

Supplementary File for “Evolutionary Multitasking with Multiple Knowledge Representations and Elite Vector Guidance for Solving Large-Scale Multi-Objective Optimization Problems”

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TABLE S1
THE AVERAGE IGD RESULTS OF MKREV-MTO AND ITS FIVE COMPETITORS ON LSMOP ($M=2$) BENCHMARKS

LSMOPs	D	LMEA(std)	LSMOF(std)	LMOCSSO(std)	MOEA-PSL(std)	ALMOEA(std)	MKREV-MTO(std)
LSMOP1	100	4.757e-1(1.64e-1)-	4.816e-1(4.45e-2)-	2.273e-1(9.83e-2)+	2.812e-1(7.61e-2)-	3.577e-1(1.34e-2)-	2.382e-1(6.39e-3)
	300	7.299e-1(4.31e-1)-	6.051e-1(1.47e-2)-	1.086e+0(2.17e-1)-	7.474e-1(1.41e-1)-	4.387e-1(6.12e-2)-	3.291e-1(1.71e-3)
	500	1.121e+1(2.47e-1)-	6.173e-1(8.98e-2)-	1.114e+0(5.12e-2)-	1.081e+0(5.29e-2)-	7.071e-1(4.55e-2)-	3.353e-1(8.28e-3)
LSMOP 2	100	2.592e-1(1.36e-2)-	6.730e-2(6.33e-3)-	1.432e-1(2.81e-3)-	1.213e-1(6.38e-3)-	8.724e-2(1.37e-3)-	4.564e-2(7.61e-4)
	300	1.141e-1(4.24e-3)-	3.126e-2(6.79e-3)-	6.912e-2(2.28e-3)-	5.047e-2(4.27e-3)-	3.411e-2(5.12e-3)-	2.095e-2(1.35e-4)
	500	7.373e-2(2.72e-3)-	2.581e-2(2.35e-3)-	4.631e-2(1.37e-3)-	3.434e-2(2.71e-3)-	2.352e-2(4.79e-3)-	1.453e-2(7.23e-4)
LSMOP 3	100	1.822e+1(4.16e+1)-	1.017e+0(1.32e-2)+	7.079e-1(1.29e-2)+	1.525e+0(4.78e-2)-	1.522e+0(4.97e-4)-	1.499e+0(1.87e-3)
	300	4.307e+1(2.13e+2)-	1.548e+0(3.10e-3)+	1.127e+0(7.48e-2)+	2.045e+1(3.05e+0)-	1.569e+0(1.69e-4)-	1.557e+0(3.78e-3)
	500	2.256e+3(1.02e+3)-	1.566e+0(1.17e-3)=	2.049e+0(8.91e-3)-	1.211e+1(1.36e+1)-	1.579e+0(3.66e-4)-	1.566e+0(8.93e-3)
LSMOP 4	100	4.178e-1(6.81e-3)-	1.471e-1(1.07e-2)-	1.149e-1(2.14e-2)+	2.406e-1(6.43e-3)-	2.167e-1(3.11e-3)-	1.265e-1(4.52e-4)
	300	1.997e-1(2.04e-3)-	7.731e-2(2.89e-3)-	1.264e-1(3.18e-3)-	1.166e-1(4.11e-3)-	9.667e-2(1.06e-3)-	6.631e-2(7.44e-4)
	500	1.368e-1(3.34e-3)-	5.198e-2(5.11e-3)-	8.922e-2(2.16e-3)-	8.772e-2(9.03e-4)-	7.135e-2(3.47e-3)-	4.260e-2(1.65e-4)
LSMOP 5	100	2.116e+1(9.90e-1)-	7.421e-1(0.00e+0)-	2.408e-1(5.51e-1)+	6.908e-1(2.68e-1)-	7.421e-1(0.00e+0)-	6.823e-1(1.03e-3)
	300	2.382e+1(2.34e+0)-	7.421e-1(0.00e+0)-	1.269e+0(2.67e-1)-	7.421e-1(0.00e+0)-	7.421e-1(0.00e+0)-	6.718e-1(1.14e-3)
	500	2.348e+1(4.38e-1)-	7.421e-1(0.00e+0)-	2.195e+0(7.22e-1)-	2.950e+0(2.96e-1)-	7.421e-1(0.00e+0)-	7.087e-1(6.28e-3)
LSMOP 6	100	1.022e+3(7.22e+2)-	4.632e-1(4.01e-3)-	7.450e-1(4.72e-2)-	1.208e+0(7.19e-1)-	6.807e-1(2.57e-2)-	4.511e-1(1.04e-3)
