Supplementary file of "A Constrained Learning-Based Competitive Swarm Optimizer for Large-scale Multi-Objective Optimization"

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1. Supplementary Figures and Tables

1.1 Figures:

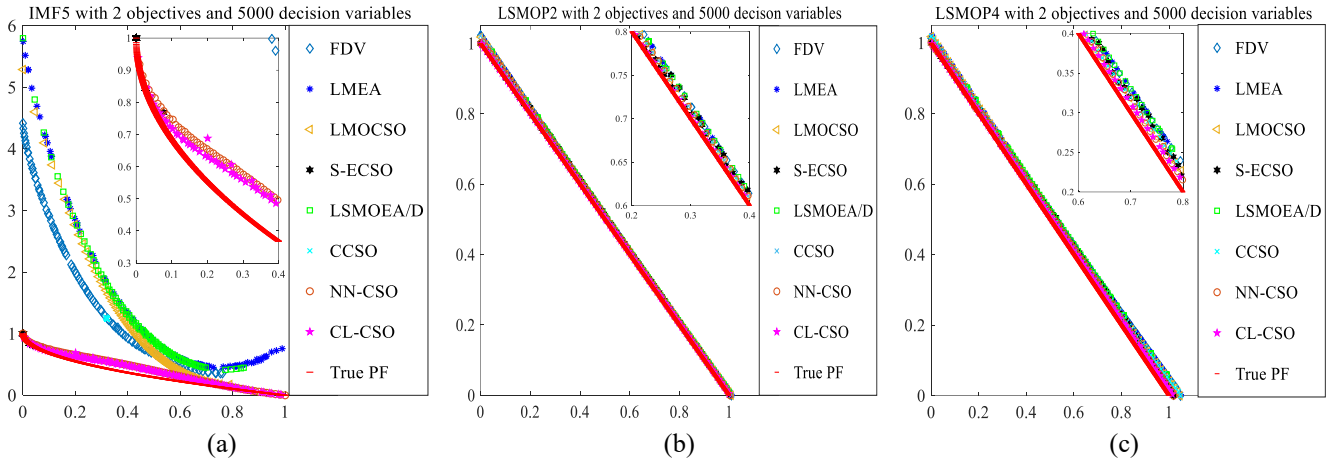


Fig. A. 1. The final population sets obtained by eight compared algorithms on a) 2-objective IMF5 with 5000 decision variables, b) 2-objective LSMOP2 with 5000 decision variables and c) 2-objective LSMOP4 with 5000 decision variables.

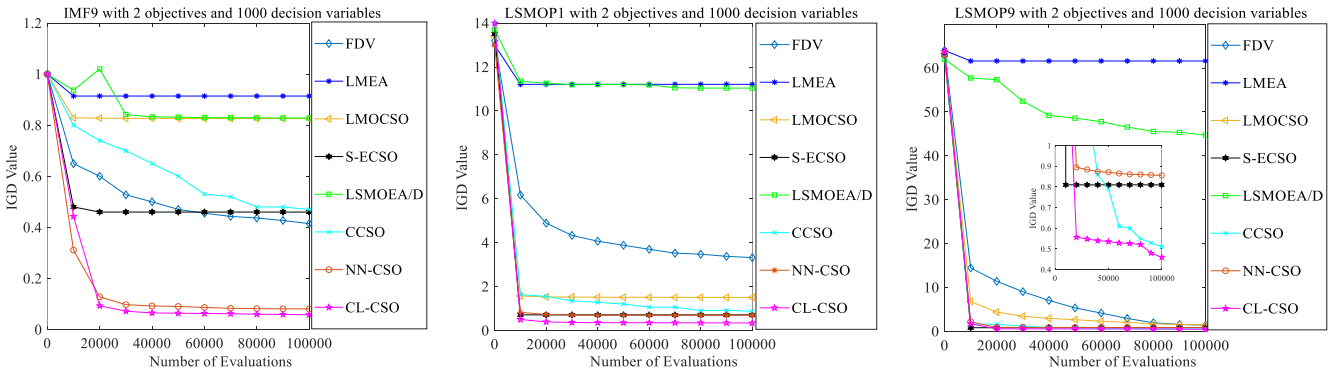
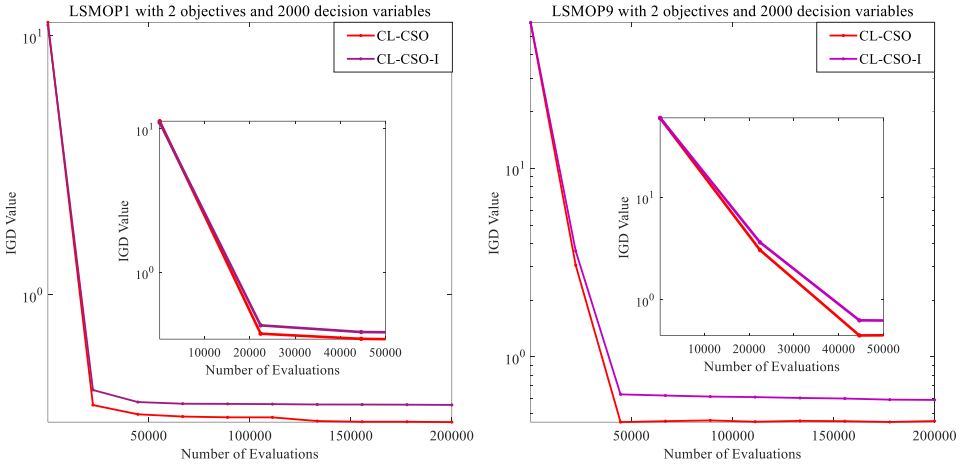


