 (9.70e-4) =	1.3147e+0 (1.97e-3) -	9.2176e-2 (1.01e-3) +	1.3015e+0 (1.02e-4) -	9.3084e-2 (1.20e-3) =	4.9351e-1 (5.68e-1) -	9.3096e-2 (1.16e-3)
	200	9.3384e-2 (9.21e-4) =	1.3156e+0 (1.70e-3) -	9.2024e-2 (1.05e-3) +	1.3013e+0 (1.18e-4) -	9.3064e-2 (1.02e-3) =	4.9141e-1 (5.72e-1) -	9.3164e-2 (8.95e-4)
	500	9.3519e-2 (1.18e-3) =	1.3149e+0 (1.71e-3) -	9.1843e-2 (9.68e-4) +	1.3012e+0 (3.69e-5) -	9.3232e-2 (9.77e-4) =	1.9442e-1 (3.15e-1) -	9.3509e-2 (9.75e-4)
	1000	9.4163e-2 (1.04e-3) =	1.3152e+0 (1.85e-3) -	9.1948e-2 (9.27e-4) +	1.3012e+0 (2.19e-5) -	9.2631e-2 (9.30e-4) +	1.5361e-1 (2.78e-1) -	9.3829e-2 (9.69e-4)
LIRCMOP14	100	9.5799e-2 (9.26e-4) -	1.2719e+0 (1.94e-3) -	1.3214e-1 (1.05e-2) -	1.2577e+0 (1.69e-4) -	9.6263e-2 (7.27e-4) -	5.2538e-1 (5.66e-1) -	9.5092e-2 (1.48e-3)
	200	9.5750e-2 (1.08e-3) -	1.2720e+0 (1.53e-3) -	1.4312e-1 (1.25e-2) -	1.2575e+0 (1.17e-4) -	9.5811e-2 (1.00e-3) -	4.3785e-1 (5.36e-1) -	9.5047e-2 (1.20e-3)
	500	9.5634e-2 (1.02e-3) -	1.2720e+0 (1.74e-3) -	1.5082e-1 (1.88e-2) -	1.2573e+0 (5.96e-5) -	9.6035e-2 (1.00e-3) -	1.0795e-1 (1.50e-2) -	9.4729e-2 (7.73e-4)
	1000	9.5419e-2 (8.60e-4) -	1.2711e+0 (1.88e-3) -	1.4551e-1 (1.96e-2) -	1.2573e+0 (2.35e-5) -	9.5667e-2 (7.84e-4) -	1.0006e-1 (1.33e-3) -	9.4685e-2 (9.05e-4)
+/-/=		5/46/5	1/54/1	4/52/0	6/49/1	6/46/4	1/52/3	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-V
THE HV RESULTS OBTAINED BY TLCMEA AND SIX COMPARED ALGORITHMS ON LIRCMOP TEST SUITE.

