Coevolutionary Framework for Generalized Multimodal Multi-objective Optimization
Supplementary Material

I. Overview

This is the supplementary material for **Coevolutionary Framework for Generalized Multimodal Multi-objective Optimization**. In this document, the detailed results (average values and variance of $IGDX$, IGD) of the compared MMEAs on various MMOP test suites are given. In addition, to intuitively present the searching behaviors, some of the obtained PSs of all MMEAs are presented through figures. For all figures, the red points and lines are true PS/PF while the blue presents the obtained solutions. Notably, we use MO_R and CSCD to represent MO_Ring _PSO_SCD and MMODE_CSCD respectively.

TABLE S-I
AVERAGE AND VARIANCE OF IGD RESULTS OF THE COMPARED ALGORITHMS ON IEEE CEC 2020 TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
MMF1	3.73E-03 2.05E-04	3.97E-03 3.42E-04	2.60E-03 1.03E-04	**2.53E-03** **1.02E-04**	3.48E-03 1.38E-04	3.85E-03 2.23E-04	3.67E-03 2.38E-04	4.17E-03 2.62E-04
MMF2	2.06E-02 4.27E-03	1.81E-02 3.68E-03	1.23E-02 2.52E-03	**7.39E-03** **1.02E-03**	9.73E-03 1.67E-03	1.59E-02 1.37E-02	2.20E-02 8.96E-03	1.25E-02 1.88E-03
MMF3	1.69E-02 3.54E-03	1.83E-02 3.83E-03	1.22E-02 1.70E-03	**6.02E-03** **6.66E-04**	9.67E-03 2.34E-03	1.12E-02 1.79E-03	1.65E-02 4.21E-03	1.30E-02 4.16E-03
MMF4	3.59E-03 2.89E-04	4.55E-03 3.29E-04	2.56E-03 1.72E-04	**2.41E-03** **1.60E-04**	2.97E-03 5.95E-04	3.75E-03 2.81E-04	3.24E-03 1.94E-04	4.54E-03 2.97E-04
MMF5	3.68E-03 1.43E-04	4.66E-03 3.16E-04	2.62E-03 7.46E-05	**2.54E-03** **8.11E-05**	3.61E-03 1.60E-04	3.62E-03 2.00E-04	3.61E-03 1.44E-04	4.55E-03 2.41E-04
MMF6	3.57E-03 1.90E-04	4.60E-03 2.80E-04	2.57E-03 8.82E-05	**2.44E-03** **6.27E-05**	3.51E-03 1.08E-04	3.75E-03 2.81E-04	3.55E-03 2.33E-04	4.53E-03 3.00E-04
MMF7	3.81E-03 2.38E-04	4.11E-03 2.49E-04	2.55E-03 6.68E-05	**2.43E-03** **5.81E-05**	3.57E-03 4.95E-04	3.96E-03 2.01E-04	3.57E-03 1.82E-04	4.26E-03 2.31E-04
MMF8	4.77E-03 3.04E-04	5.26E-03 5.03E-04	3.13E-03 1.31E-04	3.75E-03 2.96E-04	**2.82E-03** **3.56E-04**	3.82E-03 2.92E-04	4.09E-03 2.84E-04	5.79E-03 3.48E-04
MMF9	1.56E-02 1.24E-03	1.52E-02 1.29E-03	**6.72E-03** **3.50E-04**	1.03E-02 6.99E-04	7.02E-03 4.27E-04	1.05E-02 1.06E-03	2.74E-02 2.16E-03	1.57E-02 1.68E-03
MMF14	8.08E-02 2.62E-03	9.19E-02 3.56E-03	**5.75E-02** **9.41E-04**	7.29E-02 1.59E-03	6.64E-02 1.26E-03	6.94E-02 1.13E-03	1.06E-01 7.12E-03	8.46E-02 1.53E-03
MMF1_e	1.18E-02 1.17E-03	8.84E-03 2.22E-03	1.06E-02 1.31E-03	1.35E-02 2.02E-03	5.82E-03 9.21E-04	2.26E-02 9.12E-03	9.47E-03 2.14E-03	**5.46E-03** **6.04E-04**
MMF1_z	3.61E-03 1.74E-04	3.93E-03 3.01E-04	2.61E-03 9.03E-05	**2.46E-03** **7.44E-05**	3.30E-03 3.46E-04	3.76E-03 2.73E-04	3.32E-03 1.67E-04	3.76E-03 2.35E-04
MMF14_a	7.88E-02 2.12E-03	1.06E-01 4.01E-03	**5.92E-02** **9.18E-04**	7.23E-02 1.53E-03	6.74E-02 2.06E-03	7.43E-02 1.62E-03	6.88E-02 1.74E-03	7.26E-02 1.27E-03

TABLE S-II
AVERAGE AND VARIANCE OF IGDX RESULTS OF THE COMPARED ALGORITHMS ON IEEE CEC 2020 TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
MMF1	4.81E-02 2.06E-03	4.56E-02 2.43E-03	3.72E-02 1.05E-03	4.24E-02 1.58E-03	4.48E-02 1.37E-03	4.54E-02 2.13E-03	3.95E-02 1.24E-03	**3.59E-02** **9.23E-04**
MMF2	3.98E-02 1.38E-02	3.44E-02 7.94E-03	2.82E-02 4.61E-03	2.00E-02 1.02E-02	**1.70E-02** **4.40E-03**	3.98E-02 1.64E-02	4.51E-02 9.62E-03	2.40E-02 3.61E-03
MMF3	4.79E-02 1.10E-02	4.18E-02 6.41E-03	4.51E-02 4.05E-03	4.02E-02 7.25E-03	**3.68E-02** **7.40E-03**	5.17E-02 9.64E-03	5.27E-02 7.07E-03	4.04E-02 6.68E-03
MMF4	2.77E-02 1.71E-03	3.10E-02 2.16E-03	**1.95E-02** **5.12E-04**	2.21E-02 8.59E-04	2.65E-02 3.07E-03	2.57E-02 1.80E-03	1.97E-02 1.08E-03	2.22E-02 6.55E-04
MMF5	8.44E-02 4.59E-03	8.30E-02 4.75E-03	6.48E-02 1.83E-03	7.29E-02 3.04E-03	7.84E-02 3.08E-03	7.62E-02 3.94E-03	6.48E-02 2.55E-03	**5.71E-02** **1.05E-03**
MMF6	7.27E-02 3.50E-03	7.31E-02 3.61E-03	5.74E-02 1.53E-03	6.40E-02 3.02E-03	6.75E-02 2.19E-03	6.92E-02 3.73E-03	5.60E-02 1.89E-03	**5.18E-02** **1.03E-03**
MMF7	2.65E-02 1.82E-03	2.69E-02 2.29E-03	**1.95E-02** **9.21E-04**	2.29E-02 2.15E-03	2.80E-02 2.36E-03	2.54E-02 2.31E-03	1.97E-02 1.24E-03	2.08E-02 1.02E-03
MMF8	6.62E-02 5.22E-03	9.30E-02 1.94E-02	5.23E-02 4.54E-03	5.43E-02 6.52E-03	6.52E-02 1.16E-02	8.25E-02 1.65E-02	5.15E-02 6.46E-03	**4.82E-02** **2.16E-03**
MMF9	8.02E-03 5.53E-04	9.24E-03 8.51E-04	4.73E-03 1.90E-04	5.87E-03 3.59E-04	4.93E-03 1.88E-04	**4.64E-03** **1.40E-04**	9.01E-03 5.06E-04	5.58E-03 2.03E-04
MMF14	5.37E-02 1.46E-03	6.23E-02 2.51E-03	**3.96E-02** **5.61E-04**	5.10E-02 1.47E-03	5.14E-02 1.10E-03	4.25E-02 7.06E-04	5.98E-02 3.29E-03	4.64E-02 5.98E-04
MMF1_e	5.22E-01 2.38E-01	3.32E-01 6.66E-02	3.28E-01 3.47E-02	5.57E-01 4.37E-01	5.08E-01 1.98E-01	7.30E-01 2.05E-01	**3.21E-01** **4.28E-02**	4.12E-01 1.38E-01
MMF1_z	3.50E-02 2.14E-03	3.44E-02 1.78E-03	2.73E-02 1.03E-03	2.94E-02 1.18E-03	3.12E-02 1.67E-03	3.32E-02 2.91E-03	2.71E-02 1.55E-03	**2.55E-02** **8.36E-04**
MMF14_a	6.07E-02 1.89E-03	8.80E-02 3.39E-03	5.09E-02 5.10E-04	6.07E-02 1.42E-03	7.74E-02 3.42E-03	5.80E-02 1.25E-03	4.81E-02 5.26E-04	**4.78E-02** **3.90E-04**