	300	1.978e+3(2.20e+3)-	3.380e-1(1.33e-3)+	7.984e-1(1.55e-2)+	7.437e-1(1.14e-1)+	7.100e-1(2.45e-2)+	1.460e+0(4.62e-3)
	500	3.040e+3(7.51e+3)-	3.204e-1(7.09e-4)+	8.056e-1(1.04e-2)+	5.041e-1(6.99e-1)+	6.770e-1(2.28e-2)+	1.484e+0(1.69e-3)
LSMOP 7	100	5.319e+4(1.26e+4)-	1.456e+0(3.04e-3)=	1.589e+0(1.21e+0)-	1.461e+0(8.80e-1)-	1.456e+0(8.46e-4)=	1.456e+0(4.86e-4)
	300	7.467e+4(5.22e+3)-	1.498e+0(1.15e-3)=	2.139e+1(2.50e+1)-	3.426e+2(4.82e+2)-	1.503e+0(4.27e-4)-	1.498e+0(7.49e-4)
	500	8.191e+4(5.74e+2)-	1.506e+0(1.83e-3)=	1.178e+3(3.54e+1)-	4.681e+2(7.16e+2)-	1.512e+0(8.73e-4)-	1.506e+0(2.69e-4)
LSMOP 8	100	1.806e+1(7.45e-1)-	7.421e-1(0.00e+0)-	8.608e-2(1.03e-2)+	3.433e-1(1.93e-2)+	7.421e-1(0.00e+0)-	5.758e-1(1.77e-3)
	300	1.969e+1(2.62e-1)-	7.421e-1(0.00e+0)-	1.146e+1(1.77e-1)-	7.421e-1(2.04e-1)-	7.421e-1(0.00e+0)-	6.070e-1(1.94e-3)
	500	1.959e+1(3.77e-1)-	7.421e-1(0.00e+0)-	2.428e+0(5.10e-2)-	1.799e+0(7.48e-1)-	7.421e-1(0.00e+0)-	6.117e-1(5.14e-4)
LSMOP9	100	4.459e+1(1.25e+0)-	8.100e-1(4.29e-3)=	1.412e+0(5.52e-1)-	8.100e-1(5.28e-3)=	1.184e+0(2.90e-2)-	8.100e-1(2.29e-3)
	300	5.585e+1(1.24e+0)-	8.100e-1(6.67e-3)-	6.313e-1(4.14e-2)+	8.910e-1(4.37e-1)-	1.031e+0(3.29e-2)-	8.100e-1(5.15e-3)
	500	5.980e+1(2.72e+0)-	8.087e-1(2.94e-3)-	8.826e-1(4.04e-2)-	8.100e-1(2.14e-1)-	1.037e+0(1.59e-2)-	7.812e-1(3.98e-3)
+/-/-		0/0/27	4/6/17	9/0/18	3/1/23	2/1/24	—

LSMOPs	D	LMEA(std)	LSMOF(std)	LMOC SO(std)	MOEA-PSL(std)	ALMOEA(std)	MKREV-MTO(std)
LSMOP1	100	5.593e+0(2.93e-1)-	4.930e-1(7.51e-3)-	2.491e-1(6.60e-3)+	2.530e-1(6.64e-3)+	5.297e-1(4.58e-3)-	3.625e-1(2.37e-3)
	300	1.092e+1(4.53e-1)-	5.729e-1(1.21e-2)-	1.008e+0(2.15e-1)-	8.607e-1(2.89e-3)-	5.444e-1(4.67e-2)-	4.057e-1(1.29e-3)
	500	1.002e+1(7.64e-1)-	6.225e-1(1.99e-2)-	1.474e+0(5.52e-1)-	2.723e+0(1.32e-1)-	6.104e-1(3.61e-2)-	4.225e-1(7.57e-3)
LSMOP2	100	2.167e-1(5.82e-3)-	2.222e-1(8.27e-4)-	1.241e-1(4.84e-3)-	2.083e-1(5.16e-3)-	1.705e-1(1.03e-4)-	9.218e-2(1.81e-4)
	300	9.386e-2(8.89e-3)-	1.032e-1(2.48e-4)-	6.654e-2(3.63e-3)-	9.638e-2(1.18e-3)-	7.759e-2(3.61e-4)-	5.043e-2(6.97e-4)
	500	7.223e-2(1.42e-3)-	7.719e-2(3.21e-4)-	5.298e-2(1.55e-3)-	7.179e-2(3.96e-3)-	5.778e-2(6.08e-4)-	4.308e-2(5.01e-4)
LSMOP3	100	8.514e+0(7.49e+1)-	8.606e-1(0.00e+0)=	1.611e+0(1.07e+0)-	8.606e-1(2.71e-3)=	8.606e-1(0.00e+0)=	8.606e-1(0.00e+0)
	300	6.511e+1(2.24e+1)-	8.606e-1(0.00e+0)=	9.253e+0(7.75e+0)-	8.606e-1(0.00e+0)=	8.606e-1(0.00e+0)=	8.606e-1(0.00e+0)