Problem	D	CCMO	MTCMO	C_LMEA	C_LMOCSO	DPSEA	POCEA	TLCMEA
LIRCMOP1	100	1.0892e-1 (6.12e-3) -	1.2794e-1 (3.85e-3) -	9.8663e-2 (2.33e-3) -	2.3143e-1 (8.81e-4) +	1.1154e-1 (6.29e-3) -	2.0879e-1 (1.16e-2) +	2.0494e-1 (6.32e-3)
	200	1.0570e-1 (5.69e-3) -	1.1681e-1 (2.99e-3) -	NaN (0.00%) -	2.3100e-1 (7.61e-4) +	1.0785e-1 (4.76e-3) -	2.0643e-1 (1.51e-2) +	1.9213e-1 (8.04e-3)
	500	1.0398e-1 (3.00e-3) -	1.0802e-1 (1.82e-3) -	NaN (0.00%) -	2.2709e-1 (1.08e-2) +	1.0604e-1 (3.43e-3) -	1.5264e-1 (3.15e-2) -	1.6382e-1 (1.45e-2)
	1000	1.0149e-1 (2.12e-3) -	1.0345e-1 (1.14e-3) -	NaN (0.00%) -	1.7635e-1 (4.75e-2) =	1.0411e-1 (2.92e-3) -	9.6458e-2 (2.80e-3) -	1.4586e-1 (1.61e-2)
LIRCMOP2	100	2.3735e-1 (1.26e-2) -	2.4714e-1 (4.84e-3) -	2.0950e-1 (5.14e-3) -	3.5284e-1 (6.44e-4) +	2.2659e-1 (9.44e-3) -	3.3116e-1 (1.18e-2) -	3.4688e-1 (2.11e-3)
	200	2.2511e-1 (9.26e-3) -	2.3255e-1 (2.97e-3) -	NaN (0.00%) -	3.5248e-1 (7.49e-4) +	2.2184e-1 (7.07e-3) -	3.3411e-1 (8.51e-3) -	3.3960e-1 (4.16e-3)
	500	2.1679e-1 (5.20e-3) -	2.2159e-1 (2.52e-3) -	NaN (0.00%) -	3.5196e-1 (7.95e-4) +	2.2015e-1 (4.42e-3) -	3.2174e-1 (2.45e-2) =	3.2153e-1 (1.08e-2)
	1000	2.1651e-1 (3.55e-3) -	2.1588e-1 (1.58e-3) -	NaN (0.00%) -	2.2201e-1 (4.93e-3) -	2.1685e-1 (3.49e-3) -	2.1235e-1 (3.66e-3) -	3.1380e-1 (1.58e-2)
LIRCMOP3	100	1.0360e-1 (9.43e-3) -	1.1837e-1 (7.12e-3) -	9.1012e-2 (3.18e-3) -	1.4465e-1 (4.50e-2) -	9.9696e-2 (7.67e-3) -	NaN (96.67%) -	1.9898e-1 (3.53e-3)
	200	9.7855e-2 (5.59e-3) -	9.7035e-2 (2.15e-3) -	NaN (0.00%) -	9.5297e-2 (7.40e-4) -	9.5421e-2 (4.01e-3) -	NaN (96.67%) -	1.9358e-1 (4.97e-3)
	500	9.3192e-2 (2.41e-3) -	9.6730e-2 (2.24e-3) -	NaN (0.00%) -	9.4837e-2 (9.25e-4) -	9.4298e-2 (2.76e-3) -	NaN (96.67%) -	1.8547e-1 (6.50e-3)
	1000	9.3056e-2 (3.28e-3) -	9.5183e-2 (1.24e-3) -	NaN (0.00%) -	9.4747e-2 (9.80e-4) -	9.4828e-2 (2.20e-3) -	9.2160e-2 (1.73e-3) -	1.7196e-1 (1.28e-2)
LIRCMOP4	100	1.9367e-1 (1.41e-2) -	2.1639e-1 (8.46e-3) -	1.8105e-1 (3.95e-3) -	2.2524e-1 (3.59e-2) -	1.8830e-1 (9.02e-3) -	NaN (93.33%) -	3.0767e-1 (3.24e-3)
	200	1.8778e-1 (9.64e-3) -	1.9002e-1 (9.40e-3) -	NaN (0.00%) -	1.8117e-1 (1.12e-3) -	1.8505e-1 (6.48e-3) -	NaN (96.67%) -	2.9983e-1 (7.42e-3)
	500	1.8397e-1 (7.72e-3) -	1.8420e-1 (2.03e-3) -	NaN (0.00%) -	1.8041e-1 (1.37e-3) -	1.8440e-1 (5.40e-3) -	NaN (86.67%) -	2.8471e-1 (1.68e-2)
	1000	1.8144e-1 (1.74e-3) -	1.8254e-1 (2.05e-3) -	NaN (0.00%) -	1.8005e-1 (1.46e-3) -	1.8333e-1 (2.91e-3) -	1.7668e-1 (2.79e-3) -	2.8124e-1 (1.24e-2)
LIRCMOP5	100	1.3283e-1 (1.39e-2) -	6.1797e-2 (6.75e-2) -	1.1443e-1 (8.23e-2) -	0.0000e+0 (0.00e+0) -	1.3243e-1 (9.60e-3) -	4.5452e-3 (2.49e-2) -	2.2938e-1 (1.99e-2)
	200	1.3224e-1 (6.78e-3) -	5.2137e-2 (6.53e-2) -	7.5818e-2 (8.46e-2) -	0.0000e+0 (0.00e+0) -	1.3405e-1 (8.06e-3) -	0.0000e+0 (0.00e+0) -	2.0842e-1 (3.15e-2)
	500	1.2914e-1 (6.94e-3) -	0.0000e+0 (0.00e+0) -	1.1512e-2 (4.38e-2) -	0.0000e+0 (0.00e+0) -	1.2894e-1 (4.97e-3) -	0.0000e+0 (0.00e+0) -	1.5858e-1 (6.82e-2)
	1000	1.2941e-1 (4.71e-3) +	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	1.3056e-1 (3.31e-3) +	0.0000e+0 (0.00e+0) -	4.7506e-2 (8.07e-2)
LIRCMOP6	100	9.1261e-2 (1.65e-3) -	5.7863e-2 (4.49e-2) -	6.0616e-2 (4.23e-2) -	0.0000e+0 (0.00e+0) -	9.0904e-2 (1.33e-3) -	0.0000e+0 (0.00e+0) -	1.5201e-1 (1.38e-2)
	200	8.9873e-2 (6.40e-4) -	3.8562e-2 (4.49e-2) -	3.0581e-2 (4.18e-2) -	0.0000e+0 (0.00e+0) -	8.9285e-2 (6.20e-4) -	0.0000e+0 (0.00e+0) -	1.2791e-1 (1.56e-2)
	500	8.8516e-2 (6.18e-4) +	0.0000e+0 (0.00e+0) -	1.0841e-2 (2.82e-2) -	0.0000e+0 (0.00e+0) -	8.8440e-2 (4.67e-4) +	0.0000e+0 (0.00e+0) -	6.0166e-2 (4.90e-2)
	1000	8.8274e-2 (3.93e-4) +	0.0000e+0 (0.00e+0) -	1.6741e-2 (3.49e-2) =	0.0000e+0 (0.00e+0) -	8.8232e-2 (3.64e-4) +	0.0000e+0 (0.00e+0) -	2.9186e-2 (4.73e-2)
LIRCMOP7	100	2.4070e-1 (5.08e-3) -	2.4074e-1 (5.60e-3) -	1.3173e-1 (8.01e-2) -	0.0000e+0 (0.00e+0) -	2.4089e-1 (3.57e-3) -	1.0916e-1 (1.19e-1) -	2.6738e-1 (5.08e-2)
	200	2.3904e-1 (4.36e-3) -	2.3739e-1 (3.32e-3) -	8.4208e-2 (7.34e-2) -	0.0000e+0 (0.00e+0) -	2.3980e-1 (3.35e-3) -	3.7821e-2 (8.61e-2) -	2.5878e-1 (5.59e-2)
	500	2.3921e-1 (2.19e-3) -	2.3505e-1 (2.20e-3) -	3.5301e-2 (6.11e-2) -	0.0000e+0 (0.00e+0) -	2.3890e-1 (2.76e-3) -	7.6825e-3 (4.21e-2) -	2.4682e-1 (5.42e-2)
	1000	2.3858e-1 (2.07e-3) -	2.3453e-1 (1.89e-3) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	2.3912e-1 (1.26e-3) -	0.0000e+0 (0.00e+0) -	2.5322e-1 (9.49e-3)
LIRCMOP8	100	2.1979e-1 (8.88e-4) -	2.2106e-1 (3.04e-3) -	1.0169e-1 (7.66e-2) -	0.0000e+0 (0.00e+0) -	2.2121e-1 (1.64e-3) -	4.3126e-2 (8.77e-2) -	2.6791e-1 (2.14e-2)
	200	2.1949e-1 (2.89e-4) -	2.1912e-1 (9.82e-4) -	8.3803e-2 (7.26e-2) -	0.0000e+0 (0.00e+0) -	2.1923e-1 (3.86e-4) -	0.0000e+0 (0.00e+0) -	2.6357e-1 (1.07e-2)
	500	2.1895e-1 (2.22e-4) -	2.1567e-1 (7.06e-4) -	5.1843e-3 (2.84e-2) -	0.0000e+0 (0.00e+0) -	2.1887e-1 (1.15e-4) -	0.0000e+0 (0.00e+0) -	2.5015e-1 (1.12e-2)
	1000	2.1879e-1 (1.39e-4) -	2.1380e-1 (3.98e-4) -	0.0000e+0 (0.00e+0) -	0.0000e+0 (0.00e+0) -	2.1877e-1 (9.77e-5) -	0.0000e+0 (0.00e+0) -	2.3215e-1 (1.61e-2)
LIRCMOP9	100	1.9768e-1 (2.45e-2) -	1.9590e-1 (3.75e-2) -	4.1199e-1 (4.55e-2) -	3.4332e-1 (6.58e-2) -	2.1027e-1 (4.65e-2) -	2.0212e-1 (7.96e-2) -	5.2700e-1 (1.16e-2)
	200	1.6351e-1 (5.92e-3) -	1.7591e-1 (8.36e-3) -	3.9211e-1 (5.42e-2) -	3.6552e-1 (3.75e-2) -	1.6138e-1 (1.67e-3) -	1.5313e-1 (2.26e-3) -	5.1558e-1 (1.53e-2)
	500	1.5450e-1 (1.18e-3) -	1.6203e-1 (1.55e-3) -	3.3918e-1 (8.94e-2) -	2.6743e-1 (1.03e-1) -	1.5343e-1 (1.35e-3) -	1.4626e-1 (3.58e-3) -	4.6309e-1 (4.23e-2)
	1000	1.5411e-1 (1.09e-3) -	1.5986e-1 (6.18e-4) -	2.8599e-1 (1.16e-1) -	1.6951e-1 (5.87e-2) -	1.5160e-1 (1.25e-3) -	1.1339e-1 (1.82e-2) -	3.7407e-1 (1.02e-1)
LIRCMOP10	100	5.5373e-1 (1.06e-2) -	4.7049e-1 (1.01e-1) -	5.1292e-1 (4.42e-2) -	2.4765e-1 (8.49e-2) -	4.6801e-1 (1.29e-1) -	1.8677e-1 (1.18e-1) -	6.8969e-1 (7.72e-3)
	200	4.4473e-1 (1.25e-1) -	4.1954e-1 (1.37e-1) -	4.3007e-1 (6.88e-2) -	1.3491e-1 (4.92e-2) -	3.1263e-1 (1.95e-1) -	1.9397e-1 (9.88e-2) -	6.7170e-1 (1.31e-2)
	500	3.8439e-1 (1.62e-1) -	3.4525e-1 (1.18e-1) -	3.2644e-1 (1.28e-1) -	9.3969e-2 (7.28e-4) -	1.1936e-1 (9.67e-2) -	2.0848e-1 (7.21e-2) -	5.9973e-1 (6.09e-2)
	1000	3.3955e-1 (1.71e-1) -	2.4177e-1 (1.24e-1) -	2.9057e-1 (8.25e-2) -	9.3942e-2 (4.03e-4) -	1.1700e-1 (8.82e-2) -	2.2916e-1 (4.93e-2) -	4.7844e-1 (1.16e-1)
LIRCMOP11	100	5.9549e-1 (4.03e-2) -	4.0932e-1 (1.61e-1) -	4.1722e-1 (6.51e-2) -	3.1569e-1 (8.34e-2) -	5.9414e-1 (5.87e-2) -	1.7273e-1 (7.54e-2) -	6.9103e-1 (1.60e-3)
	200	4.7490e-1 (1.85e-1) -	4.5306e-1 (1.39e-1) -	4.5053e-1 (4.68e-2) -	2.4498e-1 (7.90e-2) -	4.3997e-1 (1.84e-1) -	1.8385e-1 (8.81e-2) -	6.8773e-1 (4.55e-3)
	500	2.8817e-1 (1.89e-1) -	2.3546e-1 (1.67e-1) -	3.7770e-1 (8.54e-2) -	1.2585e-1 (2.03e-3) -	1.7262e-1 (1.35e-1) -	2.2741e-1 (9.16e-2) -	6.3315e-1 (9.05e-2)
	1000	2.5348e-1 (1.74e-1) -	2.2093e-1 (1.51e-1) -	3.3627e-1 (1.09e-1) -	1.1519e-1 (1.10e-2) -	1.4034e-1 (9.78e-2) -	2.0236e-1 (1.00e-1) -	6.2281e-1 (6.78e-2)
LIRCMOP12	100	3.8220e-1 (1.66e-2) -	3.8672e-1 (1.39e-2) -	3.8749e-1 (7.85e-2) -	4.9672e-1 (1.54e-2) -	3.8072e-1 (1.03e-2) -	3.8633e-1 (2.88e-2) -	6.0622e-1 (5.14e-2)
	200	3.6686e-1 (3.95e-3) -	3.7483e-1 (3.05e-3) -	3.7568e-1 (8.21e-2) -	4.8879e-1 (2.47e-2) -	3.7321e-1 (3.01e-3) -	3.6677e-1 (9.85e-3) -	5.9937e-1 (3.82e-2)
	500	3.6421e-1 (4.18e-3) -	3.6933e-1 (8.29e-4) -	3.7522e-1 (9.72e-2) -	4.5871e-1 (5.90e-2) -	3.6746e-1 (1.53e-3) -	3.6022e-1 (4.89e-3) -	5.7829e-1 (5.64e-2)
	1000	3.6353e-1 (1.78e-3) -	3.6826e-1 (6.79e-4) -	3.3244e-1 (9.75e-2) -	4.0124e-1 (5.68e-2) -	3.6708e-1 (8.92e-4) -	3.5637e-1 (6.14e-3) -	5.3343e-1 (4.93e-2)
LIRCMOP13	100	5.5462e-1 (1.57e-3) -	1.3419e-4 (1.28e-4) -	5.6032e-1 (1.88e-3) +	4.5389e-4 (3.71e-7) -	5.5573e-1 (1.46e-3) =	3.5841e-1 (2.40e-1) -	5.5541e-1 (1.26e-3)
	200	5.5462e-1 (1.48e-3) =	1.7608e-4 (1.35e-4) -	5.6062e-1 (1.10e-3) +	4.5405e-4 (1.72e-7) -	5.5601e-1 (1.29e-3) +	3.6275e-1 (2.42e-1) -	5.5454e-1 (1.34e-3)
	500	5.5406e-1 (1.19e-3) =	1.3507e-4 (1.09e-4) -	5.6085e-1 (9.83e-4) +	4.5412e-4 (1.64e-8) -	5.5564e-1 (1.36e-3) +	4.9657e-1 (1.37e-1) -	5.5380e-1 (1.51e-3)
	1000	5.5211e-1 (1.84e-3) -	1.7362e-4 (1.17e-4) -	5.6065e-1 (9.06e-4) +	4.5413e-4 (1.87e-9) -	5.5591e-1 (1.27e-3) +	5.2853e-1 (8.61e-2) -	5.5317e-1 (1.54e-3)
LIRCMOP14	100	5.5439e-1 (1.47e-3) =	6.4007e-4 (2.63e-4) -	5.3369e-1 (8.77e-3) -	1.0066e-3 (7.17e-7) -	5.5391e-1 (1.26e-3) -	3.4073e-1 (2.47e-1) -	5.5498e-1 (1.37e-3)
	200	5.5395e-1 (1.30e-3) -	6.6733e-4 (3.23e-4) -	5.3156e-1 (9.19e-3) -	1.0069e-3 (9.87e-8) -	5.5399e-1 (1.22e-3) -	3.8562e-1 (2.40e-1) -	5.5549e-1 (1.24e-3)
	500	5.5423e-1 (1.11e-3) -	4.7685e-4 (3.64e-4) -	5.2666e-1 (1.23e-2) -	1.0070e-3 (1.47e-8) -	5.5372e-1 (1.38e-3) -	5.4109e-1 (1.54e-2) -	5.5561e-1 (1.22e-3)
	1000	5.5451e-1 (1.12e-3) -	5.6921e-4 (2.70e-4) -	5.2998e-1 (8.94e-3) -	1.0070e-3 (3.69e-8) -	5.5465e-1 (1.20e-3) -	5.4980e-1 (8.98e-4) -	5.5598e-1 (1.22e-3)
+/-/=		3/50/3	0/56/0	4/51/1	6/49/1	6/49/1	2/53/1	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.