Fig. A. 2. The convergence profiles of eight compared algorithms on a) IMF9 with 2 objectives and 1000 decision variables, b) LSMOP1 with 2 objectives and 1000 decision variables, c) LSMOP9 with 2 objectives and 1000 decision variables, respectively.



(a) (b)

Fig. A. 3. The convergence profiles of CL-CSO and CL-CSO-I on a) 2-objective LSMOP1 with 2000 decision variables and b) 2-objective LSMOP9 with 2000 decision variables.

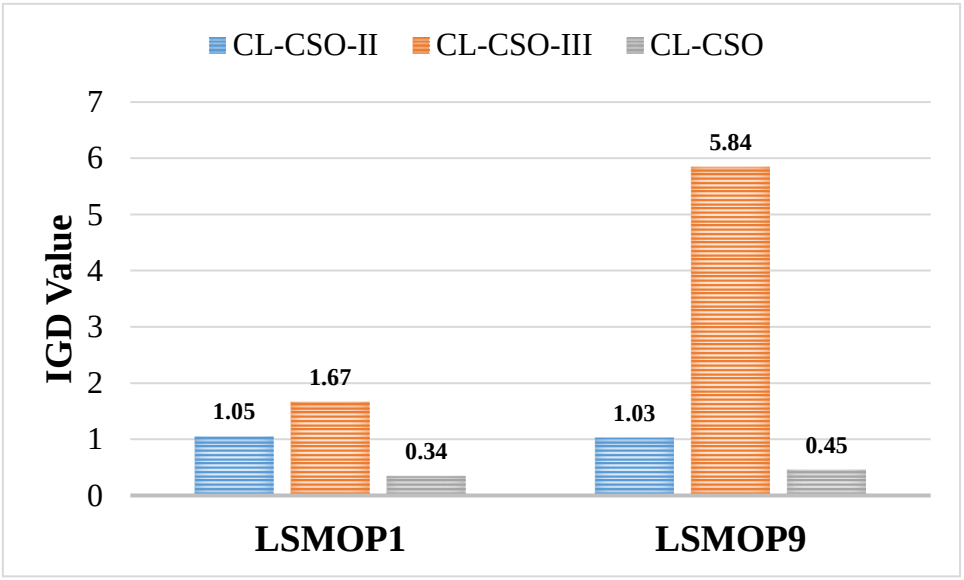


Fig. A. 4. IGD results achieved by CL-CSO-II, CLCSO-III and CL-CSO on 2-objective LSMOP1 with 2000 decision variables and 2-objective LSMOP9 with 2000 decision variables.

1.2 Tables:

Table A. 1: Search strategies and parameters settings of all the compared algorithms.

Algorithms	Search Strategies	Parameter settings
FDV	Proposed transformation +DE +PM	*Rate* = 0.8, *Acc* = 0.4, *optimizer* = "NSGA-II", *type* = 1, p_c = 1.0, p_m = 1/*D*, n_c = 20, n_m = 20
LMOCSO	Proposed CSO +PM	p_m = 1/*D*, n_m = 20, *a* = 2
LMEA	Proposed Clustering Variable Analysis +SBX +PM	p_c = 1.0, p_m = 1/*D*, n_c = 20, n_m = 20, *nSel* = 2, *nPer* = 4, *nCor* =6
S-ECSO	Proposed CSO +Proposed Convex Sparse Operator	$\lambda_{initial}$ = 0.35, *w* = 0.7968, c_1 = 1.4962, c_2 = 1.4962
LSMOEA/D	Proposed Clustering Variable Analysis + SBX +PM	p_c = 1.0, p_m = 1/*D*, n_c = 20, n_m = 20, *T* = 0.1×*N*, *nSel* = 2, *nPer* = 4, *K* = 10
CCSO	Proposed CSO +PM	p_m = 1/*D*, n_m = 20
NN-CSO	Neural Network Model +corresponding CSO	*K*=5, E_{min} = 0.01, *lr* = 0.01, *epochs* = 20
CL-CSO	Proposed CSO +PM	*T* = 10, p_m = 1/*D*, n_m = 20

Table A. 2: The IGD results of CL-CSO and its seven compared algorithms on solving LSMOP test problems with two objectives and 500-5000 decision variables.