	500	1.297e+2(6.57e+1)-	8.606e-1(0.00e+0)=	1.159e+1(9.74e+0)-	5.996e+0(7.22e+0)-	8.606e-1(0.00e+0)=	8.606e-1(0.00e+0)
LSMOP4	100	5.750e-1(6.57e-3)-	3.712e-1(9.70e-3)-	3.823e-1(8.03e-3)-	3.677e-1(5.56e-3)-	5.249e-1(1.09e-3)-	3.178e-1(2.79e-3)
	300	3.070e-1(5.77e-3)-	2.506e-1(1.37e-3)-	2.091e-1(1.98e-3)-	2.595e-1(1.87e-3)-	2.424e-1(1.64e-3)-	1.560e-1(7.99e-3)
	500	2.063e-1(1.83e-3)-	1.967e-1(2.90e-3)-	1.526e-1(4.19e-3)-	1.713e-1(1.13e-3)-	1.587e-1(2.78e-3)-	1.031e-1(1.62e-3)
LSMOP5	100	9.506e+0(2.33e+0)-	4.477e-1(5.69e-2)-	5.579e-1(1.63e-2)-	5.408e-1(2.77e-3)-	5.340e-1(2.25e-3)-	4.315e-1(2.92e-3)
	300	1.793e+1(3.13e+0)-	5.427e-1(2.04e-1)-	2.114e+0(2.03e-1)-	5.408e-1(5.41e-2)-	5.423e-1(3.36e-3)-	4.666e-1(5.68e-3)
	500	1.948e+1(2.99e+0)-	6.702e-1(1.13e-1)-	3.288e+0(4.63e-1)-	5.408e-1(4.61e-2)-	5.423e-1(2.81e-3)-	4.526e-1(7.69e-3)
LSMOP6	100	1.393e+4(5.81e+2)-	6.585e-1(1.46e-2)+	1.105e+0(9.38e-1)+	1.127e+0(1.55e-1)-	1.127e+0(1.17e-3)-	1.118e+0(2.26e-2)
	300	2.867e+4(6.94e+2)-	7.288e-1(3.43e-2)+	4.983e+0(2.18e+0)-	1.267e+0(2.61e-1)=	1.267e+0(1.59e-3)=	1.260e+0(2.16e-2)
	500	3.085e+4(4.39e+3)-	7.776e-1(6.65e-2)+	7.171e+1(1.42e+0)-	3.875e+2(2.85e+2)-	1.295e+0(5.96e-3)+	1.302e+0(3.77e-3)
LSMOP7	100	3.377e+0(3.52e-1)-	1.054e+0(3.47e-2)-	9.461e-1(1.48e-3)+	1.238e+0(9.05e-3)=	1.179e+0(9.05e-2)+	1.239e+0(5.52e-2)
	300	1.217e+2(7.40e+1)-	9.217e-1(6.58e-3)+	9.463e-1(2.63e-3)+	1.144e+0(2.56e-2)+	9.543e-1(1.12e-2)+	1.298e+0(3.79e-2)
	500	6.356e+2(4.61e+1)-	9.030e-1(1.73e-2)+	9.679e-1(1.47e-2)+	1.021e+0(2.37e-2)+	9.155e-1(6.07e-2)+	1.309e+0(9.76e-2)
LSMOP8	100	4.053e-1(1.37e-2)-	3.651e-1(1.52e-2)-	2.808e-1(1.24e-2)-	3.494e-1(6.93e-3)-	3.633e-1(8.86e-3)-	1.627e-1(6.73e-3)
	300	7.726e-1(4.25e-2)-	5.541e-1(2.67e-2)-	5.711e-1(3.67e-2)-	3.592e-1(1.03e-2)-	2.573e-1(1.60e-3)-	1.345e-1(8.37e-3)
	500	6.816e-1(1.69e-2)-	4.693e-1(8.42e-2)-	5.608e-1(9.49e-2)-	3.442e-1(1.26e-2)-	2.256e-1(1.51e-3)-	1.304e-1(1.22e-3)
LSMOP9	100	4.917e+0(3.41e-1)-	1.538e+0(0.00e+0)-	8.473e-1(4.48e-2)-	1.538e+0(2.28e-2)-	1.461e+0(1.28e-1)-	5.916e-1(1.25e-2)
	300	1.184e+2(9.37e+0)-	1.538e+0(0.00e+0)-	9.785e-1(1.38e-1)-	1.538e+0(2.84e-2)-	1.286e+0(1.95e-1)-	5.857e-1(2.78e-2)
	500	1.341e+2(2.07e+0)-	1.538e+0(0.00e+0)-	7.237e-1(6.28e-1)-	1.446e+0(7.94e-1)-	8.584e-1(2.68e-1)-	5.831e-1(1.64e-2)
+/-/-		0/0/27	5/3/19	5/0/22	3/4/20	4/4/19	—