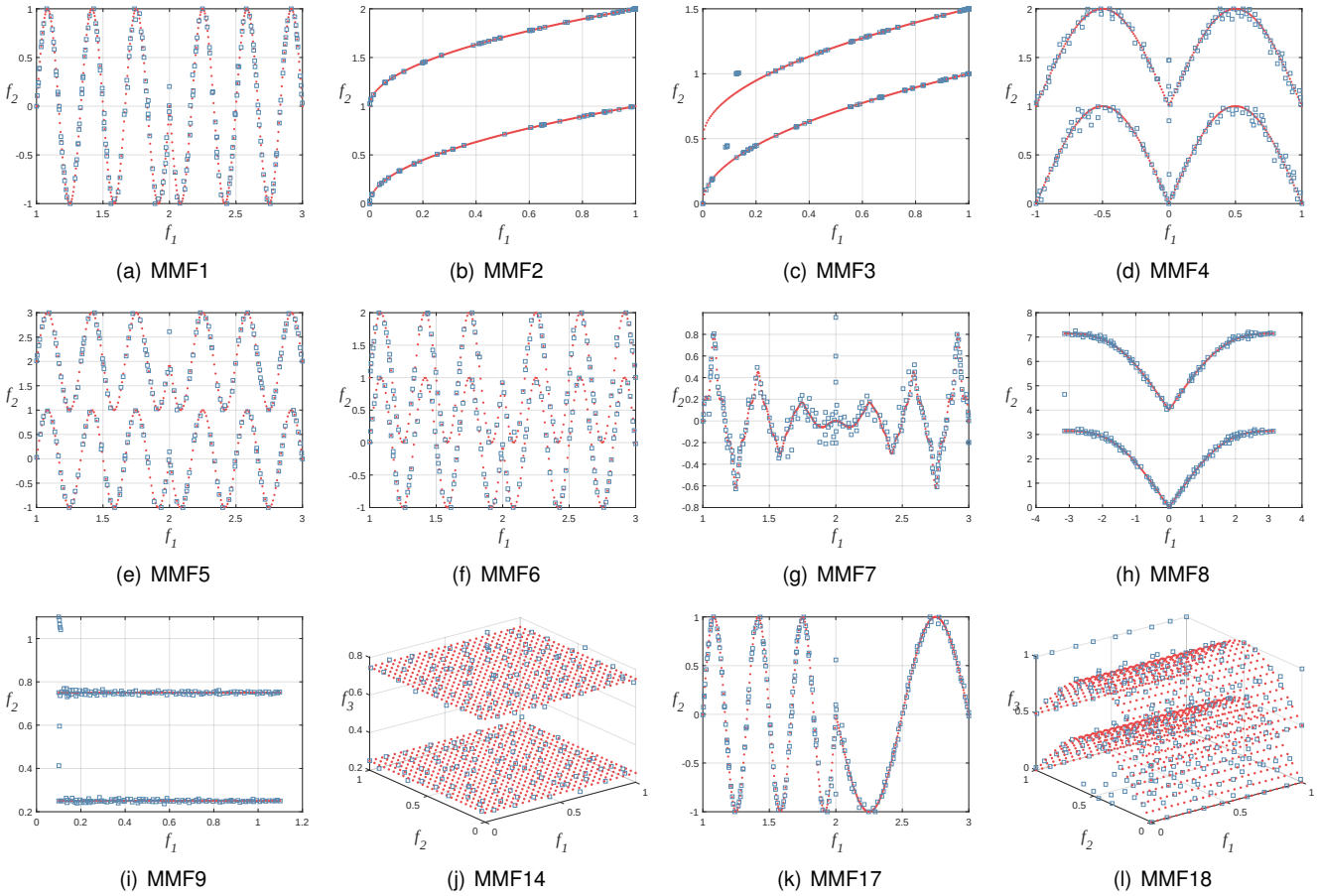


Fig. S-1. Distribution of solutions in the decision space on CEC2020 test suite obtained by CoMMEA.