Problem	M	D	FDV	LMEA	LMOCSO	S-ECSO	LSMOEA/D	CCSO	NN-CSO	CL-CSO
LSMOP1	2	500	2.7556e+0(3.26e-1)-	1.0833e+1(2.27e-1)-	1.4958e+0(3.68e-2)-	7.0711e-1(1.20e-16)-	9.8516e+00(7.93e-01)-	7.1650e-01(6.22e-02)-	7.1764e-1 (1.24e-1) -	**3.8077e-1(2.13e-2)**
LSMOP1	2	1000	3.2281e+0(4.04e-1)-	1.1312e+1(2.70e-1)-	1.5465e+0(8.60e-2)-	7.0711e-1(1.20e-16)-	1.0891e+01(2.67e-01)-	8.7893e-01(7.42e-02)-	6.4066e-1 (2.94e-1) -	**3.4523e-1(6.64e-3)**
LSMOP1	2	2000	3.9980e+0(1.85e-1)-	1.1411e+1(1.75e-1)-	1.5548e+0(4.63e-2)-	7.0711e-1(1.20e-16)-	1.1356e+01(2.39e-01)-	9.8836e-01(1.97e-02)-	5.7778e-1 (3.25e-1) -	**3.4374e-1(6.26e-3)**
LSMOP1	2	5000	4.8869e+0(1.74e-1)-	1.1583e+1(2.34e-1)-	1.5627e+0(3.13e-2)-	6.9812e-1(0.00e+0)-	1.1495e+01(1.80e-01)-	1.1680e+00(2.79e-02)-	5.4027e-1 (1.72e-1) -	**3.3341e-1(9.40e-3)**
LSMOP2	2	500	6.5232e-2(9.64e-4)-	7.3867e-2(2.07e-4)-	4.7644e-2(1.07e-3)-	6.6538e-2(0.00e+0)-	7.8419e-02(2.72e-03)-	4.3240e-02(8.82e-04)-	1.5533e-2 (7.43e-4) -	**1.3912e-2(3.10e-4)**
LSMOP2	2	1000	3.7007e-2(1.48e-4)-	4.0541e-2(1.47e-4)-	2.5942e-2(6.61e-4)-	3.8220e-2(7.49e-18)-	4.4743e-02(2.62e-03)-	2.5874e-02(6.07e-04)-	9.8540e-3 (2.26e-3) -	**8.5338e-3(3.04e-4)**
LSMOP2	2	2000	2.1078e-2(1.18e-4)-	2.3272e-2(6.77e-4)-	1.4351e-2(1.69e-4)-	2.2341e-2(0.00e+0)-	2.9288e-02(4.75e-03)-	1.4968e-02(3.30e-04)-	6.5216e-3 (6.42e-4) -	**5.7528e-3(2.30e-4)**
LSMOP2	2	5000	1.0919e-2(1.28e-4)-	1.3339e-2(5.54e-4)-	7.4813e-3(1.39e-4)-	7.0770e-3(9.37e-19)-	2.1733e-02(6.40e-03)-	7.9699e-03(3.46e-04)-	6.4300e-3 (7.38e-4) -	**4.5639e-3(2.42e-4)**
LSMOP3	2	500	1.9044e+1(1.34e+0)-	8.7174e+2(9.61e+2)-	1.7826e+1(5.11e+0)-	**1.5721e+0(2.40e-16)+**	3.6941e+01(4.18e+00)-	1.6518e+01(4.58e-01)-	2.0430e+0 (1.23e+0) +	5.1118e+0(8.12e-1)
LSMOP3	2	1000	2.0994e+1(1.19e+0)-	1.7704e+3(1.70e+3)-	1.6657e+1(2.89e+0)-	**1.5774e+0(2.40e-16)+**	3.8230e+01(3.75e+00)-	1.7471e+01(9.65e-01)-	2.3864e+0 (1.44e+0) =	3.7807e+0(7.97e-1)
LSMOP3	2	2000	2.3743e+1(7.92e-1)-	1.0345e+3(8.80e+2)-	1.3498e+1(5.01e+0)-	**1.5804e+0(2.40e-16)+**	3.9278e+01(1.25e+00)-	1.7911e+01(4.16e-01)-	2.1994e+0 (1.62e+0) +	3.5275e+0(7.10e-1)
LSMOP3	2	5000	2.7020e+1(6.47e-1)-	1.9441e+3(1.54e+3)-	1.1205e+1(3.38e+0)-	**1.5765e+0(2.40e-16)+**	4.0653e+01(8.39e-01)-	1.8723e+01(1.21e-01)-	1.9203e+0 (8.83e-1) +	3.5772e+0(2.86e-1)
LSMOP4	2	500	1.0481e-1(3.13e-3)-	1.3664e-1(3.85e-4)-	9.1732e-2(9.93e-4)-	1.2884e-1(3.00e-17)-	1.3649e-01(3.61e-03)-	8.8946e-02(6.59e-04)-	5.0758e-2 (2.65e-3) -	**4.6413e-2(2.83e-3)**
LSMOP4	2	1000	6.6225e-2(7.31e-4)-	7.8173e-2(3.59e-4)-	5.2797e-2(6.02e-4)-	7.4308e-2(1.50e-17)-	8.1991e-02(4.98e-03)-	5.2477e-02(5.95e-04)-	2.7888e-2 (1.50e-3) -	**2.4698e-2(3.99e-4)**
LSMOP4	2	2000	3.8441e-2(6.54e-4)-	4.4646e-2(4.25e-4)-	3.0176e-2(2.95e-4)-	4.1989e-2(7.49e-18)-	5.1775e-02(2.57e-03)-	3.0381e-02(4.66e-04)-	1.8411e-2 (1.81e-3) -	**1.4325e-2(5.85e-4)**
LSMOP4	2	5000	1.9098e-2(1.80e-4)-	2.2889e-2(4.32e-4)-	1.4783e-2(1.21e-4)-	1.2361e-2(1.87e-18)-	3.5459e-02(8.36e-03)-	1.5255e-02(2.77e-04)-	9.3943e-3 (6.09e-4) -	**7.3855e-3(1.81e-4)**
LSMOP5	2	500	5.8976e+0(1.94e+0)-	2.3219e+1(5.27e-1)-	3.2315e+0(2.03e-1)-	7.4209e-1(1.20e-16)=	2.3402e+01(6.58e-01)-	1.5285e+00(1.85e-01)-	1.5133e+0 (8.30e-1) -	**7.4209e-1(1.20e-16)**
LSMOP5	2	1000	6.4829e+0(1.41e+0)-	2.3737e+1(4.50e-1)-	3.2762e+0(1.45e-1)-	7.4209e-1(1.20e-16)=	2.4032e+01(7.60e-01)-	1.7302e+00(9.60e-02)-	1.6536e+0 (9.13e-1) =	**7.4209e-1(1.20e-16)**
LSMOP5	2	2000	7.4414e+0(2.13e+0)-	2.4128e+1(2.01e-1)-	3.2430e+0(7.28e-2)-	7.4209e-1(1.20e-16)=	2.4130e+01(3.65e-01)-	1.9757e+00(1.18e-01)-	1.1451e+0 (6.42e-1) =	**7.4209e-1(1.20e-16)**
LSMOP5	2	5000	9.7591e+0(1.67e+0)-	2.4433e+1(2.12e-1)-	3.2653e+0(1.04e-1)-	7.4209e-1(1.20e-16)=	2.4370e+01(3.51e-01)-	2.4064e+00(1.76e-01)-	1.2155e+0 (4.81e-1) -	**7.4209e-1(1.20e-16)**
LSMOP6	2	500	8.0740e-1(2.80e-3)-	3.5461e+3(2.58e+3)-	8.0728e-1(7.23e-3)-	7.0814e-1(1.20e-16)+	5.7178e-01(7.61e-02)+	7.3206e-01(9.66e-02)+	**4.9883e-1 (2.02e-2) +**	7.7331e-1(3.19e-3)
LSMOP6	2	1000	7.7413e-1(3.12e-4)-	2.7187e+3(2.59e+3)-	7.7439e-1(2.33e-3)-	6.8586e-1(1.20e-16)+	9.9963e-01(1.30e+00)-	6.1090e-01(1.55e-01)+	**4.3973e-1 (1.14e-2) +**	7.5544e-1(2.18e-3)
LSMOP6	2	2000	7.5738e-1(4.76e-13)-	4.0962e+3(2.18e+3)-	7.4755e-1(2.50e-2)+	6.7636e-1(1.20e-16)+	**4.5906e-01(6.89e-02)+**	5.4291e-01(1.47e-01)=	9.2869e-1 (8.69e-1) =	7.4789e-1(1.21e-3)
LSMOP6	2	5000	7.4774e-1(3.34e-13)-	2.6494e+3(2.31e+3)-	7.4774e-1(3.27e-13)-	**1.7254e-1(3.00e-17)+**	6.3853e-01(3.78e-01)=	6.9022e-01(1.32e-01)=	1.0196e+0 (7.52e-1) -	7.4435e-1(3.35e-4)
LSMOP7	2	500	8.4172e+2(1.16e+2)-	8.0776e+4(3.94e+3)-	8.0961e+2(1.30e+2)-	**1.5118e+0(0.00e+0)=**	7.7632e+04(5.13e+03)-	2.0971e+02(7.02e+01)-	1.5126e+0 (5.23e-4) =	1.5118e+0(2.00e-3)