LSMOPs	D	MOMFEA(std)	MOMFEA-SADE(std)	EMaTO-MKT(std)	MTEA-DDN(std)	MKREV-MTO(std)
LMF1	100	3.832e+0(1.91e-1)-	1.759e+0(4.52e-1)-	9.262e-1(2.43e-2)-	2.770e-1(2.05e-2)+	3.813e-1(5.93e-3)
	300	1.199e+1(2.79e-1)-	4.430e+0(2.67e-1)-	5.677e+0(3.46e-1)-	8.153e-1(4.33e-2)-	5.947e-1(3.05e-3)
	500	1.204e+1(1.79e+0)-	4.620e+0(8.48e-1)-	1.495e+1(5.87e-1)-	9.804e-1(9.45e-2)-	6.436e-1(2.58e-2)
LMF2	100	1.138e+0(2.10e-3)-	1.248e+0(5.32e-1)-	1.115e+0(2.90e-2)-	5.084e-1(1.80e-2)-	3.912e-1(2.76e-3)
	300	2.160e+0(1.98e-3)-	2.525e+0(9.41e-1)-	1.632e+0(9.06e-2)-	8.950e-1(5.91e-2)-	4.105e-1(8.95e-3)
	500	2.738e+0(1.55e-2)-	2.806e+0(1.53e-1)-	2.049e+0(3.59e-1)-	1.101e+0(3.16e-2)-	4.285e-1(2.51e-3)
LMF3	100	5.097e+1(2.87e+0)-	6.864e-1(2.08e-2)-	7.494e-1(5.43e-2)-	3.735e-1(5.49e-2)+	4.262e-1(1.53e-2)
	300	2.748e+2(4.43e+1)-	8.130e-1(5.67e-2)-	2.798e+0(1.01e-1)-	8.130e-1(4.74e-2)-	5.852e-1(7.97e-2)
	500	4.645e+2(3.55e+2)-	2.056e+0(9.19e-1)-	7.589e+0(1.92e+0)-	1.009e+0(1.11e-1)-	6.656e-1(1.62e-2)
LMF4	100	6.302e+1(5.94e+0)-	1.738e+0(2.82e-1)-	8.639e-1(2.71e-2)-	4.843e-1(4.68e-2)-	4.221e-1(3.46e-3)
	300	1.026e+2(9.83e+0)-	8.892e+0(7.59e-1)-	2.243e+0(4.75e-1)-	8.152e-1(2.32e-2)-	4.606e-1(5.05e-3)
	500	1.395e+2(1.34e+1)-	1.806e+1(1.25e+0)-	7.846e+0(6.79e+0)-	9.804e-1(7.45e-2)-	4.947e-1(2.88e-2)
LMF5	100	4.536e+0(5.62e+0)-	7.721e-1(2.88e-2)-	9.178e-1(9.77e-2)-	5.053e-1(5.75e-2)-	4.027e-1(1.27e-2)
	300	3.729e+0(7.06e-1)-	1.736e+0(1.18e-1)-	1.019e+0(1.08e-2)-	8.951e-1(2.90e-2)-	4.991e-1(1.64e-2)
	500	3.388e+0(5.41e-1)-	1.696e+0(1.57e-1)-	1.431e+0(1.42e-1)-	1.101e+0(1.15e-1)-	4.683e-1(2.54e-2)
LMF6	100	5.526e+0(9.86e-1)-	6.548e-1(1.44e-2)-	8.985e-1(2.53e-2)-	3.716e-1(5.49e-3)+	6.556e-1(2.61e-3)
	300	1.692e+1(1.37e+0)-	1.296e+0(8.23e-1)-	1.984e+0(5.27e-2)-	8.128e-1(7.73e-2)-	6.288e-1(1.06e-3)
	500	2.149e+1(1.07e+0)-	1.437e+0(5.48e-1)-	2.106e+0(7.93e-2)-	1.009e+0(2.11e-1)-	5.987e-1(8.84e-3)
LMF7	100	1.440e+2(3.61e+1)-	1.941e+0(4.75e-1)-	1.624e+0(3.97e-1)-	2.767e-1(4.68e-3)+	6.220e-1(7.59e-3)
	300	2.463e+2(7.63e+1)-	1.188e+1(2.78e+0)-	2.590e+0(2.37e+0)-	8.152e-1(3.33e-2)-	6.027e-1(3.37e-3)
	500	3.184e+2(4.28e+1)-	2.775e+1(4.31e+0)-	1.234e+1(2.03e+0)-	9.804e-1(9.45e-2)-	6.495e-1(9.69e-3)
LMF8	100	5.819e+1(3.51e+0)-	9.346e-1(4.57e-3)-	1.339e+0(3.77e-1)-	4.917e-1(5.49e-3)+	9.168e-1(3.29e-4)
	300	1.419e+2(5.55e+1)-	1.739e+0(4.68e-1)-	3.462e+0(8.02e-1)-	8.129e-1(1.74e-3)+	8.992e-1(4.28e-3)