TABLE S-III
AVERAGE AND VARIANCE OF IGD RESULTS OF THE COMPARED ALGORITHMS ON IDMP TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
IDMPM2T1	3.07E-03 2.36E-04	7.85E-04 1.61E-04	7.47E-04 1.62E-04	**5.47E-04** **1.85E-05**	9.27E-04 1.73E-04	7.61E-04 6.02E-05	6.37E-04 1.44E-04	6.75E-04 9.13E-05
IDMPM2T2	1.52E-03 1.45E-04	6.23E-04 1.55E-04	5.49E-04 7.02E-05	**4.86E-04** **2.16E-05**	5.93E-04 7.59E-05	6.83E-04 3.36E-05	5.39E-04 2.25E-05	6.11E-04 5.30E-05
IDMPM2T3	1.66E-03 1.83E-04	6.16E-04 8.77E-05	6.82E-04 6.93E-05	**4.75E-04** **1.62E-05**	8.06E-04 1.05E-04	8.05E-04 7.75E-05	5.40E-04 2.28E-05	6.73E-04 2.98E-05
IDMPM2T4	3.42E-03 7.52E-04	5.30E-04 1.90E-04	6.19E-04 1.47E-04	**4.99E-04** **1.93E-05**	7.43E-04 1.73E-04	7.33E-04 7.59E-05	5.05E-04 6.92E-05	5.02E-04 1.39E-04
IDMPM3T1	1.33E-02 8.88E-04	5.70E-03 4.16E-04	**4.72E-03** **2.48E-04**	5.21E-03 3.00E-04	6.71E-03 5.23E-04	5.10E-03 1.63E-04	4.88E-03 2.13E-04	5.66E-03 2.62E-04
IDMPM3T2	1.11E-02 1.18E-03	5.11E-03 4.08E-04	**4.34E-03** **1.30E-04**	4.69E-03 1.11E-04	5.62E-03 2.47E-04	4.97E-03 1.66E-04	4.56E-03 9.20E-05	5.24E-03 2.13E-04
IDMPM3T3	1.05E-02 9.43E-04	5.34E-03 3.37E-04	**4.55E-03** **1.41E-04**	4.80E-03 1.28E-04	6.41E-03 5.54E-04	5.15E-03 1.19E-04	4.58E-03 1.28E-04	5.44E-03 1.64E-04
IDMPM3T4	2.10E-02 4.55E-03	4.73E-03 6.00E-04	**4.46E-03** **3.85E-04**	4.69E-03 1.08E-04	6.23E-03 7.91E-04	5.04E-03 2.93E-04	4.51E-03 1.96E-04	5.07E-03 3.02E-04
IDMPM4T1	3.46E-02 3.10E-03	**5.58E-03** **4.30E-04**	6.25E-03 5.64E-04	7.85E-03 3.59E-04	1.83E-02 1.98E-03	8.39E-03 8.08E-04	8.92E-03 2.41E-03	7.23E-03 7.72E-04
IDMPM4T2	3.20E-02 6.18E-03	**5.41E-03** **5.30E-04**	5.52E-03 4.68E-04	6.51E-03 1.41E-04	1.58E-02 1.82E-03	7.04E-03 7.57E-04	6.21E-03 1.12E-03	6.37E-03 6.27E-04
IDMPM4T3	3.17E-02 5.62E-03	**5.79E-03** **6.03E-04**	5.88E-03 3.79E-04	6.75E-03 4.51E-04	1.61E-02 1.50E-03	6.98E-03 4.08E-04	6.40E-03 1.36E-03	7.13E-03 7.17E-04
IDMPM4T4	6.72E-02 1.73E-02	**5.54E-03** **5.96E-04**	5.61E-03 8.81E-04	6.53E-03 1.88E-04	1.87E-02 2.88E-03	6.88E-03 1.03E-03	7.07E-03 2.18E-03	6.65E-03 1.19E-03

TABLE S-IV
AVERAGE AND VARIANCE OF IGDX RESULTS OF THE COMPARED ALGORITHMS ON IDMP TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
IDMPM2T1	5.90E-02 1.67E-01	1.62E-03 2.30E-03	1.03E-03 5.41E-04	2.25E-01 3.22E-01	8.76E-04 1.15E-04	9.32E-04 7.13E-05	3.09E-03 6.51E-03	**6.47E-04** **6.84E-05**
IDMPM2T2	5.58E-03 2.91E-03	1.97E-03 1.35E-03	9.55E-04 1.33E-04	2.70E-01 3.35E-01	1.03E-03 1.14E-04	1.12E-03 8.61E-05	1.52E-03 3.52E-03	**8.54E-04** **8.74E-05**
IDMPM2T3	3.35E-03 4.22E-04	2.90E-03 1.58E-03	3.70E-03 1.47E-03	2.67E-03 5.63E-03	1.85E-03 1.92E-04	1.99E-03 2.49E-04	2.82E-03 1.05E-03	**1.34E-03** **1.34E-04**
IDMPM2T4	8.67E-02 2.00E-01	1.32E-02 2.15E-02	2.32E-02 1.23E-01	5.61E-01 2.55E-01	9.06E-02 2.32E-01	4.58E-02 1.71E-01	5.23E-03 8.78E-03	**6.13E-04** **8.89E-05**
IDMPM3T1	1.19E-01 1.47E-01	3.48E-02 7.39E-02	1.53E-02 4.42E-02	2.60E-01 2.06E-01	8.41E-03 3.97E-04	7.48E-03 1.78E-04	**6.75E-03** **1.45E-04**	7.08E-03 1.58E-04
IDMPM3T2	1.45E-01 1.25E-01	3.69E-02 7.35E-02	7.23E-03 2.56E-04	4.12E-01 2.11E-01	8.17E-03 2.71E-04	7.69E-03 2.01E-04	7.76E-03 3.23E-03	**7.19E-03** **1.25E-04**
IDMPM3T3	2.65E-02 4.34E-02	3.87E-02 7.37E-02	2.65E-02 6.09E-02	8.02E-02 1.46E-01	1.01E-02 6.01E-04	2.55E-02 6.29E-02	1.07E-02 4.04E-03	**8.16E-03** **1.54E-04**
IDMPM3T4	2.64E-01 1.82E-01	8.36E-02 1.08E-01	5.71E-02 9.87E-02	7.40E-01 2.54E-01	1.84E-02 3.13E-02	1.54E-01 1.52E-01	**1.04E-02** **4.07E-03**	2.32E-02 6.13E-02
IDMPM4T1	9.36E-01 2.75E-01	1.09E-01 1.50E-01	7.03E-01 2.89E-01	8.58E-01 3.23E-01	4.44E-02 7.50E-02	2.68E-02 6.77E-02	6.65E-02 8.96E-02	**2.62E-02** **6.73E-02**
IDMPM4T2	5.59E-01 2.64E-01	2.99E-01 2.46E-01	5.47E-01 2.36E-01	8.83E-01 2.35E-01	**2.62E-02** **5.25E-02**	3.62E-01 2.81E-01	4.67E-01 3.46E-01	1.05E-01 1.58E-01
IDMPM4T3	8.04E-02 8.42E-02	1.41E-01 1.60E-01	4.07E-01 2.56E-01	2.31E-01 2.53E-01	**1.66E-02** **1.33E-03**	4.16E-01 2.92E-01	4.33E-01 3.07E-01	3.00E-02 6.50E-02
IDMPM4T4	6.86E-01 3.44E-01	1.79E-01 2.36E-01	7.94E-01 3.19E-01	9.92E-01 2.97E-01	**3.87E-02** **6.08E-02**	7.28E-01 3.28E-01	5.25E-01 3.88E-01	1.42E-01 1.75E-01