LSMOP7	2	1000	1.2563e+3(1.72e+2)-	8.7506e+4(1.81e+3)-	8.8738e+2(1.40e+2)-	1.5189e+0(2.40e-16)-	8.3159e+04(3.52e+03)-	1.4026e+02(2.88e+01)-	1.5193e+0 (2.16e-4) -	**1.5151e+0(1.02e-3)**
LSMOP7	2	2000	2.0842e+3(4.40e+2)-	8.9829e+4(2.70e+3)-	9.3441e+2(7.70e+1)-	1.5224e+0(0.00e+0)-	8.6198e+04(3.00e+03)-	1.5776e+02(1.00e+02)-	1.5212e+0 (1.30e-3) -	**1.5171e+0(7.01e-4)**
LSMOP7	2	5000	3.4897e+3(1.98e+2)-	9.2604e+4(1.66e+3)-	1.0292e+3(1.05e+2)-	1.5173e+0(0.00e+0)=	9.0392e+04(1.91e+03)-	2.2699e+02(1.51e+02)-	1.5206e+0 (1.61e-3) -	**1.5172e+0(7.06e-4)**
LSMOP8	2	500	4.4066e+0(3.42e-1)-	1.9918e+1(3.99e-1)-	2.3245e+0(1.42e-1)-	7.4209e-1(1.20e-16)=	1.8934e+01(6.76e-01)-	1.1250e+00(1.03e-01)-	1.0448e+0 (2.69e-1) -	**7.4209e-1(1.20e-16)**
LSMOP8	2	1000	5.4678e+0(2.64e-1)-	2.0377e+1(3.21e-1)-	2.2645e+0(1.29e-1)-	7.4209e-1(1.20e-16)=	1.9855e+01(2.78e-01)-	1.2561e+00(4.30e-02)-	9.1094e-1 (1.77e-1) -	**7.4209e-1(1.20e-16)**
LSMOP8	2	2000	7.0737e+0(4.24e-1)-	2.0195e+1(3.76e-1)-	2.3436e+0(8.55e-2)-	7.4209e-1(1.20e-16)=	2.0329e+01(1.77e-01)-	1.4308e+00(7.28e-02)-	9.2829e-1 (1.54e-1) -	**7.4209e-1(1.20e-16)**
LSMOP8	2	5000	7.7684e+0(2.97e-1)-	2.0844e+1(2.37e-1)-	2.3850e+0(8.13e-2)-	7.4209e-1(1.20e-16)=	2.0817e+01(2.64e-01)-	1.7022e+00(3.52e-02)-	7.8350e-1 (4.04e-2) -	**7.4209e-1(1.20e-16)**
LSMOP9	2	500	1.2940e+0(2.76e-1)-	5.7192e+1(3.32e+0)-	1.1525e+0(1.34e-1)-	8.1004e-1(0.00e+0)-	3.4418e+01(3.22e+00)-	**4.7438e-01(1.60e-02)=**	8.1962e-1 (1.84e-2) -	5.3561e-1(9.16e-2)
LSMOP9	2	1000	1.5129e+0(2.10e-1)-	5.8805e+1(2.25e+0)-	1.7649e+0(4.14e-1)-	8.1004e-1(0.00e+0)-	4.0541e+01(3.81e+00)-	4.9522e-01(6.37e-03)-	8.3379e-1 (1.87e-2) -	**4.8714e-1(1.26e-1)**
LSMOP9	2	2000	1.9383e+0(1.92e-1)-	6.0675e+1(1.68e+0)-	2.3323e+0(5.08e-1)-	8.1004e-1(0.00e+0)-	4.8032e+01(2.61e+00)-	5.4251e-01(2.00e-02)=	7.8128e-1 (8.82e-2) -	**4.5785e-1(1.78e-1)**
LSMOP9	2	5000	3.9105e+0(6.55e-1)-	6.1156e+1(9.81e-1)-	5.1807e+0(1.67e+0)-	8.1004e-1(0.00e+0)-	5.1929e+01(3.45e+00)-	6.9323e-01(3.41e-02)-	7.6860e-1 (6.89e-2) -	**5.1708e-1(2.57e-2)**
+/-/=			0/36/0	0/36/0	1/35/0	8/18/10	2/33/1	2/30/4	5/26/5	