	500	2.578e+2(7.24e+1)-	1.873e+0(4.54e-1)-	6.187e+0(3.17e+0)-	8.526e-1(8.14e-2)-	8.317e-1(3.92e-3)
+/-/-		0/0/24	0/0/24	0/0/24	6/0/18	—

LSMOPs	D	MOMFEA(std)	MOMFEA-SADE(std)	EMaTO-MKT(std)	MTEA-DDN(std)	MKREV-MTO(std)
LMF1	100	3.325e+1(5.03e+0)-	1.759e+0(3.58e-1)-	1.287e+1(5.51e+0)-	4.404e-1(1.35e-1)+	5.115e-1(8.18e-3)
	300	1.715e+2(4.60e+1)-	1.109e+2(4.33e+0)-	3.836e+1(2.00e+1)-	6.070e-1(2.82e-1)+	6.652e-1(1.88e-3)
	500	3.743e+2(1.21e+2)-	1.583e+2(2.56e+1)-	6.852e+1(2.95e+1)-	1.294e+0(6.74e-1)-	7.394e-1(2.21e-2)
LMF2	100	1.282e+0(1.75e-1)-	1.248e+0(1.22e-1)-	1.156e+0(5.90e-2)-	7.651e-1(5.98e-2)-	2.416e-1(7.04e-3)
	300	1.746e+0(1.52e-1)-	2.104e+0(2.23e-1)-	1.549e+0(4.86e-2)-	8.668e-1(3.64e-2)-	2.543e-1(3.78e-3)
	500	2.389e+0(1.39e-1)-	2.335e+0(5.23e-1)-	2.007e+0(2.35e-1)-	1.535e+0(2.78e-1)-	2.516e-1(2.64e-3)
LMF3	100	7.096e-1(6.87e-2)-	6.864e-1(1.69e-2)-	1.061e+0(9.65e-2)-	5.949e-1(7.15e-2)-	5.901e-1(8.46e-2)
	300	9.127e+0(1.44e-1)-	1.288e+1(1.69e+0)-	3.700e+0(9.75e-2)-	7.278e-1(3.42e-2)+	7.353e-1(5.99e-2)
	500	1.665e+1(2.32e+0)-	1.871e+1(8.51e+0)-	8.031e+0(7.69e-1)-	1.423e+0(7.34e-1)-	1.316e+0(2.25e-1)
LMF4	100	4.791e+0(1.43e-1)-	1.738e+0(8.64e-1)-	2.195e+0(6.13e-1)-	4.428e-1(1.12e-2)+	5.451e-1(1.64e-2)
	300	2.859e+1(5.37e+0)-	2.875e+1(5.69e+0)-	7.007e+0(2.74e-1)-	6.031e-1(2.86e-2)+	6.173e-1(2.36e-2)
	500	4.857e+1(1.16e+0)-	3.499e+1(3.32e+0)-	1.333e+1(6.25e+0)-	1.302e+0(6.67e-1)-	6.647e-1(1.56e-2)
LMF5	100	2.111e+0(4.44e-2)-	7.721e-1(1.07e-2)-	1.291e+0(4.45e-2)-	7.648e-1(6.05e-2)-	2.019e-1(2.34e-3)
	300	5.976e+0(7.67e-1)-	2.187e+0(3.69e-1)-	3.588e+0(2.68e-2)-	8.663e-1(3.63e-2)-	2.447e-1(7.85e-3)
	500	6.399e+0(1.12e-1)-	3.499e+0(1.82e+0)-	5.029e+0(3.57e-2)-	1.533e+0(4.62e-1)-	3.387e-1(6.98e-2)
LMF6	100	1.288e+0(1.12e-1)-	6.547e-1(3.05e-3)-	8.241e-1(1.39e-1)-	5.950e-1(8.37e-2)-	5.800e-1(1.03e-3)
	300	2.958e+0(3.09e-1)-	2.703e+0(3.48e-2)-	1.982e+0(2.48e-1)-	7.250e-1(3.44e-2)-	6.865e-1(7.49e-3)
	500	3.913e+0(9.76e-1)-	3.601e+0(1.67e-1)-	3.697e+0(3.89e-1)-	1.422e+0(5.33e-1)-	6.940e-1(1.65e-2)
LMF7	100	1.565e+1(4.33e+0)-	1.941e+0(4.30e+0)-	7.898e+0(1.27e-1)-	4.442e-1(1.35e-3)+	7.403e-1(9.08e-3)
	300	4.687e+1(3.08e+0)-	4.452e+1(3.76e+0)-	1.541e+1(7.83e+0)-	6.031e-1(2.86e-3)+	7.828e-1(5.21e-3)
	500	1.036e+2(8.58e+0)-	5.997e+1(2.66e+1)-	3.531e+1(1.01e+0)-	1.274e+0(6.78e-1)-	8.561e-1(8.27e-3)
LMF8	100	1.195e+1(9.87e+0)-	9.346e-1(2.39e-2)-	7.799e+0(4.47e+0)-	5.959e-1(8.69e-2)+	8.916e-1(1.27e-3)