(a) CCMO (b) MTCMO (c) C_LMEA

(d) C_LMOCSO (e) DPSEA (f) POCEA

(g) TLCMEA

Fig. S-II. The population distribution of median IGD values obtained by seven algorithms on 1000-dimensional LIRCMOP4.

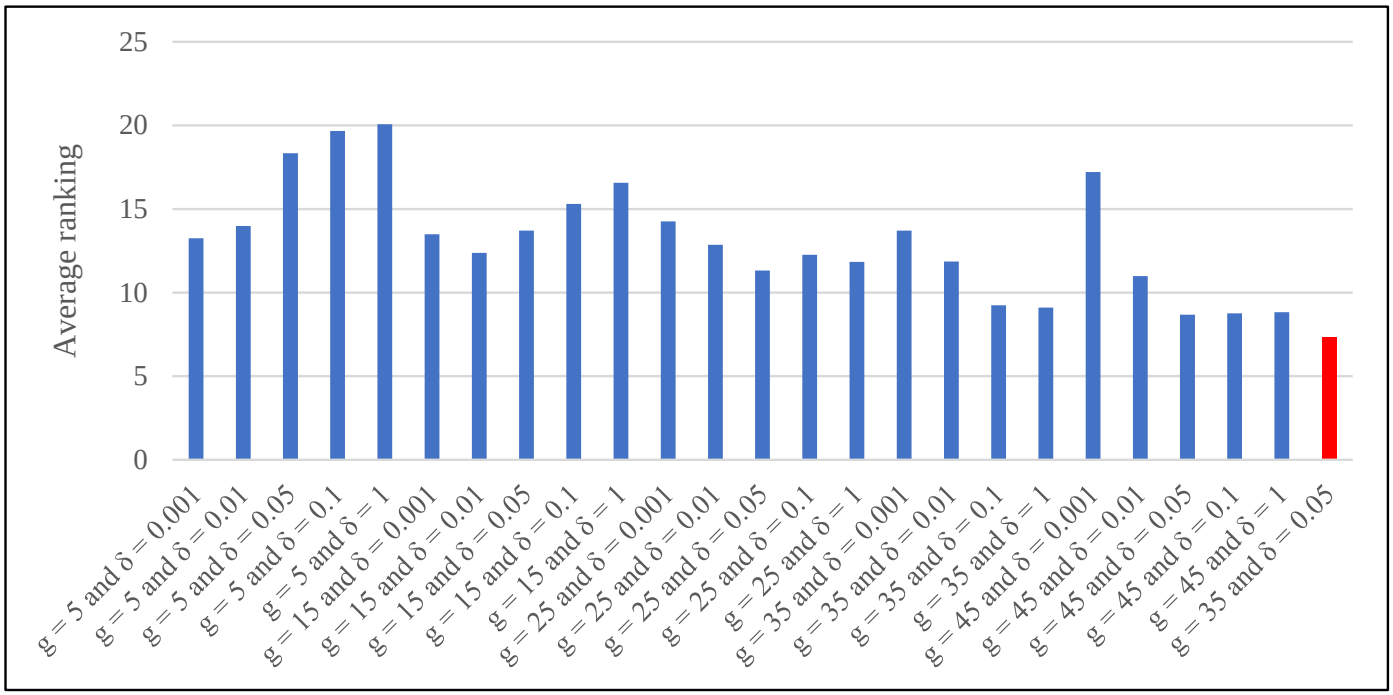
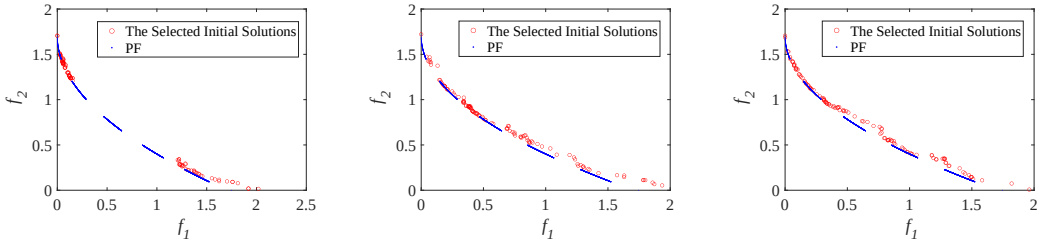


Fig. S-III. The ranking results of the Friedman's test for IGD values of the compared algorithms.



(a) k = 0 (b) k = 50 (c) k = 100

Fig. S-IV. The distribution of the initial population obtained by the APR method on the LIRCMOP10 problem with different k.