Table A. 3: The IGD results of CL-CSO and its seven compared algorithms on solving IMF test problems with two objectives and 500-5000 decision variables.

Problem	M	D	FDV	LMEA	LMOCSO	S-ECSO	LSMOEA/D	CCSO	NN-CSO	CL-CSO
IMF1	2	500	5.5970e-1(3.44e-2)-	1.5657e+1(6.45e-1)-	5.5752e+0(1.07e-1)-	6.0132e-1(0.00e+0)-	1.2638e+01(9.02e-01)-	1.1358e+00(8.02e-02)-	4.3845e-1 (8.75e-2) -	**3.8031e-1(2.95e-2)**
IMF1	2	1000	7.1922e-1(4.92e-2)-	1.5593e+1(7.36e-1)-	6.2005e+0(2.45e-1)-	6.1507e-1(0.00e+0)-	1.3843e+01(5.59e-01)-	1.2740e+00(5.28e-02)-	4.9834e-1 (1.04e-1) -	**3.4168e-1(5.69e-2)**
IMF1	2	2000	8.2546e-1(3.08e-2)-	1.6445e+1(5.22e-1)-	6.6671e+0(2.06e-1)-	5.9171e-1(0.00e+0)-	1.4438e+01(4.44e-01)-	1.2985e+00(5.31e-02)-	4.6747e-1 (2.38e-2) -	**3.5932e-1(3.63e-2)**
IMF1	2	5000	1.2072e+0(4.00e-2)-	1.6561e+1(2.77e-1)-	7.1473e+0(6.31e-2)-	5.8822e-1(1.20e-16)-	1.5520e+01(4.71e-01)-	1.3467e+00(4.36e-02)-	5.8349e-1 (5.03e-2) -	**3.6090e-1(2.36e-2)**
IMF2	2	500	9.8670e-1(8.94e-2)-	1.9115e+1(8.40e-1)-	8.0882e+0(1.46e-1)-	6.0949e-1(1.20e-16)-	1.6684e+01(1.14e+00)-	1.9510e+00(6.71e-02)-	6.3720e-1 (5.02e-2) =	**6.0946e-1(2.54e-4)**
IMF2	2	1000	1.1424e+0(6.22e-2)-	1.9341e+1(8.10e-1)-	8.5476e+0(3.06e-1)-	**6.0949e-1(1.20e-16)+**	1.7611e+01(7.73e-01)-	2.1204e+00(1.59e-01)-	6.4447e-1 (5.08e-2) =	6.0949e-1(1.64e-8)
IMF2	2	2000	1.5926e+0(1.23e-1)-	2.0441e+1(4.56e-1)-	9.4274e+0(1.57e-1)-	**6.0949e-1(1.20e-16)=**	1.9024e+01(5.73e-01)-	2.2131e+00(4.86e-02)-	7.8467e-1 (1.90e-1) =	6.0949e-1(1.81e-16)
IMF2	2	5000	2.2246e+0(1.11e-1)-	2.0624e+1(5.16e-1)-	9.9694e+0(9.17e-2)-	**6.0949e-1(1.20e-16)=**	1.9418e+01(5.51e-01)-	2.3230e+00(6.34e-02)-	6.7302e-1 (8.49e-2) =	6.0949e-1(1.76e-16)
IMF3	2	500	1.1513e+0(2.18e-1)-	1.9093e+1(1.03e+0)-	8.1546e+0(1.71e-1)-	2.2086e-1(0.00e+0)-	1.6962e+01(9.55e-01)-	1.9186e+00(5.08e-02)-	6.9717e-2 (4.27e-2) -	**1.0564e-2(2.19e-3)**
IMF3	2	1000	1.4379e+0(1.95e-1)-	2.0306e+1(9.69e-1)-	8.8785e+0(2.05e-1)-	1.6973e-1(0.00e+0)-	1.8778e+01(5.53e-01)-	1.9867e+00(7.91e-02)-	1.6189e-1 (1.32e-1) -	**8.8849e-3(1.18e-3)**
IMF3	2	2000	1.8847e+0(1.55e-1)-	2.0119e+1(6.73e-1)-	9.1350e+0(3.99e-1)-	2.3170e-1(3.00e-17)-	1.9387e+01(4.30e-01)-	1.9895e+00(1.21e-01)-	8.7162e-2 (5.83e-2) -	**8.4593e-3(8.62e-4)**
IMF3	2	5000	2.5498e+0(1.69e-1)-	2.0962e+1(3.62e-1)-	9.3484e+0(1.84e-1)-	5.2329e-2(0.00e+0)-	1.9799e+01(2.53e-01)-	2.2821e+00(7.80e-02)-	6.6610e-2 (6.05e-2) -	**8.7152e-3(9.58e-4)**
IMF4	3	500	9.2068e+1(7.10e+0)-	1.0587e+3(3.44e+1)-	5.7504e+2(5.51e+1)-	5.9890e-1(0.00e+0)=	8.9571e+02(3.05e+01)-	3.3803e+02(1.01e+02)-	3.5431e+2 (3.32e+2) -	**5.8523e-1(3.44e-4)**
IMF4	3	1000	2.1004e+2(1.60e+1)-	2.2005e+3(6.18e+1)-	1.1936e+3(8.52e+1)-	**5.5068e-1(0.00e+0)+**	1.8432e+03(4.98e+01)-	6.6226e+02(2.73e+02)-	1.1121e+3 (4.91e+2) -	5.5757e-1(3.25e-2)