	300	2.417e+1(2.66e+0)-	1.211e+1(4.06e-1)-	9.636e+0(1.20e+0)-	7.253e-1(3.43e-2)+	8.769e-1(9.72e-3)
	500	3.627e+1(1.33e+0)-	2.213e+1(1.22e+1)-	9.730e+0(3.83e+0)-	1.417e+0(7.43e-1)-	9.700e-1(2.42e-3)
+/-/-		0/0/24	0/0/24	0/0/24	9/0/15	—

LSMOPs	D	LERD(std)	IMCMOEAD(std)	MTEA-DTSD(std)	MTDE-MKTA(std)	MKREV-MTO(std)
LMF1	500	7.421e-1(0.00e+0)-	7.421e-1(0.00e+0)-	3.238e+0(1.08e-1)-	8.280e-1(1.14e-1)-	6.436e-1(2.58e-2)
	700	7.421e-1(0.00e+0)-	7.421e-1(0.00e+0)-	4.780e+0(6.53e-1)-	1.469e+0(7.54e-2)-	7.182e-1(1.43e-1)
	1000	7.421e-1(0.00e+0)+	7.421e-1(0.00e+0)+	5.420e+0(8.02e-1)-	1.780e+0(2.60e-1)-	9.817e-1(2.26e-1)
LMF2	500	4.635e-1(3.31e-2)-	6.615e-1(1.50e-3)-	1.251e+0(6.13e-1)-	1.091e+0(1.12e-1)-	4.285e-1(2.51e-3)
	700	4.106e-1(2.72e-3)+	5.898e-1(5.57e-2)-	2.458e+0(3.67e-1)-	1.704e+0(4.68e-2)-	4.421e-1(1.12e-3)
	1000	4.425e-1(1.46e-2)-	5.733e-1(8.10e-2)-	1.560e+0(5.21e-1)-	2.028e+0(1.35e-2)-	4.133e-1(7.57e-3)
LMF3	500	7.071e-1(3.59e-3)-	7.071e-1(5.04e-3)-	2.266e+0(9.23e-1)-	9.798e-1(1.06e-1)-	6.656e-1(1.62e-2)
	700	7.071e-1(8.01e-3)-	7.071e-1(4.18e-3)-	2.154e+0(4.71e-1)-	1.628e+0(4.89e-2)-	6.693e-1(8.57e-2)
	1000	7.071e-1(2.64e-3)+	7.071e-1(5.56e-3)+	1.390e+0(3.78e-1)-	1.934e+0(1.26e-1)-	8.952e-1(1.33e-1)
LMF4	500	5.374e-1(6.31e-3)-	5.392e-1(3.64e-3)-	2.752e+0(3.45e-1)-	8.283e-1(1.12e-1)-	4.947e-1(2.88e-2)
	700	5.435e-1(5.34e-3)-	5.286e-1(1.54e-2)-	3.531e+0(5.44e-1)-	1.465e+0(7.64e-2)-	5.268e-1(4.39e-2)
	1000	5.395e-1(2.49e-2)-	5.394e-1(6.02e-2)-	9.182e+0(1.42e+0)-	1.779e+0(2.49e-2)-	5.308e-1(5.08e-2)
LMF5	500	6.616e-1(4.74e-3)-	6.616e-1(2.23e-3)-	8.710e-1(1.36e+0)-	1.091e+0(1.09e-1)-	4.683e-1(2.54e-2)
	700	6.616e-1(4.98e-3)-	6.616e-1(5.28e-3)-	5.663e+0(4.03e+0)-	1.703e+0(4.75e-2)-	6.320e-1(3.15e-2)
	1000	6.616e-1(1.57e-4)-	6.616e-1(7.14e-3)-	9.034e+0(7.94e-1)-	2.026e+0(7.73e-2)-	5.389e-1(4.65e-2)
LMF6	500	7.468e-1(3.47e-2)-	6.958e-1(4.38e-3)-	1.449e+0(1.64e+0)-	9.747e-1(1.10e-1)-	5.987e-1(8.84e-3)
	700	7.670e-1(5.53e-2)-	7.032e-1(6.86e-3)-	5.028e+0(7.15e+0)-	1.623e+0(5.31e-2)-	5.304e-1(1.46e-2)
	1000	7.823e-1(3.10e-3)-	7.056e-1(4.39e-3)-	7.535e+0(4.08e+0)-	1.937e+0(3.56e-2)-	5.324e-1(5.78e-3)
LMF7	500	6.949e-1(1.97e-2)-	6.020e-1(5.84e-3)+	6.729e+0(4.52e+0)-	8.296e-1(1.13e-1)-	6.495e-1(9.69e-3)
	700	7.587e-1(9.28e-2)-	6.519e-1(1.55e-2)+	1.528e+0(2.81e+0)-	1.465e+0(7.40e-2)-	7.219e-1(3.55e-1)