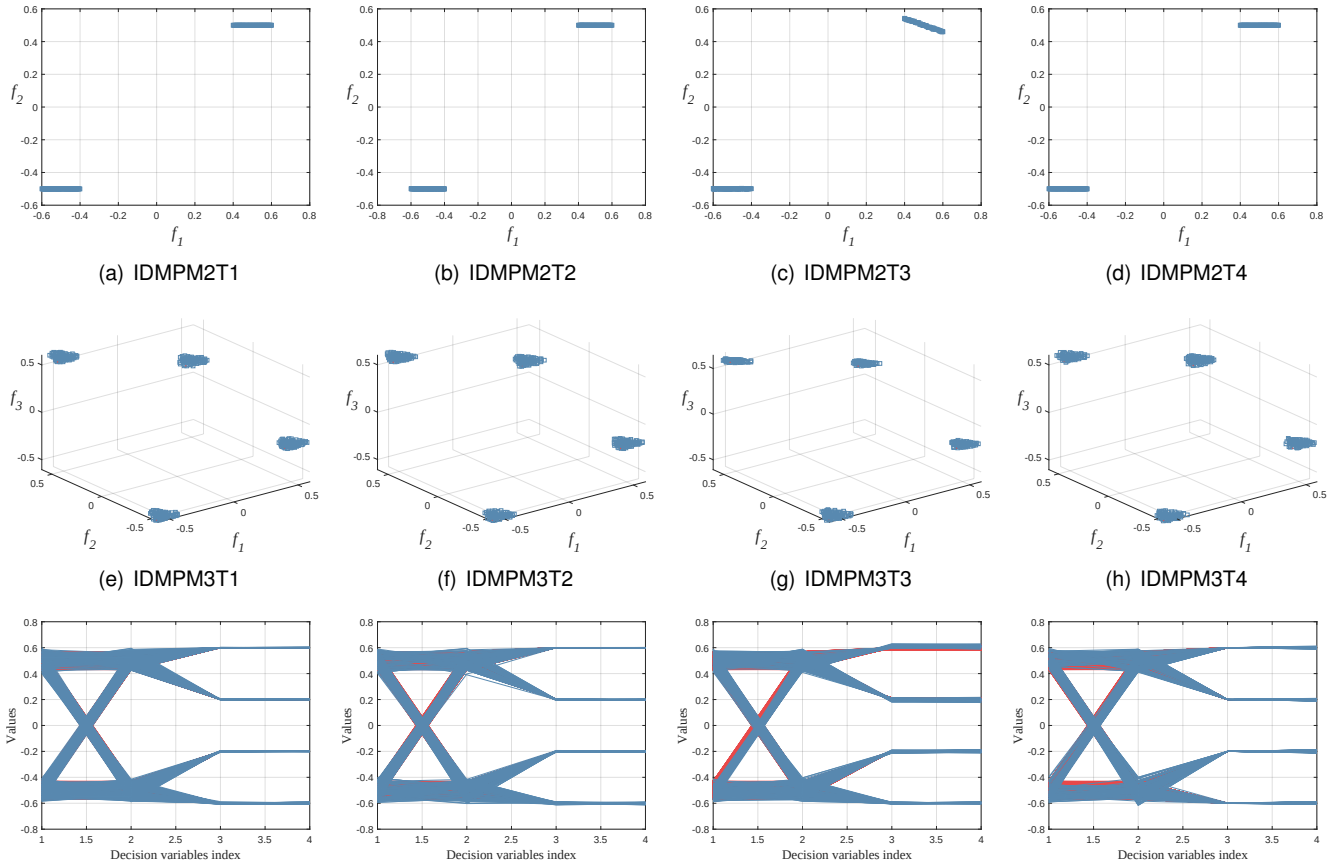


Fig. S-2. Distribution of solutions in the decision space on IDMP test suite obtained by CoMMEA.

TABLE S-V
AVERAGE AND VARIANCE OF IGD RESULTS OF THE COMPARED ALGORITHMS ON MMOPL TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
IDMPM2T1e	7.18E-03 1.66E-04	3.42E-03 1.72E-03	7.18E-03 5.60E-05	7.12E-03 2.15E-05	1.36E-03 1.69E-04	7.16E-03 6.13E-05	**9.85E-04** **1.26E-04**	9.98E-04 1.66E-04
IDMPM2T2e	7.24E-03 1.17E-04	2.88E-03 1.66E-03	7.22E-03 3.84E-05	7.19E-03 2.20E-05	9.65E-04 1.49E-04	7.26E-03 6.04E-05	**9.16E-04** **5.05E-05**	9.88E-04 1.50E-04
IDMPM2T3e	8.67E-03 8.51E-04	1.64E-03 1.86E-04	4.98E-03 2.45E-05	8.45E-03 1.72E-03	**1.11E-03** **9.26E-05**	5.11E-03 4.87E-05	1.15E-03 7.70E-05	1.13E-03 6.84E-05
IDMPM2T4e	1.39E-02 1.25E-03	4.92E-03 3.49E-04	1.60E-02 3.10E-04	1.60E-02 3.99E-05	1.61E-03 8.97E-04	1.58E-02 8.12E-04	**1.54E-03** **1.52E-04**	1.60E-03 8.77E-05
IDMPM3T1e	2.51E-02 7.53E-04	7.71E-03 8.30E-04	2.46E-02 1.75E-04	2.46E-02 1.63E-04	7.61E-03 3.07E-04	2.47E-02 1.75E-04	**6.83E-03** **1.84E-04**	7.17E-03 2.01E-04
IDMPM3T2e	3.85E-02 1.32E-03	1.59E-02 1.44E-03	3.66E-02 2.20E-04	3.70E-02 2.75E-04	8.12E-03 2.08E-04	3.67E-02 2.59E-04	7.77E-03 2.31E-04	**7.48E-03** **2.70E-04**
IDMPM3T3e	3.72E-02 8.40E-04	1.65E-02 1.45E-03	3.67E-02 2.13E-04	3.70E-02 1.89E-04	9.09E-03 1.38E-03	3.66E-02 1.91E-04	**8.33E-03** **4.79E-04**	1.01E-02 1.33E-03
IDMPM3T4e	4.20E-02 2.24E-03	1.72E-02 1.48E-03	3.67E-02 2.10E-04	3.70E-02 2.54E-04	9.31E-03 4.86E-04	3.67E-02 3.59E-04	8.62E-03 3.31E-04	**8.21E-03** **3.39E-04**
MMF10	2.03E-01 1.81E-02	3.25E-02 5.88E-03	1.92E-01 1.38E-03	1.62E-01 1.19E-02	**1.67E-02** **2.59E-02**	1.91E-01 1.40E-02	2.62E-02 3.84E-03	2.40E-02 1.03E-03
MMF11	8.46E-02 5.61E-03	3.85E-02 5.72E-03	9.13E-02 2.02E-04	8.56E-02 6.95E-03	**1.42E-02** **4.25E-04**	9.50E-02 1.18E-03	3.82E-02 6.36E-03	2.62E-02 1.47E-03
MMF12	6.80E-02 1.37E-02	4.59E-02 1.32E-02	8.28E-02 2.58E-04	6.96E-02 1.73E-02	**2.56E-03** **7.92E-05**	8.31E-02 3.04E-04	6.55E-03 3.50E-04	1.17E-02 2.10E-04
MMF13	1.04E-01 2.25E-02	1.49E-01 1.58E-02	1.38E-01 2.19E-02	8.13E-02 2.57E-02	**2.56E-02** **6.33E-03**	1.51E-01 6.18E-03	4.85E-02 1.05E-02	6.60E-02 6.52E-03
MMF15	1.72E-01 2.23E-03	1.43E-01 6.72E-03	1.71E-01 2.99E-03	1.66E-01 3.87E-03	**1.00E-01** **1.82E-03**	1.85E-01 1.65E-03	1.27E-01 5.37E-03	1.19E-01 1.81E-03
MMF15_a	1.76E-01 3.91E-03	1.58E-01 4.12E-03	1.69E-01 2.58E-03	1.66E-01 3.57E-03	1.35E-01 1.35E-02	1.78E-01 3.41E-03	1.15E-01 5.94E-03	**1.05E-01** **1.24E-03**
MMF16_l1	1.48E-01 2.19E-03	1.41E-01 4.98E-03	1.42E-01 3.45E-03	1.43E-01 2.64E-03	9.87E-02 2.49E-03	1.54E-01 2.72E-03	9.78E-02 1.73E-03	**9.56E-02** **1.18E-03**
MMF16_l2	2.13E-01 4.23E-03	1.67E-01 5.57E-03	2.24E-01 4.30E-03	2.09E-01 5.70E-03	1.34E-01 3.65E-03	2.39E-01 2.62E-03	1.33E-01 3.42E-03	**1.17E-01** **9.39E-04**
MMF16_l3	1.82E-01 3.99E-03	1.68E-01 5.08E-03	1.84E-01 2.50E-03	1.76E-01 3.24E-03	1.28E-01 6.89E-03	1.99E-01 2.75E-03	1.28E-01 3.90E-03	**1.17E-01** **1.24E-03**