IMF4	3	2000	5.2007e+2(2.79e+1)-	4.4076e+3(8.06e+1)-	2.3014e+3(1.17e+2)-	5.7880e-1(0.00e+0)-	3.8700e+03(1.05e+02)-	1.0601e+03(5.35e+02)-	2.2195e+3 (9.86e+2) -	**5.4523e-1(3.94e-4)**
IMF4	3	5000	2.1504e+3(1.15e+3)-	1.1390e+4(1.25e+2)-	5.9335e+3(1.93e+2)-	5.5433e-1(0.00e+0)-	1.0121e+04(2.10e+02)-	1.4624e+03(1.13e+03)-	4.2785e+3 (2.40e+3) -	**5.4466e-1(3.28e-4)**
IMF5	2	500	2.1541e-1(9.64e-3)-	3.4009e-1(7.48e-3)-	2.0104e-1(2.18e-3)-	5.8591e-1(0.00e+0)-	3.1520e-01(9.49e-03)-	2.8673e-01(1.40e-02)-	5.8041e-2 (4.60e-3) -	**4.4784e-2(1.90e-3)**
IMF5	2	1000	2.4006e-1(1.14e-2)-	3.4318e-1(3.18e-3)-	1.9884e-1(1.65e-3)-	6.1505e-1(1.20e-16)-	3.2885e-01(9.18e-03)-	3.1187e-01(3.16e-02)-	5.3515e-2 (2.39e-3) -	**4.6515e-2(1.49e-3)**
IMF5	2	2000	2.7079e-1(8.06e-3)-	3.4762e-1(2.37e-3)-	2.0056e-1(3.99e-3)-	5.9155e-1(0.00e+0)-	3.3988e-01(5.57e-03)-	3.3505e-01(1.28e-02)-	5.1172e-2 (2.70e-3) -	**4.6305e-2(1.01e-3)**
IMF5	2	5000	2.8486e-1(6.54e-3)-	3.5429e-1(1.60e-3)-	1.9939e-1(1.15e-3)-	6.1739e-1(1.20e-16)-	3.4573e-01(7.68e-03)-	3.1903e-01(3.90e-02)-	4.8505e-2 (1.98e-3) -	**4.6560e-2(4.31e-4)**
IMF6	2	500	3.7782e-1(1.54e-2)-	6.0382e-1(2.19e-2)-	2.9101e-1(5.18e-3)-	6.0949e-1(1.20e-16)-	5.4028e-01(1.39e-02)-	3.8701e-01(4.22e-02)-	9.4466e-2 (6.63e-3) =	**9.1588e-2(1.87e-3)**
IMF6	2	1000	4.2077e-1(8.64e-3)-	6.0807e-1(1.07e-2)-	2.8607e-1(1.95e-3)-	6.0949e-1(1.20e-16)-	5.7105e-01(1.91e-02)-	3.8611e-01(4.11e-02)-	**8.4711e-2 (5.41e-3)** +	9.1462e-2(1.54e-3)
IMF6	2	2000	4.6773e-1(7.82e-3)-	6.2208e-1(8.41e-3)-	2.8628e-1(2.08e-3)-	6.0949e-1(1.20e-16)-	6.0204e-01(8.79e-03)-	4.6220e-01(1.94e-02)-	**7.8863e-2 (4.78e-3)** +	9.1459e-2(9.31e-4)
IMF6	2	5000	5.1459e-1(1.59e-2)-	6.3098e-1(5.21e-3)-	2.8662e-1(5.93e-4)-	6.0949e-1(1.20e-16)-	6.1861e-01(1.23e-02)-	4.5225e-01(2.14e-02)-	**9.4161e-2 (2.04e-3)** =	1.6830e-1(2.04e-1)
IMF7	2	500	3.2172e-1(8.55e-3)-	5.2187e-1(1.24e-2)-	3.0499e-1(3.46e-3)-	1.4213e-1(0.00e+0)-	4.6701e-01(1.24e-02)-	6.9082e-01(2.74e-03)-	8.2363e-2 (4.09e-2) -	**2.0732e-2(7.77e-3)**
IMF7	2	1000	3.4872e-1(9.71e-3)-	5.2447e-1(4.79e-3)-	3.0632e-1(4.43e-3)-	1.6972e-1(3.00e-17)-	5.0381e-01(1.70e-02)-	6.8842e-01(3.68e-03)-	4.9162e-2 (2.09e-2) -	**2.1142e-2(7.62e-3)**
IMF7	2	2000	3.6278e-1(5.34e-3)-	5.3313e-1(4.88e-3)-	3.0399e-1(4.83e-3)-	2.7832e-1(6.00e-17)-	5.1928e-01(9.61e-03)-	6.8488e-01(3.67e-03)-	4.5665e-2 (1.07e-2) -	**1.8225e-2(2.23e-3)**
IMF7	2	5000	3.8990e-1(2.86e-3)-	5.3909e-1(5.31e-3)-	3.0278e-1(1.88e-3)-	2.5266e-2(7.49e-18)-	5.2601e-01(1.25e-02)-	6.8247e-01(1.41e-03)-	3.9243e-2 (1.36e-2) -	**1.7306e-2(3.61e-3)**
IMF8	3	500	7.7309e+0(1.62e+0)-	2.5848e+1(1.17e+0)-	5.5544e+0(1.78e-1)-	5.8663e-1(0.00e+0)-	2.1968e+01(2.08e+00)-	2.5519e+00(3.31e-01)-	4.9722e-1 (2.33e-1) =	**3.6191e-1(1.50e-3)**