TABLE S-VI
THE IGD COMPARISON RESULTS OF FIXING δ TO 0.05 AND TAKING DIFFERENT VALUES OF g

Problem	g = 5 and δ = 0.05	g = 15 and δ = 0.05	g = 25 and δ = 0.05	g = 35 and δ = 0.05	g = 45 and δ = 0.05
C1_DTLZ1	3.9030e-2 (9.97e-3) -	4.4978e-2 (1.34e-2) -	2.3397e-2 (6.70e-3) =	2.1656e-2 (7.64e-4)	2.1713e-2 (2.94e-4) =
C1_DTLZ3	6.6843e+0 (3.02e+0) -	5.8452e-1 (2.02e+0) =	5.3380e-2 (5.15e-4) =	5.3401e-2 (8.39e-4)	5.3316e-2 (6.19e-4) =
C2_DTLZ2	4.2617e-2 (5.32e-4) =	4.2610e-2 (6.19e-4) =	4.2674e-2 (5.37e-4) =	4.2478e-2 (3.72e-4)	4.2419e-2 (4.63e-4) =
C3_DTLZ4	1.1927e-1 (1.36e-1) =	9.4649e-2 (1.36e-3) =	1.1957e-1 (1.36e-1) =	1.1941e-1 (1.36e-1)	9.4438e-2 (1.32e-3) =
DC1_DTLZ1	2.8315e-2 (5.50e-3) -	2.1743e-2 (5.31e-3) -	1.2144e-2 (8.65e-4) -	1.1516e-2 (1.60e-4)	1.1427e-2 (1.24e-4) +
DC1_DTLZ3	3.4710e-2 (5.63e-4) -	3.4399e-2 (5.15e-4) -	3.3903e-2 (3.71e-4) =	3.3915e-2 (4.04e-4)	3.3734e-2 (4.30e-4) =
DC2_DTLZ1	NaN (0.00%) -	NaN (16.67%) -	4.9299e-2 (5.85e-2) -	2.0216e-2 (1.84e-4)	2.0132e-2 (1.34e-4) =
DC2_DTLZ3	NaN (6.67%) -	NaN (56.67%) -	8.6997e-2 (1.30e-1) -	5.2633e-2 (3.42e-4)	5.2703e-2 (4.04e-4) =
DC3_DTLZ1	9.3322e+0 (2.46e+0) -	9.1310e-1 (6.49e-1) -	8.1438e-3 (1.43e-3) -	6.9864e-3 (1.65e-4)	6.9100e-3 (1.33e-4) +
DC3_DTLZ3	9.1881e+0 (5.39e+0) -	8.1349e-1 (8.09e-1) -	1.9984e-2 (2.40e-4) =	1.9924e-2 (2.12e-4)	2.0018e-2 (2.09e-4) =
LIRCMOP1	6.4540e-2 (1.94e-2) -	5.5233e-2 (1.42e-2) =	5.6571e-2 (1.45e-2) =	4.9450e-2 (9.58e-3)	NaN (93.33%) -
LIRCMOP2	5.0605e-2 (1.77e-2) -	3.4057e-2 (5.47e-3) -	3.5638e-2 (6.21e-3) -	3.0733e-2 (4.39e-3)	3.0361e-2 (3.88e-3) =
LIRCMOP3	5.8278e-2 (2.47e-2) -	3.9536e-2 (1.46e-2) -	2.7342e-2 (8.08e-3) =	2.4964e-2 (1.01e-2)	NaN (80.00%) -
LIRCMOP4	8.0970e-2 (3.43e-2) -	3.6695e-2 (1.31e-2) -	2.5396e-2 (7.79e-3) =	2.4573e-2 (7.63e-3)	NaN (96.67%) -
LIRCMOP5	8.5466e-1 (4.92e-1) -	3.7155e-1 (3.92e-1) -	1.5868e-1 (5.36e-2) -	1.2488e-1 (3.96e-2)	1.0956e-1 (3.30e-2) =
LIRCMOP6	9.3532e-1 (5.15e-1) -	3.3357e-1 (2.41e-1) -	1.9881e-1 (9.89e-2) -	1.2337e-1 (6.38e-2)	1.2130e-1 (6.14e-2) =
LIRCMOP7	3.0643e-1 (5.49e-1) -	5.8753e-2 (2.68e-2) +	4.1953e-2 (1.82e-2) =	1.2624e-1 (4.81e-1)	NaN (96.67%) -
LIRCMOP8	1.9889e-1 (1.07e-1) -	1.0389e-1 (4.83e-2) -	8.4752e-2 (3.83e-2) -	7.2234e-2 (8.60e-2)	NaN (96.67%) -
LIRCMOP9	4.7043e-1 (2.65e-1) -	1.4956e-1 (8.74e-2) -	1.1025e-1 (3.05e-2) =	1.0477e-1 (2.91e-2)	9.9082e-2 (2.29e-2) =
LIRCMOP10	3.0497e-1 (1.33e-1) -	8.9363e-2 (6.24e-2) -	3.3781e-2 (2.03e-2) -	2.9075e-2 (1.93e-2)	2.4595e-2 (7.60e-3) =
LIRCMOP11	1.9910e-1 (2.18e-1) -	1.9535e-2 (2.23e-2) -	8.6784e-3 (6.39e-3) =	6.0970e-3 (2.36e-3)	7.7327e-2 (2.69e-1) =
LIRCMOP12	1.7780e-1 (2.15e-1) -	2.8672e-2 (1.58e-2) +	1.8059e-2 (7.63e-3) +	4.5125e-2 (1.78e-1)	7.4893e-2 (2.24e-1) =
LIRCMOP13	2.9703e-1 (4.64e-1) =	9.3074e-2 (9.05e-4) =	9.3421e-2 (9.63e-4) =	9.3096e-2 (1.16e-3)	9.3047e-2 (1.19e-3) =
LIRCMOP14	4.0903e-1 (5.29e-1) -	9.5154e-2 (1.02e-3) =	9.5119e-2 (9.94e-4) =	9.5092e-2 (1.48e-3)	9.5208e-2 (9.43e-4) =
MW1	2.5684e-3 (1.05e-3) -	1.7550e-3 (2.94e-4) -	1.6130e-3 (9.51e-6) =	1.6091e-3 (1.09e-5)	1.6131e-3 (1.17e-5) =
MW2	6.2620e-3 (2.86e-3) =	5.6069e-3 (5.37e-4) =	5.6570e-3 (9.03e-4) =	5.6942e-3 (5.97e-4)	5.6645e-3 (7.24e-4) =
MW3	6.1425e-3 (6.06e-4) -	5.7283e-3 (3.72e-4) -	5.6017e-3 (3.26e-4) =	5.4699e-3 (2.24e-4)	5.4166e-3 (3.00e-4) =
MW4	4.1991e-2 (2.68e-3) +	4.0588e-2 (1.15e-3) +	4.8852e-2 (1.46e-3) =	4.8342e-2 (1.61e-3)	4.8620e-2 (1.60e-3) =
MW5	NaN (66.67%) -	NaN (76.67%) -	NaN (90.00%) -	NaN (93.33%)	NaN (93.33%) =
MW6	1.0770e-2 (2.06e-2) -	2.7509e-3 (2.51e-5) =	2.7519e-3 (2.25e-5) =	2.7454e-3 (2.80e-5)	2.7541e-3 (1.97e-5) =
MW7	6.0524e-3 (8.55e-4) -	5.1882e-3 (3.69e-4) -	4.6162e-3 (2.49e-4) =	4.5148e-3 (2.16e-4)	4.4061e-3 (1.73e-4) +
MW8	4.3377e-2 (1.64e-3) =	4.2927e-2 (6.49e-4) =	4.2944e-2 (6.53e-4) =	4.2930e-2 (5.77e-4)	4.2852e-2 (5.70e-4) =
MW9	NaN (63.33%) -	NaN (83.33%) -	NaN (86.67%) -	NaN (93.33%)	NaN (83.33%) -
MW10	7.1587e-3 (1.01e-2) -	3.4105e-3 (4.23e-5) =	3.4176e-3 (3.31e-5) =	3.4078e-3 (4.88e-5)	3.4242e-3 (5.67e-5) =
MW11	5.8969e-3 (1.05e-4) =	5.9331e-3 (1.07e-4) =	5.8939e-3 (9.71e-5) =	5.9115e-3 (1.16e-4)	5.9404e-3 (1.12e-4) =
MW12	NaN (83.33%) -	NaN (80.00%) -	NaN (90.00%) -	NaN (93.33%)	NaN (86.67%) -
MW13	1.2660e-2 (8.92e-3) =	1.0654e-2 (1.67e-4) =	1.0816e-2 (8.91e-4) =	1.0715e-2 (1.66e-4)	1.0670e-2 (1.40e-4) =
MW14	1.2044e-1 (3.79e-2) -	9.8885e-2 (1.76e-3) -	9.8020e-2 (2.14e-3) =	9.7530e-2 (2.06e-3)	9.7031e-2 (1.96e-3) =
+/-/=	1/30/7	3/23/12	1/12/25		3/7/28

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-VII
THE IGD COMPARISON RESULTS OF FIXING g TO 35 AND TAKING DIFFERENT VALUES OF δ