TABLE S-VI
AVERAGE AND VARIANCE OF IGD RESULTS OF THE COMPARED ALGORITHMS ON MULTI POLYGON TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	D	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
PolygonM3	**4**	3.49E-01	1.05E-01	2.27E+01	**8.33E-02**	1.72E-01	9.92E-02	1.22E-01	1.13E-01
	8	4.77E+00	2.33E-01	1.11E+02	**1.30E-01**	8.30E-01	1.39E-01	2.69E-01	2.46E-01
	10	4.68E+00	2.15E-01	1.61E+02	1.00E+00	7.12E-01	**1.96E-01**	3.63E-01	3.08E-01
	14	1.22E+01	2.91E-01	1.05E+02	1.08E+01	1.02E+00	**2.30E-01**	4.50E-01	4.46E-01
	20	2.74E+01	6.21E-01	3.08E+02	3.05E+01	1.63E+00	**3.56E-01**	8.81E-01	6.00E-01
	30	6.12E+01	6.67E-01	1.96E+02	5.39E+01	2.01E+00	**4.47E-01**	1.42E+00	9.46E-01
PolygonM4	**4**	4.57E-01	1.59E-01	2.64E+01	**1.28E-01**	2.36E-01	1.45E-01	1.86E-01	1.61E-01
	8	4.06E+00	2.52E-01	1.22E+02	**2.08E-01**	7.57E-01	2.13E-01	3.48E-01	3.51E-01
	10	5.63E+00	3.23E-01	1.87E+02	2.96E-01	1.03E+00	**2.91E-01**	5.04E-01	4.55E-01
	14	1.38E+01	4.17E-01	1.22E+02	9.48E+00	1.36E+00	**3.61E-01**	6.36E-01	6.38E-01
	20	3.23E+01	8.18E-01	3.56E+02	3.22E+01	2.34E+00	**5.92E-01**	1.15E+00	8.77E-01
	30	7.36E+01	9.33E-01	2.21E+02	5.83E+01	2.63E+00	**7.48E-01**	1.74E+00	1.30E+00

TABLE S-VII
AVERAGE AND VARIANCE OF IGDX RESULTS OF THE COMPARED ALGORITHMS ON MMOPL TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
IDMPM2T1e	6.74E-01 8.52E-04	2.05E-03 1.18E-03	6.73E-01 1.92E-04	6.73E-01 4.97E-05	8.92E-04 1.11E-04	6.73E-01 1.83E-04	6.12E-04 4.16E-05	**6.00E-04** **3.74E-05**
IDMPM2T2e	6.74E-01 7.36E-04	3.10E-03 4.91E-03	6.73E-01 3.20E-04	6.73E-01 2.08E-04	1.02E-03 1.05E-04	6.73E-01 3.84E-04	**9.09E-04** **7.18E-05**	9.62E-04 6.74E-05
IDMPM2T3e	1.18E-01 1.49E-01	3.16E-03 4.01E-03	3.01E-01 4.29E-04	4.94E-01 2.46E-01	1.38E-03 6.44E-05	3.01E-01 5.04E-04	1.39E-03 9.16E-05	**1.26E-03** **6.64E-05**
IDMPM2T4e	7.02E-01 2.51E-01	2.67E-01 9.08E-02	1.01E+00 2.00E-04	1.01E+00 6.63E-05	1.28E-01 9.28E-02	1.00E+00 3.64E-02	4.69E-03 3.39E-03	**4.22E-03** **1.27E-02**
IDMPM3T1e	6.42E-01 1.09E-02	3.51E-02 7.43E-02	6.26E-01 1.53E-03	6.25E-01 8.44E-04	8.08E-03 2.09E-04	6.25E-01 1.15E-03	**6.96E-03** **1.01E-04**	7.08E-03 1.06E-04
IDMPM3T2e	5.38E-01 1.54E-01	1.79E-01 1.11E-01	4.96E-01 9.46E-04	8.48E-01 1.19E-01	7.84E-03 1.38E-04	4.96E-01 9.61E-04	7.41E-03 2.36E-04	**7.00E-03** **2.46E-04**
IDMPM3T3e	5.05E-01 6.09E-03	2.44E-01 5.54E-02	5.01E-01 3.44E-03	5.42E-01 1.34E-01	1.20E-02 1.55E-02	5.00E-01 2.95E-03	**8.88E-03** **8.65E-04**	1.03E-02 1.79E-03
IDMPM3T4e	7.12E-01 1.25E-01	4.84E-01 1.27E-01	8.50E-01 1.61E-03	9.43E-01 1.40E-01	1.32E-02 6.90E-03	9.49E-01 1.65E-01	**1.07E-02** **4.54E-04**	5.81E-02 7.78E-02
MMF10	1.69E-01 8.40E-03	1.37E-02 2.71E-03	2.01E-01 5.26E-05	1.64E-01 1.37E-02	1.28E-02 3.21E-02	1.98E-01 1.02E-02	8.15E-03 8.90E-04	**7.19E-03** **2.72E-04**
MMF11	2.10E-01 2.49E-02	1.94E-02 1.00E-02	2.49E-01 1.45E-04	2.11E-01 2.99E-02	**5.62E-03** **1.82E-04**	2.49E-01 1.81E-04	1.07E-02 2.22E-03	6.81E-03 2.33E-04
MMF12	1.90E-01 4.29E-02	1.88E-01 7.19E-02	2.45E-01 1.95E-04	2.08E-01 4.96E-02	**2.50E-03** **1.18E-04**	2.45E-01 2.57E-04	2.78E-03 9.62E-05	3.30E-03 1.46E-04
MMF13	2.35E-01 1.57E-02	2.55E-01 1.36E-02	2.50E-01 8.60E-03	2.31E-01 1.60E-02	8.97E-02 2.68E-02	2.52E-01 5.98E-04	**6.39E-02** **2.56E-03**	7.88E-02 1.59E-03
MMF15	1.51E-01 1.04E-02	6.65E-02 4.10E-03	2.30E-01 1.82E-02	1.37E-01 1.33E-02	5.41E-02 1.61E-03	2.58E-01 1.04E-03	5.41E-02 2.25E-03	**5.06E-02** **8.60E-04**
MMF15_a	1.67E-01 1.21E-02	9.54E-02 4.87E-03	2.05E-01 4.26E-03	1.55E-01 9.35E-03	9.17E-02 1.45E-02	2.08E-01 3.76E-03	5.45E-02 2.63E-03	**4.97E-02** **5.61E-04**
MMF16_l1	1.16E-01 8.55E-03	8.12E-02 4.31E-03	1.44E-01 5.34E-03	1.10E-01 6.74E-03	6.85E-02 2.57E-03	1.52E-01 6.21E-04	4.78E-02 7.44E-04	**4.64E-02** **5.81E-04**
MMF16_l2	1.94E-01 1.86E-02	8.35E-02 5.00E-03	2.96E-01 1.96E-02	1.81E-01 1.52E-02	1.07E-01 1.82E-02	3.31E-01 1.66E-03	6.14E-02 9.02E-03	**4.54E-02** **3.31E-04**
MMF16_l3	1.55E-01 1.30E-02	1.24E-01 4.78E-03	1.94E-01 7.64E-03	1.44E-01 1.12E-02	1.07E-01 9.86E-03	2.07E-01 8.23E-04	5.97E-02 4.00E-03	**5.05E-02** **2.49E-04**

TABLE S-VIII
AVERAGE AND VARIANCE OF IGDX RESULTS OF THE COMPARED ALGORITHMS ON MULTI POLYGON TEST SUITE, WHERE THE BEST MEAN FOR EACH TEST INSTANCE IS HIGHLIGHTED.