IMF8	3	1000	1.7483e+1(2.51e+0)-	5.3550e+1(1.30e+0)-	1.0744e+1(5.58e-1)-	5.5627e-1(1.20e-16)-	4.8125e+01(2.20e+00)-	4.6656e+00(9.85e-01)-	**3.6061e-1 (2.14e-4)** +	3.6172e-1(5.83e-4)
IMF8	3	2000	6.8070e+1(1.84e+1)-	1.0897e+2(3.42e+0)-	2.1241e+1(6.17e-1)-	5.7880e-1(0.00e+0)-	9.8647e+01(2.02e+00)-	1.0690e+01(2.99e-01)-	4.5153e-1 (2.41e-1) -	**3.6164e-1(6.30e-4)**
IMF8	3	5000	2.8946e+2(5.34e+1)-	2.7392e+2(2.80e+0)-	5.3796e+1(1.01e+0)-	6.7750e-1(0.00e+0)-	2.5310e+02(4.94e+00)-	1.9105e+01(7.87e+00)-	4.9794e-1 (2.34e-1) =	**3.6143e-1(3.17e-4)**
IMF9	2	500	3.4468e-1(1.69e-2)-	7.2260e-1(7.47e-3)-	6.6999e-1(7.13e-3)-	3.7396e-1(6.00e-17)-	6.8698e-01(6.54e-03)-	4.5716e-01(3.28e-02)-	1.6097e-1 (1.23e-1) -	**6.8946e-2(9.76e-3)**
IMF9	2	1000	4.0239e-1(1.18e-2)-	9.1184e-1(8.53e-3)-	8.1138e-1(1.24e-2)-	4.6196e-1(0.00e+0)-	8.6745e-01(2.38e-02)-	5.1276e-01(2.67e-02)-	8.8517e-2 (1.12e-2) -	**7.6492e-2(1.50e-2)**
IMF9	2	2000	5.0773e-1(1.62e-2)-	1.3250e+0(2.02e-2)-	1.1172e+0(1.54e-2)-	5.0605e-1(1.20e-16)-	1.2498e+00(3.01e-02)-	6.4376e-01(1.27e-02)-	1.3462e-1 (1.46e-2) -	**9.9996e-2(3.17e-2)**
IMF9	2	5000	7.9123e-1(1.50e-2)-	2.8203e+0(4.39e-2)-	2.1071e+0(4.47e-2)-	**3.5713e-2(0.00e+0)**+	2.5414e+00(5.64e-02)-	8.9786e-01(2.41e-02)-	2.4210e-1 (9.26e-2) -	1.5646e-1(4.45e-2)
+/-/=			0/36/0	0/36/0	0/36/0	3/30/3	0/36/0	0/36/0	3/25/8	