	1000	6.600e-1(3.16e-2)+	7.337e-1(5.41e-2)+	1.185e+0(5.08e-1)+	1.794e+0(1.83e-2)-	1.299e+0(5.19e+0)
LMF8	500	9.236e-1(3.94e-2)-	8.615e-1(2.49e-3)-	3.557e+0(1.78e+0)-	9.710e-1(1.10e-1)-	8.317e-1(3.92e-3)
	700	8.910e-1(4.41e-2)+	8.182e-1(6.28e-2)+	1.718e+0(4.10e+0)-	1.626e+0(5.18e-2)-	8.945e-1(1.48e-2)
	1000	9.929e-1(1.41e-1)-	8.633e-1(1.74e-2)=	1.443e+0(6.27e-1)-	1.932e+0(2.93e-2)-	8.634e-1(3.50e-2)
O-N-solutions		4	6	0	0	17
+/-/-		5/0/19	6/1/17	1/0/23	0/0/24	—
Friedman's test		2.3958	2.1250	4.7500	4.2083	1.5208

TABLE S6
THE AVERAGE IGD RESULTS OF MKREV-MTO AND ITS FOUR COMPETITORS ON LMF ($M=3$) BENCHMARKS

LSMOPs	D	LERD(std)	IMCMOEAD(std)	MTEA-DTSD(std)	MTDE-MKTA(std)	MKREV-MTO(std)
LMF1	500	8.234e-1(1.18e-1)-	7.832e-1(1.15e-1)-	2.554e+1(7.19e-1)-	1.847e+0(4.07e-1)-	7.394e-1(2.21e-2)
	700	8.419e-1(8.98e-2)-	8.207e-1(2.07e-2)+	2.828e+1(2.60e+0)-	2.729e+0(5.76e-1)-	8.229e-1(5.12e-2)
	1000	1.313e+0(8.36e-1)-	9.459e-1(7.52e-2)+	8.008e+1(2.92e+0)-	3.687e+0(7.17e-1)-	1.115e+0(2.86e-1)
LMF2	500	2.785e-1(3.78e-3)-	4.319e-1(2.02e-1)-	1.065e+0(9.07e-2)-	2.207e+0(6.59e-1)-	2.516e-1(2.64e-3)
	700	2.751e-1(3.80e-2)-	4.352e-1(6.67e-1)-	1.529e+0(1.42e-1)-	3.021e+0(3.26e-1)-	2.719e-1(1.52e-2)
	1000	4.207e-1(2.04e-1)-	7.221e-1(2.65e-1)-	1.982e+0(6.19e-1)-	3.987e+0(4.73e-1)-	3.032e-1(7.97e-2)
LMF3	500	8.607e-1(0.00e+0)+	8.607e-1(0.00e+0)+	1.944e+0(1.52e-1)-	2.088e+0(6.48e-1)-	1.316e+0(2.25e-1)
	700	8.607e-1(0.00e+0)+	8.607e-1(0.00e+0)+	1.821e+0(1.64e-1)+	2.875e+0(4.77e-1)-	2.057e+0(8.82e-1)
	1000	8.607e-1(0.00e+0)+	8.607e-1(0.00e+0)+	2.904e+0(8.27e-1)+	3.964e+0(4.63e-1)+	4.576e+0(5.22e+0)
LMF4	500	7.329e-1(2.90e-2)-	8.147e-1(2.79e-2)-	1.887e+0(3.04e-1)-	1.934e+0(2.35e-1)-	6.647e-1(1.56e-2)
	700	8.153e-1(6.23e-2)-	8.284e-1(3.29e-2)-	3.387e+0(3.60e-1)-	2.715e+0(5.73e-1)-	7.662e-1(1.71e-2)
	1000	7.672e-1(2.81e-1)-	8.282e-1(1.93e-1)-	6.787e+0(1.55e+0)-	3.806e+0(4.90e-1)-	7.501e-1(1.16e-1)
LMF5	500	2.723e-1(1.81e-2)+	6.386e-1(4.64e-1)-	1.464e+0(1.23e-1)-	2.144e+0(7.06e-1)-	3.387e+0(6.98e-2)
	700	2.711e-1(7.40e-2)+	8.193e-1(3.73e-2)-	2.011e+0(6.32e-1)-	3.027e+0(1.09e-1)-	3.608e-1(5.94e-3)
	1000	4.050e-1(6.30e-2)+	8.768e-1(5.69e-1)-	2.803e+0(4.01e-1)-	4.156e+0(4.85e-1)-	4.461e-1(1.10e-2)
LMF6	500	8.607e-1(5.56e-4)-	8.564e-1(3.03e-2)-	1.905e+0(5.47e-2)-	2.127e+0(6.19e-1)-	6.940e-1(1.65e-2)
	700	8.607e-1(3.32e-4)-	8.607e-1(1.69e-3)-	2.627e+0(3.14e-1)-	2.910e+0(1.42e-1)-	7.702e-1(2.43e-2)