Problems	D	MO_R	DNEA-L	CPDEA	CSCD	DC	WI	HREA	CoMMEA
PolygonM3	**4**	1.07E+00	8.37E-01	1.78E+01	3.02E-01	4.17E-01	5.57E-01	3.57E+00	**2.70E-01**
	8	7.86E+00	5.86E+00	6.85E+01	3.84E+00	1.46E+00	2.66E+00	7.09E+00	**6.33E-01**
	10	8.80E+00	7.91E+00	9.81E+01	8.13E+00	2.11E+00	2.09E+00	8.31E+00	**7.55E-01**
	14	1.37E+01	9.95E+00	6.56E+01	1.47E+01	1.87E+00	1.20E+00	1.03E+01	**1.04E+00**
	20	2.39E+01	1.23E+01	1.84E+02	2.54E+01	3.77E+00	3.04E+00	1.25E+01	**1.47E+00**
	30	4.35E+01	1.52E+01	1.20E+02	3.91E+01	4.22E+00	**2.57E+00**	1.59E+01	3.27E+00
PolygonM4	**4**	1.07E+00	6.36E-01	1.75E+01	**2.49E-01**	4.63E-01	3.19E-01	3.08E+00	3.13E-01
	8	6.50E+00	5.38E+00	6.64E+01	3.65E+00	1.26E+00	1.02E+00	7.20E+00	**7.30E-01**
	10	8.56E+00	7.00E+00	9.89E+01	6.69E+00	1.63E+00	1.52E+00	8.28E+00	**8.49E-01**
	14	1.43E+01	9.20E+00	6.65E+01	1.34E+01	2.07E+00	1.28E+00	1.00E+01	**1.17E+00**
	20	2.38E+01	1.21E+01	1.84E+02	2.42E+01	3.27E+00	2.26E+00	1.23E+01	**1.63E+00**
	30	4.51E+01	1.39E+01	1.17E+02	3.73E+01	4.46E+00	**2.77E+00**	1.49E+01	3.30E+00

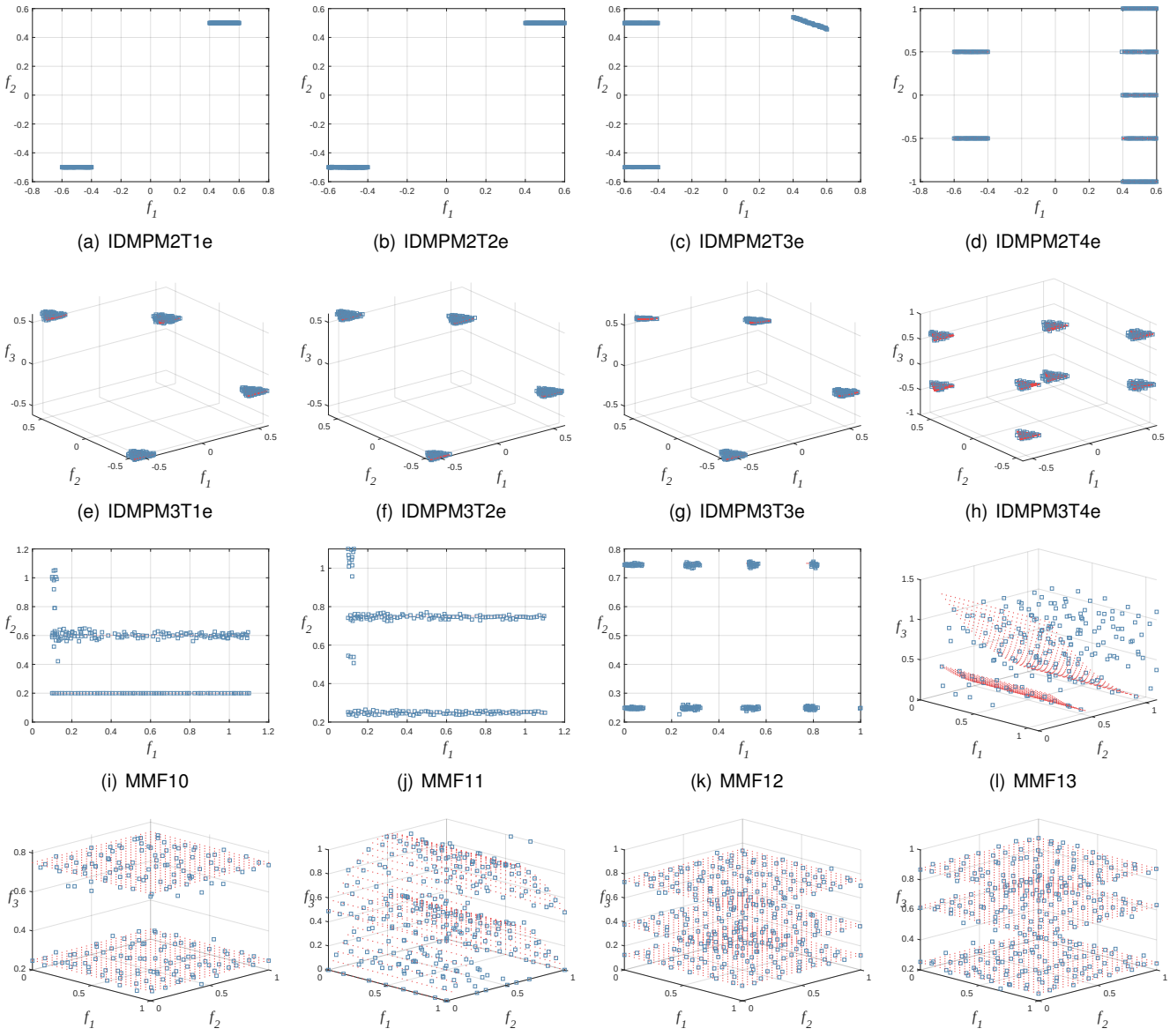


Fig. S-3. Distribution of solutions in the decision space on MMOPL test suite obtained by CoMMEA.