Problem	g = 35 and δ = 0.001	g = 35 and δ = 0.01	g = 35 and δ = 0.05	g = 35 and δ = 0.1	g = 35 and δ = 1
C1_DTLZ1	2.1670e-2 (2.86e-4) =	2.1700e-2 (1.91e-4) =	2.1656e-2 (7.64e-4)	2.0476e-2 (8.80e-4) +	2.0938e-2 (1.08e-3) +
C1_DTLZ3	5.3381e-2 (7.34e-4) =	5.3282e-2 (7.49e-4) =	5.3401e-2 (8.39e-4)	5.3218e-2 (5.84e-4) =	5.3339e-2 (6.07e-4) =
C2_DTLZ2	4.2672e-2 (5.14e-4) =	4.2494e-2 (6.05e-4) =	4.2478e-2 (3.72e-4)	4.2651e-2 (5.86e-4) =	4.2604e-2 (5.65e-4) =
C3_DTLZ4	NaN (83.33%) -	2.1885e-1 (2.83e-1) =	1.1941e-1 (1.36e-1)	1.1942e-1 (1.36e-1) =	1.1943e-1 (1.36e-1) =
DC1_DTLZ1	1.1404e-2 (8.85e-5) +	1.1389e-2 (9.59e-5) +	1.1516e-2 (1.60e-4)	1.1800e-2 (3.57e-4) -	1.1589e-2 (1.84e-4) =
DC1_DTLZ3	3.3750e-2 (3.78e-4) =	3.3914e-2 (3.31e-4) =	3.3915e-2 (4.04e-4)	3.3786e-2 (3.37e-4) =	3.3724e-2 (3.13e-4) +
DC2_DTLZ1	2.0048e-2 (1.20e-4) +	2.0082e-2 (1.26e-4) +	2.0216e-2 (1.84e-4)	2.0290e-2 (2.01e-4) =	2.0254e-2 (1.52e-4) =
DC2_DTLZ3	5.2762e-2 (4.14e-4) =	5.2667e-2 (3.38e-4) =	5.2633e-2 (3.42e-4)	5.2753e-2 (4.19e-4) =	5.2717e-2 (3.92e-4) =
DC3_DTLZ1	6.8620e-3 (5.63e-5) +	6.8634e-3 (4.95e-5) +	6.9864e-3 (1.65e-4)	7.2675e-3 (3.44e-4) -	7.1961e-3 (2.36e-4) -
DC3_DTLZ3	1.9919e-2 (3.22e-4) =	1.9879e-2 (2.45e-4) =	1.9924e-2 (2.12e-4)	1.9986e-2 (2.26e-4) =	2.0009e-2 (2.96e-4) =
LIRCMOP1	NaN (0.00%) -	NaN (46.67%) -	4.9450e-2 (9.58e-3)	5.4047e-2 (1.18e-2) =	5.7387e-2 (9.83e-3) -
LIRCMOP2	NaN (3.33%) =	NaN (60.00%) -	3.0733e-2 (4.39e-3)	3.2775e-2 (4.31e-3) -	3.4528e-2 (6.34e-3) -
LIRCMOP3	NaN (0.00%) -	NaN (6.67%) -	2.4964e-2 (1.01e-2)	2.6496e-2 (8.75e-3) =	2.7442e-2 (8.72e-3) =
LIRCMOP4	NaN (0.00%) -	NaN (60.00%) -	2.4573e-2 (7.63e-3)	2.8375e-2 (1.07e-2) =	2.8771e-2 (1.07e-2) =
LIRCMOP5	6.6187e-2 (1.99e-2) +	7.7009e-2 (2.10e-2) +	1.2488e-1 (3.96e-2)	1.6062e-1 (3.23e-2) -	1.7154e-1 (3.21e-2) -
LIRCMOP6	5.5998e-2 (1.71e-2) +	5.9993e-2 (2.28e-2) +	1.2337e-1 (6.38e-2)	1.5077e-1 (6.41e-2) =	1.9798e-1 (7.38e-2) -
LIRCMOP7	NaN (66.67%) -	NaN (63.33%) -	1.2624e-1 (4.81e-1)	4.7234e-2 (1.76e-2) =	4.8294e-2 (2.21e-2) +
LIRCMOP8	NaN (66.67%) -	NaN (66.67%) -	7.2234e-2 (8.60e-2)	7.7961e-2 (3.51e-2) -	5.9238e-2 (2.90e-2) =
LIRCMOP9	1.0923e-1 (3.42e-2) =	1.0540e-1 (2.75e-2) =	1.0477e-1 (2.91e-2)	1.0461e-1 (2.55e-2) =	1.4240e-1 (4.49e-2) -
LIRCMOP10	2.4283e-2 (5.93e-3) =	2.5122e-2 (5.98e-3) =	2.9075e-2 (1.93e-2)	4.1652e-2 (2.53e-2) -	4.4582e-2 (2.58e-2) -
LIRCMOP11	NaN (90.00%) -	4.7149e-1 (5.22e-1) -	6.0970e-3 (2.36e-3)	6.5715e-3 (3.35e-3) =	8.4674e-3 (4.20e-3) -
LIRCMOP12	NaN (96.67%) -	4.7063e-1 (4.70e-1) -	4.5125e-2 (1.78e-1)	1.7796e-2 (8.02e-3) +	2.2981e-2 (1.20e-2) +
LIRCMOP13	9.3726e-2 (1.32e-3) =	9.3239e-2 (1.03e-3) =	9.3096e-2 (1.16e-3)	9.3086e-2 (1.05e-3) =	9.3240e-2 (1.01e-3) =
LIRCMOP14	9.4891e-2 (7.48e-4) =	9.5209e-2 (1.07e-3) =	9.5092e-2 (1.48e-3)	9.5400e-2 (1.14e-3) =	9.5233e-2 (9.83e-4) =
MW1	1.6130e-3 (1.40e-5) =	1.6131e-3 (1.12e-5) =	1.6091e-3 (1.09e-5)	1.6093e-3 (9.68e-6) =	1.6114e-3 (9.20e-6) =
MW2	5.4098e-3 (7.12e-4) =	5.5330e-3 (7.30e-4) =	5.6942e-3 (5.97e-4)	5.4221e-3 (6.26e-4) =	5.6099e-3 (4.37e-4) =
MW3	3.7112e-2 (2.41e-2) -	5.4801e-3 (3.65e-4) =	5.4699e-3 (2.24e-4)	5.4935e-3 (2.28e-4) =	5.4310e-3 (2.66e-4) =
MW4	4.8517e-2 (1.76e-3) =	4.8350e-2 (1.86e-3) =	4.8342e-2 (1.61e-3)	4.8778e-2 (1.64e-3) =	4.8318e-2 (1.59e-3) =
MW5	NaN (90.00%) -	NaN (86.67%) -	NaN (93.33%)	2.7636e-2 (1.34e-1) =	NaN (76.67%) -
MW6	2.7490e-3 (1.88e-5) =	2.7548e-3 (2.87e-5) =	2.7454e-3 (2.80e-5)	2.7462e-3 (2.21e-5) =	2.7504e-3 (3.16e-5) =
MW7	2.0216e-1 (8.94e-2) -	1.1077e-2 (3.62e-2) =	4.5148e-3 (2.16e-4)	4.6159e-3 (2.36e-4) =	4.5194e-3 (2.14e-4) =
MW8	4.3156e-2 (5.42e-4) =	4.3006e-2 (6.66e-4) =	4.2930e-2 (5.77e-4)	4.2962e-2 (6.04e-4) =	4.2833e-2 (5.53e-4) =
MW9	NaN (90.00%) -	NaN (80.00%) -	NaN (93.33%)	NaN (90%) -	NaN (93.33%) -
MW10	3.3965e-3 (3.73e-5) =	3.4133e-3 (8.96e-5) =	3.4078e-3 (4.88e-5)	3.4193e-3 (4.13e-5) =	3.4238e-3 (4.30e-5) =
MW11	NaN (6.67%) -	NaN (83.33%) -	5.9115e-3 (1.16e-4)	5.9215e-3 (1.07e-4) =	5.8850e-3 (9.55e-5) =
MW12	NaN (76.67%) -	NaN (93.33%) =	NaN (93.33%)	NaN (86.67%) -	NaN (96.67%) -
MW13	1.0709e-2 (1.76e-4) =	1.0703e-2 (1.41e-4) =	1.0715e-2 (1.66e-4)	1.0743e-2 (1.17e-4) =	1.1021e-2 (1.21e-3) =
MW14	1.8491e-1 (4.20e-2) -	1.1483e-1 (3.97e-2) =	9.7530e-2 (2.06e-3)	9.8019e-2 (1.51e-3) =	9.7703e-2 (1.92e-3) =
+/-/=	5/15/18	5/11/22		2/8/28	4/11/23

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-VIII
THE IGD RESULTS OF TLCMEA WITH DIFFERENT k VALUES FOR DTLZ, LIRCMOP AND MW TEST SUITES ON 100D.