Table A. 4: The average IGD values of CL-CSO with different values of *rmp* in solving IMF problems with 500 decision variables.

Problem	*M*	*D*	*p*=0	*p*=0.3	*p*=0.6	*p*=1	*p*=0.9
IMF1	2	500	4.04E-01	3.73E-01	**3.49E-01**	4.83E+00	3.80E-01
IMF2	2	500	6.09E-01	6.09E-01	6.09E-01	7.03E+00	**6.09E-01**
IMF3	2	500	2.29E+00	**9.52E-03**	9.14E-03	8.23E+00	1.06E-02
IMF4	3	500	4.66E+01	**5.45E-01**	5.11E+01	4.97E+02	5.85E-01
IMF5	2	500	5.20E-02	4.88E-02	4.67E-02	2.00E-01	**4.48E-02**
IMF6	2	500	9.37E-02	9.34E-02	9.18E-02	2.81E-01	**9.16E-02**
IMF7	2	500	7.18E-02	7.58E-02	2.53E-02	3.04E-01	**2.07E-02**
IMF8	3	500	3.61E-01	3.61E-01	**3.61E-01**	4.49E+00	3.62E-01
IMF9	2	500	7.56E-02	7.28E-02	8.46E-02	6.45E-01	**6.89E-02**
Friedman Rank			3.2	2.4	2.2	5	2

Table A. 5: The average IGD values of CL-CSO with different values of *T* in solving IMF problems with 500 decision variables.

Problem	*M*	*D*	*T*=0	*T*=5	*T*=20	*T*=35	*T*=50	*T*=10
IMF1	2	500	4.39E-01	3.84E-01	**3.61E-01**	3.70E-01	3.91E-01	3.80E-01
IMF2	2	500	6.09E-01	6.10E-01	6.09E-01	6.13E-01	6.10E-01	**6.09E-01**
IMF3	2	500	1.24E-02	**9.81E-03**	1.05E-02	9.56E-03	9.89E-03	1.06E-02
IMF4	3	500	9.43E+01	3.56E+00	**5.49E-01**	3.22E+00	2.71E+01	5.85E-01
IMF5	2	500	4.85E-02	4.59E-02	4.54E-02	4.76E-02	4.84E-02	**4.48E-02**
IMF6	2	500	**8.95E-02**	9.03E-02	9.02E-02	9.10E-02	9.25E-02	9.16E-02
IMF7	2	500	2.64E-02	**2.01E-02**	2.24E-02	2.75E-02	2.45E-02	2.07E-02
IMF8	3	500	3.62E-01	3.62E-01	**3.62E-01**	3.62E-01	3.62E-01	3.62E-01
IMF9	2	500	7.45E-02	**6.22E-02**	6.84E-02	6.54E-02	8.14E-02	6.89E-02
Friedman Rank			4.5	2.9	2.4	3.5	4.7	3