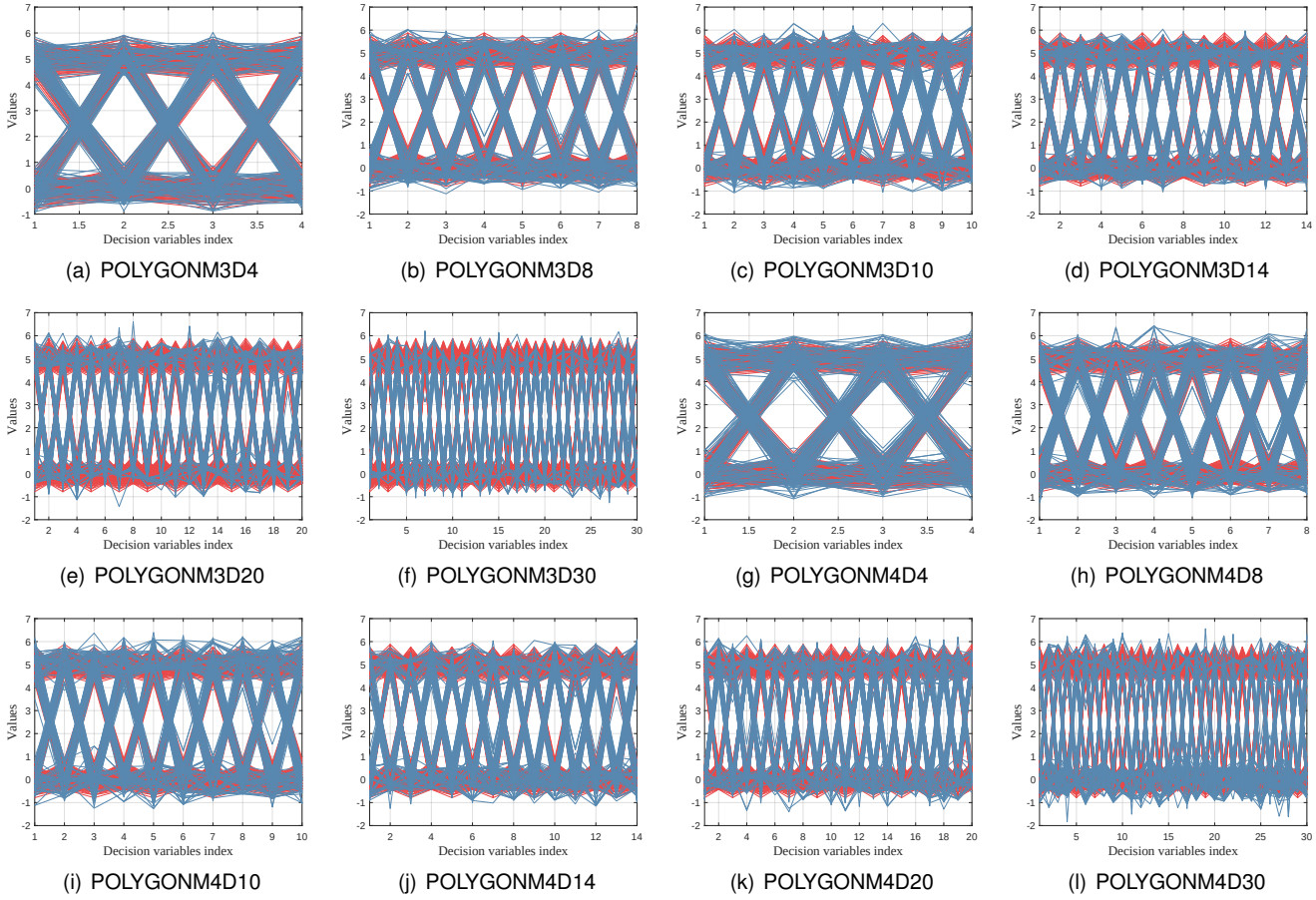


Fig. S-4. Distribution of solutions in the decision space on multi Polygon test suite obtained by CoMMEA.

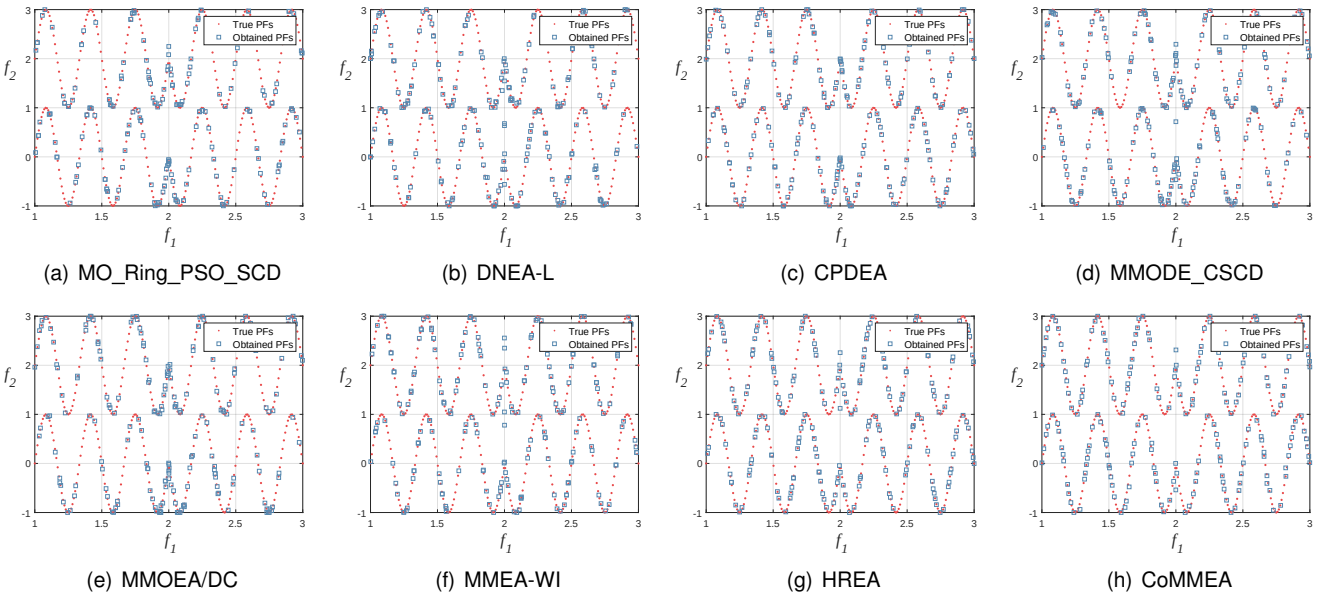
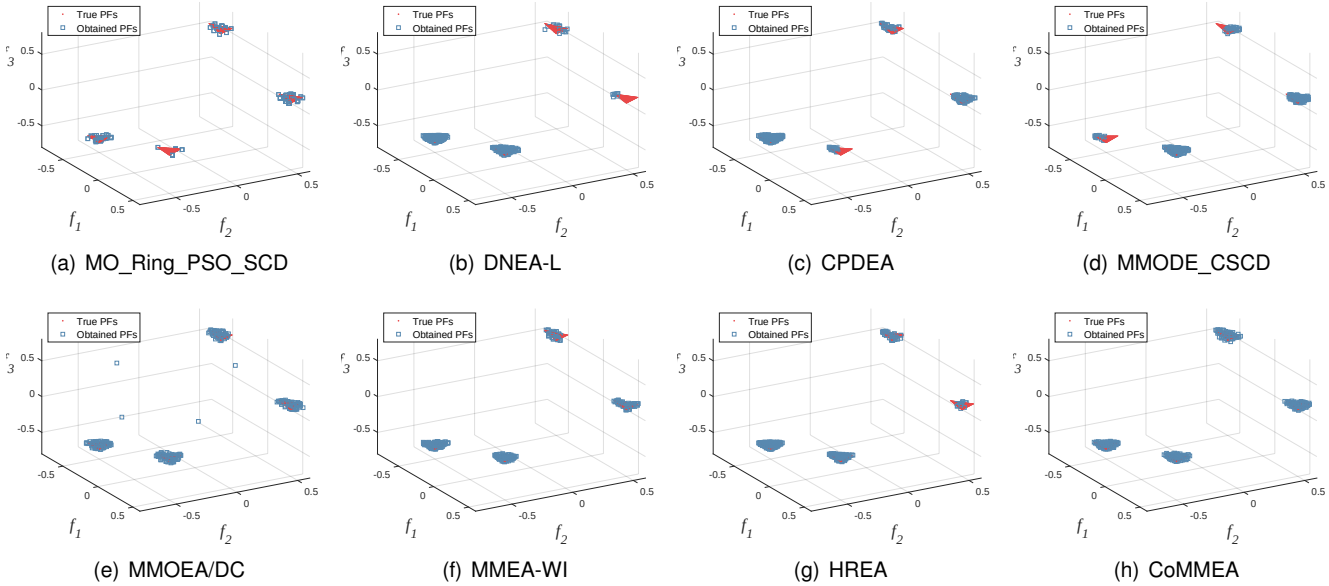