Problem	k = 0	k = 1	k = 10	k = 50	k = 80	k = 100
C1_DTLZ1	2.1264e-2 (7.29e-4) +	2.1243e-2 (9.79e-4) =	2.1192e-2 (9.17e-4) +	2.1457e-2 (5.91e-4) =	2.1545e-2 (8.57e-4) =	2.1656e-2 (7.64e-4)
C1_DTLZ3	5.3358e-2 (8.63e-4) =	5.3378e-2 (6.52e-4) =	5.3468e-2 (7.86e-4) =	5.3438e-2 (5.93e-4) =	5.3416e-2 (6.97e-4) =	5.3401e-2 (8.39e-4)
C2_DTLZ2	4.2936e-2 (5.34e-4) -	4.2455e-2 (4.76e-4) =	4.2567e-2 (6.33e-4) =	4.2404e-2 (5.01e-4) =	4.2762e-2 (7.03e-4) =	4.2478e-2 (3.72e-4)
C3_DTLZ4	1.4418e-1 (1.89e-1) =	1.1928e-1 (1.36e-1) =	1.9362e-1 (2.58e-1) =	1.1945e-1 (1.36e-1) =	9.4311e-2 (1.31e-3) =	1.1941e-1 (1.36e-1)
DC1_DTLZ1	1.1498e-2 (1.03e-4) =	1.1513e-2 (2.09e-4) =	1.1494e-2 (2.15e-4) =	1.1534e-2 (1.55e-4) =	1.1518e-2 (2.03e-4) =	1.1516e-2 (1.60e-4)
DC1_DTLZ3	3.3901e-2 (3.25e-4) =	3.3797e-2 (3.08e-4) =	3.3945e-2 (4.13e-4) =	3.3817e-2 (3.09e-4) =	3.3865e-2 (3.75e-4) =	3.3915e-2 (4.04e-4)
DC2_DTLZ1	2.0151e-2 (1.99e-4) =	2.0175e-2 (1.90e-4) =	2.0188e-2 (1.66e-4) =	2.0183e-2 (1.91e-4) =	2.0239e-2 (1.93e-4) =	2.0216e-2 (1.84e-4)
DC2_DTLZ3	5.2760e-2 (5.00e-4) =	5.2594e-2 (4.63e-4) =	5.2677e-2 (3.65e-4) =	5.2578e-2 (4.21e-4) =	5.2805e-2 (5.10e-4) =	5.2633e-2 (3.42e-4)
DC3_DTLZ1	6.9575e-3 (1.81e-4) =	7.0047e-3 (2.33e-4) =	7.0280e-3 (2.51e-4) =	7.0711e-3 (2.42e-4) =	7.0357e-3 (2.61e-4) =	6.9864e-3 (1.65e-4)
DC3_DTLZ3	1.9913e-2 (2.29e-4) =	1.9954e-2 (2.26e-4) =	2.0009e-2 (2.54e-4) =	2.0004e-2 (2.30e-4) =	1.9995e-2 (2.95e-4) =	1.9924e-2 (2.12e-4)
LIRCMOP1	5.5377e-2 (1.12e-2) =	4.8011e-2 (1.15e-2) =	6.1636e-2 (1.44e-2) -	5.1031e-2 (1.07e-2) =	5.2434e-2 (1.03e-2) =	4.9450e-2 (9.58e-3)
LIRCMOP2	3.0017e-2 (5.88e-3) =	2.9525e-2 (3.48e-3) =	2.8820e-2 (2.83e-3) =	2.9851e-2 (5.55e-3) =	3.2604e-2 (6.70e-3) =	3.0733e-2 (4.39e-3)
LIRCMOP3	2.1081e-2 (6.82e-3) =	1.8825e-2 (8.22e-3) +	2.5941e-2 (9.29e-3) =	2.1512e-2 (7.93e-3) =	2.5787e-2 (1.17e-2) =	2.4964e-2 (1.01e-2)
LIRCMOP4	2.3448e-2 (1.01e-2) =	2.1140e-2 (8.16e-3) =	2.2934e-2 (6.93e-3) =	2.7017e-2 (8.53e-3) =	2.6929e-2 (6.78e-3) =	2.4573e-2 (7.63e-3)
LIRCMOP5	1.6317e-1 (7.12e-2) -	1.5076e-1 (6.23e-2) =	1.3196e-1 (3.79e-2) =	1.3165e-1 (4.73e-2) =	1.2377e-1 (3.98e-2) =	1.2488e-1 (3.96e-2)
LIRCMOP6	1.6023e-1 (4.89e-2) -	1.8197e-1 (9.01e-2) -	1.4700e-1 (8.05e-2) =	1.3008e-1 (6.12e-2) =	1.4273e-1 (7.20e-2) =	1.2337e-1 (6.38e-2)
LIRCMOP7	4.1428e-2 (1.45e-2) =	3.6054e-2 (1.59e-2) =	3.3258e-2 (1.41e-2) =	5.7136e-2 (1.13e-1) =	3.5540e-2 (1.59e-2) =	1.2624e-1 (4.81e-1)
LIRCMOP8	6.6657e-2 (3.01e-2) =	7.5815e-2 (1.13e-1) =	6.7437e-2 (3.42e-2) =	6.2421e-2 (3.10e-2) =	1.5355e-1 (4.18e-1) =	7.2234e-2 (8.60e-2)
LIRCMOP9	3.4010e-1 (1.10e-1) -	2.7098e-1 (9.32e-2) -	1.2203e-1 (2.28e-2) -	1.0315e-1 (2.75e-2) =	1.0168e-1 (2.17e-2) =	1.0477e-1 (2.91e-2)
LIRCMOP10	1.4058e-1 (4.33e-2) -	1.3809e-1 (4.32e-2) -	4.0497e-2 (1.87e-2) -	2.9947e-2 (1.51e-2) -	3.0068e-2 (1.94e-2) =	2.9075e-2 (1.93e-2)
LIRCMOP11	6.2036e-2 (2.03e-1) -	3.7240e-2 (3.68e-2) -	1.9541e-2 (2.51e-2) -	7.2729e-3 (3.46e-3) =	6.5645e-3 (3.51e-3) =	6.0970e-3 (2.36e-3)
LIRCMOP12	1.2306e-1 (2.64e-2) -	1.4773e-1 (1.64e-1) -	2.0014e-2 (1.10e-2) +	1.4578e-2 (7.18e-3) =	1.3437e-2 (6.88e-3) =	4.5125e-2 (1.78e-1)
LIRCMOP13	9.3232e-2 (1.15e-3) =	9.3523e-2 (1.04e-3) =	9.3219e-2 (8.62e-4) =	9.3614e-2 (1.26e-3) =	9.3380e-2 (1.18e-3) =	9.3096e-2 (1.16e-3)
LIRCMOP14	9.4899e-2 (1.07e-3) =	9.5032e-2 (8.30e-4) =	9.5221e-2 (1.04e-3) =	9.4977e-2 (1.07e-3) =	9.5278e-2 (7.88e-4) =	9.5092e-2 (1.48e-3)
MW1	1.6130e-3 (9.82e-6) =	1.6132e-3 (1.18e-5) =	1.6145e-3 (1.28e-5) =	1.6124e-3 (9.09e-6) =	1.6152e-3 (1.37e-5) =	1.6091e-3 (1.09e-5)
MW2	5.5890e-3 (1.04e-3) =	5.4025e-3 (6.95e-4) =	4.7974e-3 (1.08e-3) +	5.3477e-3 (5.40e-4) +	5.3269e-3 (7.82e-4) +	5.6942e-3 (5.97e-4)
MW3	5.4219e-3 (2.89e-4) =	5.4715e-3 (3.29e-4) =	5.4426e-3 (2.70e-4) =	5.4369e-3 (3.19e-4) =	5.4171e-3 (2.89e-4) =	5.4699e-3 (2.24e-4)
MW4	4.8971e-2 (1.67e-3) =	4.8617e-2 (1.78e-3) =	4.8577e-2 (1.51e-3) =	4.8721e-2 (1.30e-3) =	4.8672e-2 (1.95e-3) =	4.8342e-2 (1.61e-3)
MW5	NaN (90.00%) -	NaN (93.33%) =	NaN (83.33%) -	NaN (86.67%) -	NaN (83.33%) -	NaN (93.33%)
MW6	6.9106e-3 (2.28e-2) =	2.7500e-3 (2.21e-5) =	2.7520e-3 (2.18e-5) =	2.7635e-3 (2.93e-5) -	2.7508e-3 (2.35e-5) =	2.7454e-3 (2.80e-5)
MW7	4.4572e-3 (2.35e-4) =	4.4304e-3 (2.29e-4) =	4.4856e-3 (2.01e-4) =	4.4949e-3 (2.27e-4) =	4.5326e-3 (2.38e-4) =	4.5148e-3 (2.16e-4)
MW8	4.2854e-2 (5.95e-4) =	4.2978e-2 (5.92e-4) =	4.2851e-2 (5.83e-4) =	4.3161e-2 (4.89e-4) =	4.2970e-2 (5.08e-4) =	4.2930e-2 (5.77e-4)
MW9	NaN (90.00%) -	NaN (86.67%) -	NaN (93.33%) =	NaN (93.33%) =	NaN (80.00%) -	NaN (93.33%)
MW10	3.4080e-3 (4.23e-5) =	3.4109e-3 (4.28e-5) =	3.4038e-3 (4.34e-5) =	3.4179e-3 (5.53e-5) =	3.4225e-3 (4.68e-5) =	3.4078e-3 (4.88e-5)
MW11	5.9146e-3 (1.05e-4) =	5.9187e-3 (1.17e-4) =	5.9537e-3 (1.06e-4) =	5.9074e-3 (9.91e-5) =	5.9270e-3 (1.15e-4) =	5.9115e-3 (1.16e-4)
MW12	NaN (86.67%) -	NaN (90.00%) -	NaN (93.33%) =	NaN (93.33%) =	NaN (83.33%) -	NaN (93.33%)
MW13	2.6522e-2 (8.67e-2) =	7.5564e-2 (1.64e-1) =	1.0699e-2 (1.58e-4) =	1.0651e-2 (1.40e-4) =	1.0892e-2 (8.72e-4) =	1.0715e-2 (1.66e-4)
MW14	1.2200e-1 (4.96e-2) =	1.1781e-1 (4.63e-2) =	9.7364e-2 (1.72e-3) =	9.7765e-2 (1.46e-3) =	9.7080e-2 (1.63e-3) =	9.7530e-2 (2.06e-3)
+/-/=	1/10/27	1/7/30	3/5/30	1/3/34	1/3/34	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-IX
THE COMPARISON RESULTS OF TLCMEA AND TLCMEA-LMEA ON IGD VALUES

Problem	TLCMEA-LMEA	TLCMEA
C1_DTLZ1	2.3441e-2 (7.60e-4) -	2.1656e-2 (7.64e-4)
C1_DTLZ3	5.4406e-2 (6.64e-4) -	5.3401e-2 (8.39e-4)
C2_DTLZ2	5.6314e-2 (1.54e-3) -	4.2478e-2 (3.72e-4)
C3_DTLZ4	NaN (0.00%) -	1.1941e-1 (1.36e-1)
DC1_DTLZ1	2.0896e-2 (1.23e-3) -	1.1516e-2 (1.60e-4)
DC1_DTLZ3	5.6859e-2 (2.58e-3) -	3.3915e-2 (4.04e-4)
DC2_DTLZ1	2.1191e-2 (3.51e-4) -	2.0216e-2 (1.84e-4)
DC2_DTLZ3	5.5142e-2 (2.90e-3) -	5.2633e-2 (3.42e-4)
DC3_DTLZ1	3.0771e-2 (6.79e-3) -	6.9864e-3 (1.65e-4)
DC3_DTLZ3	6.2996e-2 (7.07e-3) -	1.9924e-2 (2.12e-4)
LIRCMOP1	NaN (0.00%) -	4.9450e-2 (9.58e-3)
LIRCMOP2	NaN (0.00%) -	3.0733e-2 (4.39e-3)
LIRCMOP3	NaN (0.00%) -	2.4964e-2 (1.01e-2)
LIRCMOP4	NaN (0.00%) -	2.4573e-2 (7.63e-3)
LIRCMOP5	1.6921e-1 (4.26e-2) -	1.2488e-1 (3.96e-2)
LIRCMOP6	1.9349e-1 (5.59e-2) -	1.2337e-1 (6.38e-2)
LIRCMOP7	NaN (0.00%) -	1.2624e-1 (4.81e-1)
LIRCMOP8	NaN (0.00%) -	7.2234e-2 (8.60e-2)
LIRCMOP9	1.5730e-1 (5.57e-2) -	1.0477e-1 (2.91e-2)
LIRCMOP10	6.7891e-2 (5.14e-2) -	2.9075e-2 (1.93e-2)
LIRCMOP11	5.6897e-1 (2.73e-1) -	6.0970e-3 (2.36e-3)
LIRCMOP12	NaN (56.67%) -	4.5125e-2 (1.78e-1)
LIRCMOP13	9.2198e-2 (1.15e-3) +	9.3096e-2 (1.16e-3)
LIRCMOP14	NaN (0.00%) -	9.5092e-2 (1.48e-3)
MW1	4.3662e-3 (1.45e-3) -	1.6091e-3 (1.09e-5)
MW2	4.2330e-3 (1.51e-4) +	5.6942e-3 (5.97e-4)
MW3	5.3557e-2 (1.84e-3) -	5.4699e-3 (2.24e-4)
MW4	4.9491e-2 (2.00e-3) -	4.8342e-2 (1.61e-3)
MW5	NaN (80.00%) -	NaN (93.33%)
MW6	5.5720e-3 (7.10e-4) -	2.7454e-3 (2.80e-5)
MW7	2.0875e-1 (4.53e-3) -	4.5148e-3 (2.16e-4)
MW8	6.0716e-2 (2.12e-3) -	4.2930e-2 (5.77e-4)
MW9	NaN (20.00%) -	NaN (93.33%)
MW10	NaN (96.67%) -	3.4078e-3 (4.88e-5)
MW11	NaN (0.00%) -	5.9115e-3 (1.16e-4)
MW12	NaN (30.00%) -	NaN (93.33%)
MW13	9.5734e-2 (4.83e-2) -	1.0715e-2 (1.66e-4)
MW14	1.1196e-1 (2.27e-2) -	9.7530e-2 (2.06e-3)
+/-/=	2/36/0	