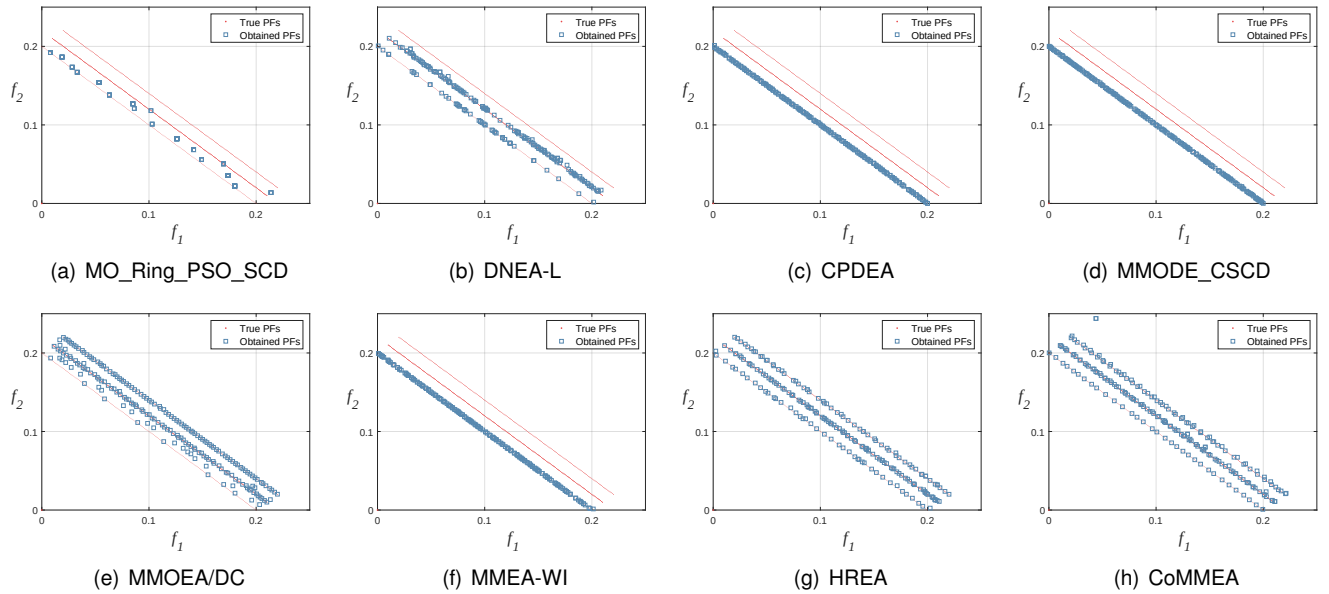
Fig. S-5. Distribution of solutions in the decision space on MMF5 obtained by different algorithms



(a) MO_Ring_PSO_SCD (b) DNEA-L (c) CPDEA (d) MMODE_CSCD

(e) MMOEA/DC (f) MMEA-WI (g) HREA (h) CoMMEA

Fig. S-6. Distribution of solutions in the decision space on IDMPM3T3 obtained by different algorithms



(a) MO_Ring_PSO_SCD (b) DNEA-L (c) CPDEA (d) MMODE_CSCD

(e) MMOEA/DC (f) MMEA-WI (g) HREA (h) CoMMEA

Fig. S-7. Distribution of solutions in the objective space on IDMPM2T4_e obtained by different algorithms

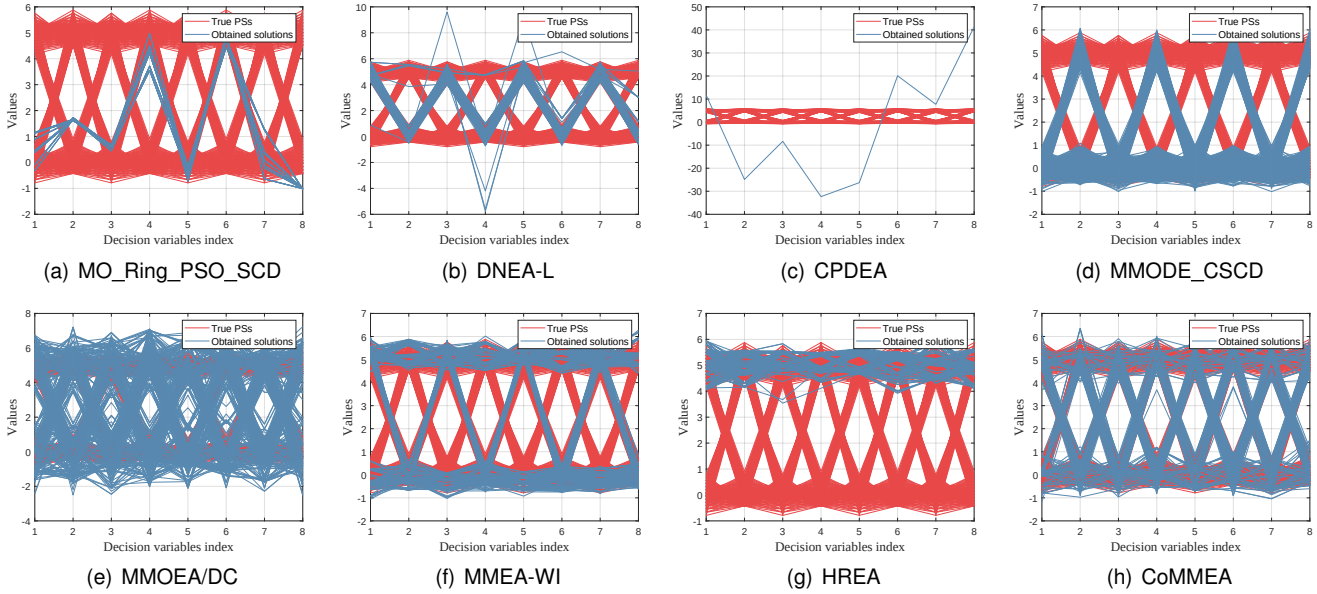


Fig. S-8. Distribution of solutions in the decision space on multi Polygon with 3 objectives and 8 decision variables obtained by different algorithms