The best value in each row is marked in gray. “NaN ” indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only “(FR)” is given in this case.

TABLE S-X
THE COMPARISON RESULTS OF TLCMEA AND TLCMEA-UPF ON IGD VALUES

Problem	TLCMEA-UPF	TLCMEA
C1_DTLZ1	2.1772e-2 (8.78e-4) =	2.1656e-2 (7.64e-4)
C1_DTLZ3	5.3360e-2 (7.22e-4) =	5.3401e-2 (8.39e-4)
C2_DTLZ2	4.2618e-2 (5.75e-4) =	4.2478e-2 (3.72e-4)
C3_DTLZ4	9.4637e-2 (1.63e-3) =	1.1941e-1 (1.36e-1)
DC1_DTLZ1	1.1583e-2 (2.59e-4) =	1.1516e-2 (1.60e-4)
DC1_DTLZ3	3.3798e-2 (2.68e-4) =	3.3915e-2 (4.04e-4)
DC2_DTLZ1	2.0338e-2 (3.68e-4) =	2.0216e-2 (1.84e-4)
DC2_DTLZ3	5.2709e-2 (3.25e-4) =	5.2633e-2 (3.42e-4)
DC3_DTLZ1	7.6371e-3 (2.45e-3) -	6.9864e-3 (1.65e-4)
DC3_DTLZ3	1.9947e-2 (2.32e-4) =	1.9924e-2 (2.12e-4)
LIRCMOP1	7.5703e-2 (3.08e-2) -	4.9450e-2 (9.58e-3)
LIRCMOP2	4.7472e-2 (1.46e-2) -	3.0733e-2 (4.39e-3)
LIRCMOP3	4.2959e-2 (1.52e-2) -	2.4964e-2 (1.01e-2)
LIRCMOP4	5.5334e-2 (1.25e-2) -	2.4573e-2 (7.63e-3)
LIRCMOP5	1.1445e-1 (3.27e-2) =	1.2488e-1 (3.96e-2)
LIRCMOP6	1.1883e-1 (5.95e-2) =	1.2337e-1 (6.38e-2)
LIRCMOP7	1.6780e-1 (4.45e-1) -	1.2624e-1 (4.81e-1)
LIRCMOP8	7.3040e-2 (3.94e-2) =	7.2234e-2 (8.60e-2)
LIRCMOP9	9.8108e-2 (1.76e-2) =	1.0477e-1 (2.91e-2)
LIRCMOP10	2.7911e-2 (1.64e-2) =	2.9075e-2 (1.93e-2)
LIRCMOP11	8.1480e-3 (1.20e-2) =	6.0970e-3 (2.36e-3)
LIRCMOP12	2.0741e-2 (1.83e-2) =	4.5125e-2 (1.78e-1)
LIRCMOP13	9.3184e-2 (1.10e-3) =	9.3096e-2 (1.16e-3)
LIRCMOP14	9.5146e-2 (1.09e-3) =	9.5092e-2 (1.48e-3)
MW1	1.6121e-3 (1.20e-5) =	1.6091e-3 (1.09e-5)
MW2	5.5009e-3 (3.32e-4) =	5.6942e-3 (5.97e-4)
MW3	5.3745e-3 (2.40e-4) =	5.4699e-3 (2.24e-4)
MW4	4.8631e-2 (1.73e-3) =	4.8342e-2 (1.61e-3)
MW5	NaN (86.67%) -	NaN (93.33%)
MW6	2.7523e-3 (2.64e-5) =	2.7454e-3 (2.80e-5)
MW7	4.4120e-3 (1.82e-4) =	4.5148e-3 (2.16e-4)
MW8	4.2973e-2 (4.08e-4) =	4.2930e-2 (5.77e-4)
MW9	NaN (80.00%) -	NaN (93.33%)
MW10	3.4146e-3 (4.45e-5) =	3.4078e-3 (4.88e-5)
MW11	5.9282e-3 (1.24e-4) =	5.9115e-3 (1.16e-4)
MW12	NaN (83.33%) -	NaN (93.33%)
MW13	1.0851e-2 (8.85e-4) =	1.0715e-2 (1.66e-4)
MW14	9.7588e-2 (1.85e-3) =	9.7530e-2 (2.06e-3)
+/-/=	0/9/29	

The best value in each row is marked in gray. “NaN ” indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only “(FR)” is given in this case.

TABLE S-XI
THE COMPARISON RESULTS OF TLCMEA AND TLCMEA-RANDOM ON IGD VALUES

Problem	TLCMEA-random1	TLCMEA-random2	TLCMEA
C1_DTLZ1	2.1630e-2 (8.13e-4) =	2.1685e-2 (7.46e-4) =	2.1656e-2 (7.64e-4)
C1_DTLZ3	5.3464e-2 (6.16e-4) =	5.3432e-2 (8.02e-4) =	5.3401e-2 (8.39e-4)
C2_DTLZ2	4.2592e-2 (5.73e-4) =	4.2676e-2 (4.09e-4) -	4.2478e-2 (3.72e-4)
C3_DTLZ4	1.1910e-1 (1.36e-1) =	9.4422e-2 (1.38e-3) =	1.1941e-1 (1.36e-1)
DC1_DTLZ1	1.1554e-2 (2.27e-4) =	1.1595e-2 (2.75e-4) =	1.1516e-2 (1.60e-4)
DC1_DTLZ3	3.3867e-2 (3.62e-4) =	3.3940e-2 (3.88e-4) =	3.3915e-2 (4.04e-4)
DC2_DTLZ1	2.0238e-2 (2.29e-4) =	2.0195e-2 (2.37e-4) =	2.0216e-2 (1.84e-4)
DC2_DTLZ3	5.2776e-2 (3.73e-4) =	5.2682e-2 (3.28e-4) =	5.2633e-2 (3.42e-4)
DC3_DTLZ1	7.0316e-3 (1.87e-4) =	7.0410e-3 (4.08e-4) =	6.9864e-3 (1.65e-4)
DC3_DTLZ3	1.9939e-2 (1.82e-4) =	1.9936e-2 (1.89e-4) =	1.9924e-2 (2.12e-4)
LIRCMOP1	6.1079e-2 (1.49e-2) -	6.3579e-2 (1.69e-2) -	4.9450e-2 (9.58e-3)
LIRCMOP2	3.5019e-2 (5.42e-3) -	3.4410e-2 (7.96e-3) -	3.0733e-2 (4.39e-3)
LIRCMOP3	3.1555e-2 (1.23e-2) -	3.0753e-2 (8.16e-3) -	2.4964e-2 (1.01e-2)
LIRCMOP4	3.0828e-2 (1.12e-2) -	3.1739e-2 (8.06e-3) -	2.4573e-2 (7.63e-3)
LIRCMOP5	1.3151e-1 (4.10e-2) =	1.3342e-1 (4.13e-2) =	1.2488e-1 (3.96e-2)
LIRCMOP6	1.0410e-1 (5.42e-2) =	1.2622e-1 (5.51e-2) =	1.2337e-1 (6.38e-2)
LIRCMOP7	3.7998e-2 (1.65e-2) =	5.0644e-2 (2.57e-2) =	1.2624e-1 (4.81e-1)
LIRCMOP8	8.0821e-2 (1.20e-1) =	7.2723e-2 (3.94e-2) =	7.2234e-2 (8.60e-2)
LIRCMOP9	1.1258e-1 (3.55e-2) =	1.4298e-1 (4.95e-2) -	1.0477e-1 (2.91e-2)
LIRCMOP10	3.3359e-2 (2.34e-2) =	4.4116e-2 (2.81e-2) -	2.9075e-2 (1.93e-2)
LIRCMOP11	6.7313e-3 (3.39e-3) =	1.5014e-2 (2.21e-2) -	6.0970e-3 (2.36e-3)
LIRCMOP12	1.4594e-2 (6.83e-3) =	2.0024e-2 (1.74e-2) =	4.5125e-2 (1.78e-1)
LIRCMOP13	9.3264e-2 (1.11e-3) =	9.3275e-2 (1.22e-3) =	9.3096e-2 (1.16e-3)
LIRCMOP14	9.5292e-2 (7.63e-4) =	9.5245e-2 (1.01e-3) =	9.5092e-2 (1.48e-3)
MW1	1.6153e-3 (1.51e-5) =	1.6117e-3 (1.47e-5) =	1.6091e-3 (1.09e-5)
MW2	5.6226e-3 (7.21e-4) =	5.2578e-3 (7.21e-4) +	5.6942e-3 (5.97e-4)
MW3	5.3507e-3 (2.58e-4) =	5.3160e-3 (2.74e-4) +	5.4699e-3 (2.24e-4)
MW4	4.8245e-2 (1.73e-3) =	4.8400e-2 (1.74e-3) =	4.8342e-2 (1.61e-3)
MW5	NaN (86.67%) -	NaN (86.67%) -	NaN (93.33%)
MW6	2.7611e-3 (6.42e-5) =	2.7592e-3 (2.42e-5) =	2.7454e-3 (2.80e-5)
MW7	4.4396e-3 (2.25e-4) =	4.4242e-3 (1.95e-4) =	4.5148e-3 (2.16e-4)
MW8	4.2835e-2 (6.43e-4) =	4.2965e-2 (5.95e-4) =	4.2930e-2 (5.77e-4)
MW9	NaN (90.00%) -	NaN (83.33%) -	NaN (93.33%)
MW10	3.4290e-3 (3.49e-5) -	3.4130e-3 (4.89e-5) =	3.4078e-3 (4.88e-5)
MW11	5.9284e-3 (1.03e-4) =	5.9170e-3 (1.26e-4) =	5.9115e-3 (1.16e-4)
MW12	NaN (90.00%) -	NaN (83.33%) -	NaN (93.33%)
MW13	1.0666e-2 (1.80e-4) =	1.0671e-2 (1.66e-4) =	1.0715e-2 (1.66e-4)
MW14	9.8331e-2 (4.59e-3) =	9.7107e-2 (1.42e-3) =	9.7530e-2 (2.06e-3)
+/-/=	0/8/30	2/11/25	

The best value in each row is marked in gray. "NaN " indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only "(FR)" is given in this case.

TABLE S-XII
THE IGD RESULTS OBTAINED BY TLCMEA AND SIX COMPARED ALGORITHMS ON CLSMOP TEST SUITE.

Problem	D	CCMO	MTCMO	C_LMEA	C_LMOCSO	DPSEA	POCEA	TLCMEA
CLSMOP1	100	9.3170e-1 (6.68e-2) -	9.2177e-1 (7.62e-2) -	6.9251e-1 (8.20e-2) =	7.0540e-1 (3.08e-4) +	9.2503e-1 (6.99e-2) -	7.0502e-1 (4.91e-3) +	7.4539e-1 (1.09e-1)
	200	9.5903e-1 (9.52e-3) -	9.5548e-1 (1.18e-2) -	7.2839e-1 (6.47e-2) =	7.0539e-1 (4.81e-4) +	9.6925e-1 (6.47e-3) -	6.9225e-1 (6.48e-2) +	7.5388e-1 (1.16e-1)
	500	9.5799e-1 (3.60e-3) -	9.5754e-1 (4.80e-3) -	6.5741e-1 (9.55e-2) =	7.0498e-1 (1.13e-3) +	9.6379e-1 (4.57e-3) -	6.8211e-1 (1.17e-1) +	7.4189e-1 (1.12e-1)
	1000	9.5693e-1 (3.90e-3) -	9.5502e-1 (3.82e-3) -	6.5053e-1 (1.21e-1) =	7.0416e-1 (7.50e-3) +	9.5408e-1 (3.64e-3) -	5.0216e-1 (1.48e-1) +	7.4160e-1 (1.09e-1)
CLSMOP2	100	4.2593e-2 (2.87e-3) =	4.1546e-2 (2.75e-3) =	9.6983e-2 (6.80e-2) -	4.6196e-2 (1.20e-2) =	4.5525e-2 (2.65e-3) -	3.1295e-2 (1.50e-2) +	3.9453e-2 (8.91e-3)
	200	4.9259e-2 (4.94e-3) -	4.8857e-2 (5.49e-3) -	7.5939e-2 (3.94e-2) -	2.0972e-2 (5.40e-3) +	3.5118e-2 (2.21e-3) =	2.6429e-2 (6.68e-3) +	3.7085e-2 (1.13e-2)
	500	2.5976e-2 (2.02e-4) =	2.5976e-2 (2.29e-4) =	5.0904e-2 (1.71e-2) -	1.5501e-2 (3.60e-3) +	2.5533e-2 (2.91e-4) =	2.1313e-2 (1.46e-3) +	2.3539e-2 (3.20e-3)
	1000	1.4932e-2 (1.21e-4) =	1.4960e-2 (1.24e-4) =	3.0629e-2 (7.89e-3) -	1.4322e-2 (1.68e-3) =	1.4452e-2 (1.28e-4) +	1.2816e-2 (5.95e-4) +	1.4933e-2 (4.77e-4)
CLSMOP3	100	1.0834e+0 (5.29e-2) -	1.0801e+0 (5.01e-2) -	8.2892e-1 (3.01e-1) =	4.7564e+0 (1.86e+1) -	1.0989e+0 (4.67e-2) -	9.9215e-1 (3.82e-2) =	7.4740e-1 (3.75e-1)
	200	1.0205e+0 (1.18e-2) =	1.0229e+0 (1.16e-2) -	2.3400e+0 (3.87e+0) -	1.4132e+0 (9.67e-1) =	1.0223e+0 (1.10e-2) -	9.7059e-1 (1.56e-1) -	8.7535e-1 (3.02e-1)
	500	1.0018e+0 (1.89e-3) =	1.0034e+0 (5.57e-3) -	1.1193e+0 (1.73e+0) -	1.5072e+1 (7.20e+1) -	1.0026e+0 (2.20e-3) -	9.8660e-1 (5.28e-2) -	9.7257e-1 (1.27e-1)
	1000	9.9904e-1 (5.30e-4) -	9.9933e-1 (1.39e-3) -	1.2454e+0 (1.40e+0) -	6.1884e+1 (2.32e+2) -	9.9967e-1 (2.36e-3) -	9.9939e-1 (1.41e-3) -	9.4428e-1 (1.67e-1)
CLSMOP4	100	6.1401e-1 (1.39e-2) =	6.1322e-1 (1.45e-2) =	5.6147e-1 (5.33e-2) +	6.8134e-1 (1.24e-3) -	6.0855e-1 (9.84e-3) =	6.9761e-1 (5.59e-3) -	6.1415e-1 (1.77e-2)
	200	6.1952e-1 (1.13e-2) +	6.2198e-1 (9.29e-3) +	6.4559e-1 (3.29e-2) -	6.9452e-1 (7.49e-4) -	6.2939e-1 (5.35e-3) +	7.0377e-1 (1.57e-3) -	6.3658e-1 (8.67e-3)
	500	6.2106e-1 (9.48e-3) +	6.2195e-1 (9.21e-3) +	6.7601e-1 (2.10e-2) -	7.0167e-1 (2.25e-4) -	6.6430e-1 (3.77e-3) =	7.0516e-1 (4.86e-4) -	6.6152e-1 (1.26e-2)
	1000	6.4849e-1 (8.64e-3) +	6.5131e-1 (9.78e-3) +	6.9131e-1 (1.26e-2) -	7.0442e-1 (1.81e-4) -	6.6447e-1 (2.43e-3) +	7.0627e-1 (2.44e-4) -	6.7345e-1 (1.40e-2)
CLSMOP5	100	3.4247e-1 (5.54e-5) -	3.4247e-1 (5.53e-5) -	4.5485e-1 (2.58e-1) -	5.4295e-2 (1.87e-1) +	3.4382e-1 (3.43e-3) -	5.3243e-1 (1.84e-1) -	1.6287e-1 (1.26e-1)
	200	3.4248e-1 (9.22e-5) -	3.4246e-1 (3.90e-5) -	4.9730e-1 (2.38e-1) -	5.3952e-2 (1.87e-1) +	3.4828e-1 (2.11e-2) -	5.9889e-1 (1.58e-1) -	2.2336e-1 (1.24e-1)
	500	3.4245e-1 (4.65e-5) -	3.4244e-1 (1.81e-5) -	4.8686e-1 (2.25e-1) -	2.5915e-1 (3.50e-1) +	3.4295e-1 (4.37e-4) -	7.4209e-1 (2.16e-5) -	2.9388e-1 (1.05e-1)
	1000	3.4240e-1 (2.24e-5) -	3.4240e-1 (1.69e-5) -	5.3818e-1 (1.81e-1) -	5.3612e-1 (3.19e-1) -	3.4252e-1 (1.04e-4) -	7.3808e-1 (2.20e-2) -	2.8330e-1 (1.14e-1)
+/-/=		3/11/6	3/13/4	1/14/5	9/8/3	3/13/4	8/11/1	

The best value in each row is marked in gray. “NaN ” indicates that the corresponding algorithm cannot continuously obtain feasible solutions in 30 runs, and only “(FR)” is given in this case.