	1000	8.607e-1(3.32e-4)-	8.607e-1(8.22e-3)-	2.616e+0(1.11e-1)-	3.967e+0(5.05e-1)-	7.993e-1(3.27e-2)
LMF7	500	1.253e+0(5.89e-1)-	9.585e-1(4.19e-2)-	2.975e+0(9.52e-1)-	1.907e+0(5.97e-1)-	8.561e-1(8.27e-3)
	700	8.070e-1(4.73e-2)+	9.772e-1(4.98e-2)-	6.517e+0(7.62e-1)-	2.692e+0(3.25e-1)-	9.783e-1(1.29e-2)
	1000	1.672e+0(8.89e-1)-	9.879e-1(1.18e-1)+	1.184e+1(4.12e+0)-	3.728e+0(6.43e-1)-	1.029e+0(1.09e-1)
LMF8	500	9.654e-1(4.84e-3)+	9.780e-1(4.15e-3)-	2.886e+0(2.33e-1)-	2.088e+0(7.81e-1)-	9.700e-1(2.42e-3)
	700	9.712e-1(5.93e-2)-	9.744e-1(7.19e-1)-	2.848e+0(5.50e-1)-	2.891e+0(4.97e-1)-	9.597e-1(1.31e-2)
	1000	9.610e-1(4.19e-1)+	9.808e-1(5.31e-1)+	4.247e+0(3.94e-1)-	3.863e+0(5.60e-1)-	1.367e+0(3.08e-1)
O-N-solutions		9	6	0	0	12
+/-/-		9/0/15	7/0/17	2/0/22	1/0/23	—
Friedman's test		1.9792	2.3125	4.3333	4.5417	1.8333

TABLE S7
PARAMETERS SETTINGS OF ALL THE COMPARED ALGORITHMS

Algorithms	Parameters settings
LMEA	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, nSel = 5, nPer = 5, nCor = 6$
LSMOF	$CR = 1, F = 0.5, p_m = 1/n, \eta_m = 15, NCA = 20, NIA = 6$
LMOCSO	$p_m = 1/n, \eta_m = 20, \alpha = 2$
MOEA-PSL	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, epochs = 10, \eta = 0.1$
DGEA	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, RefNo = 10$
ALMOEA	$p_m = 1/n, \eta_m = 20, epochs = 1, momentum = 0$
MOMFEA	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, rmp = 0.9$
MOMFEA-SADE	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, rmp = 0.3, \alpha = 0.6, \beta = 0.5, e = 60$
EMaTo-MKT	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, amp = 0.1, l = 5, C = 10$
MTEA-DDN	$F = 0.5, CR = 0.9, p_m = 1/n, \eta_m = 20, \beta = 0.2, T = 20$
DRNEA	$p_c = 1, p_m = 1/n, \eta_c = 20, \eta_m = 20, epochs = 1, \eta = 0.1, \lambda = N/10$
LERD	$F = 0.5, CR = 1, p_m = 1/n, \eta_m = 20, sN = 3, NB = 10$
IMCMOEAD	$p_m = 1/n, \eta_m = 20, K = 10, NB = 10$
MTEA-DTSD	$F = 0.5, CR = 0.9, p_m = 1/n, \eta_m = 15, tr = 0.2, SNum = 10, CF = 0.4, NR = 2, Delta = 0.9$
MTDE-MKTA	$F = 0.2+rand, CR = rand, TR = rand, KP = rand, \alpha = 0.5, \tau_{kt} = 0.1, \tau_{eo} = 0.2$

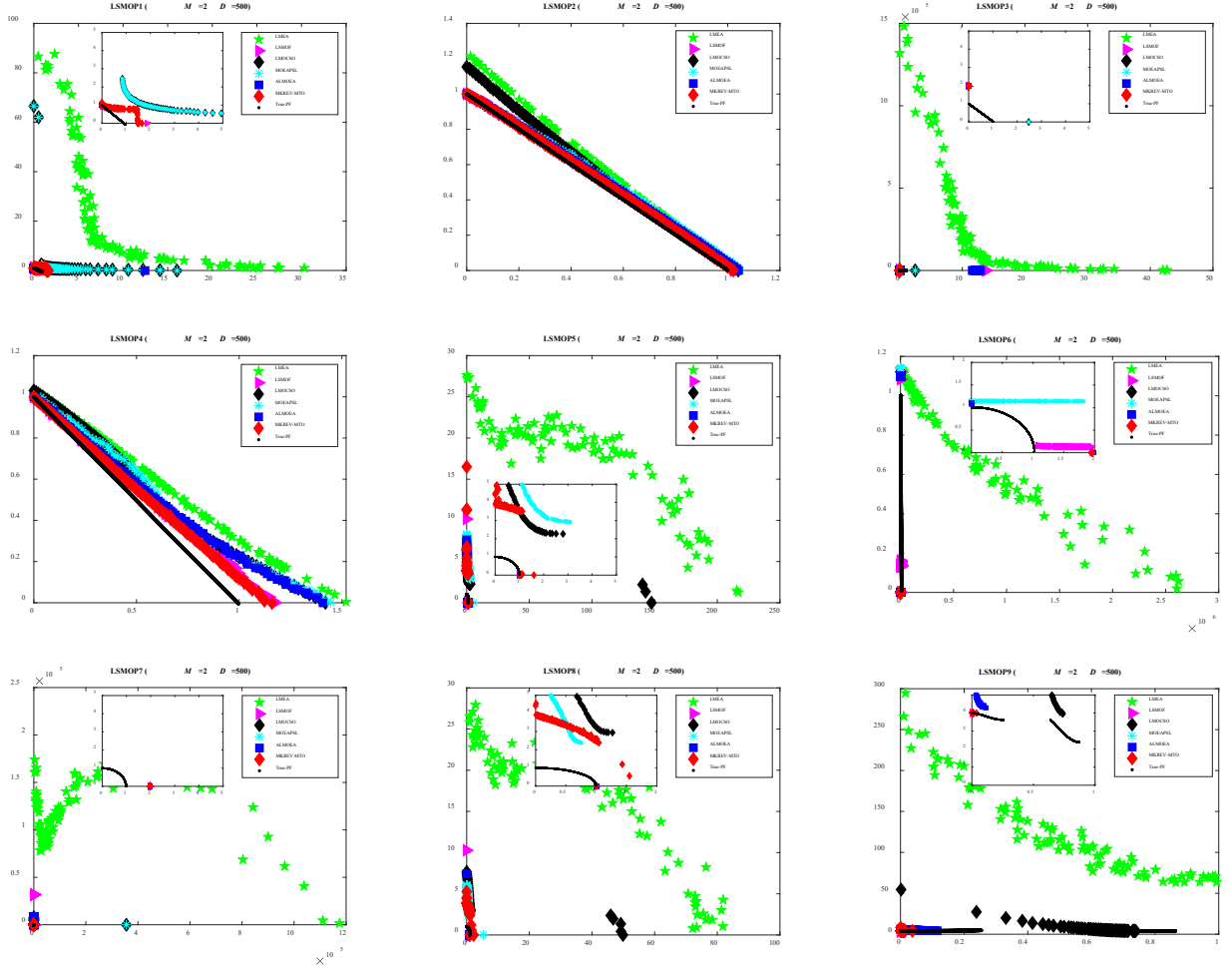
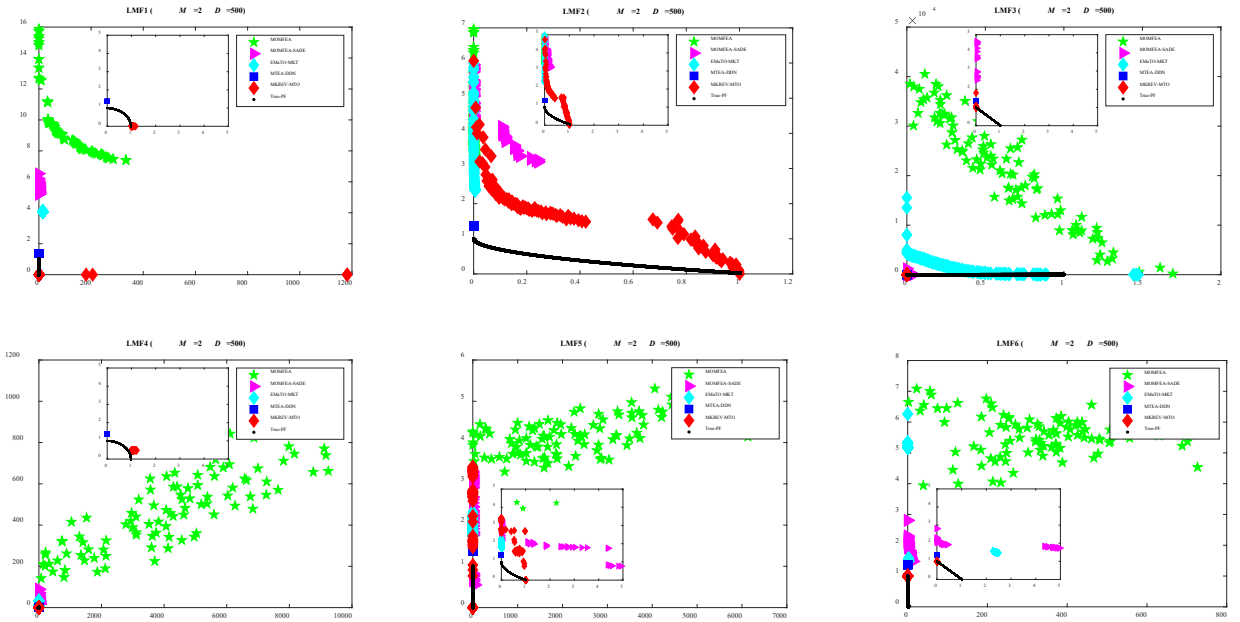


Fig. S1 The final non-dominated solutions obtained by six LSMOAs on 2-objective LSMOP ($D=500$).



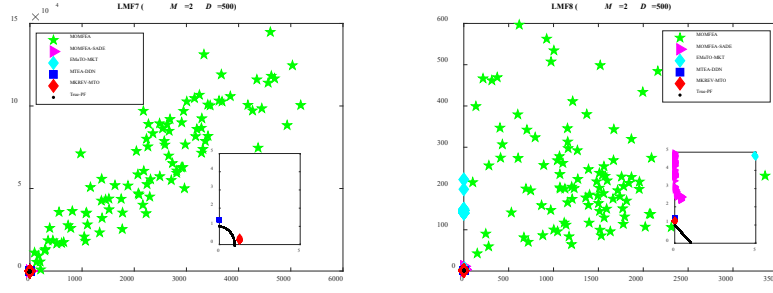
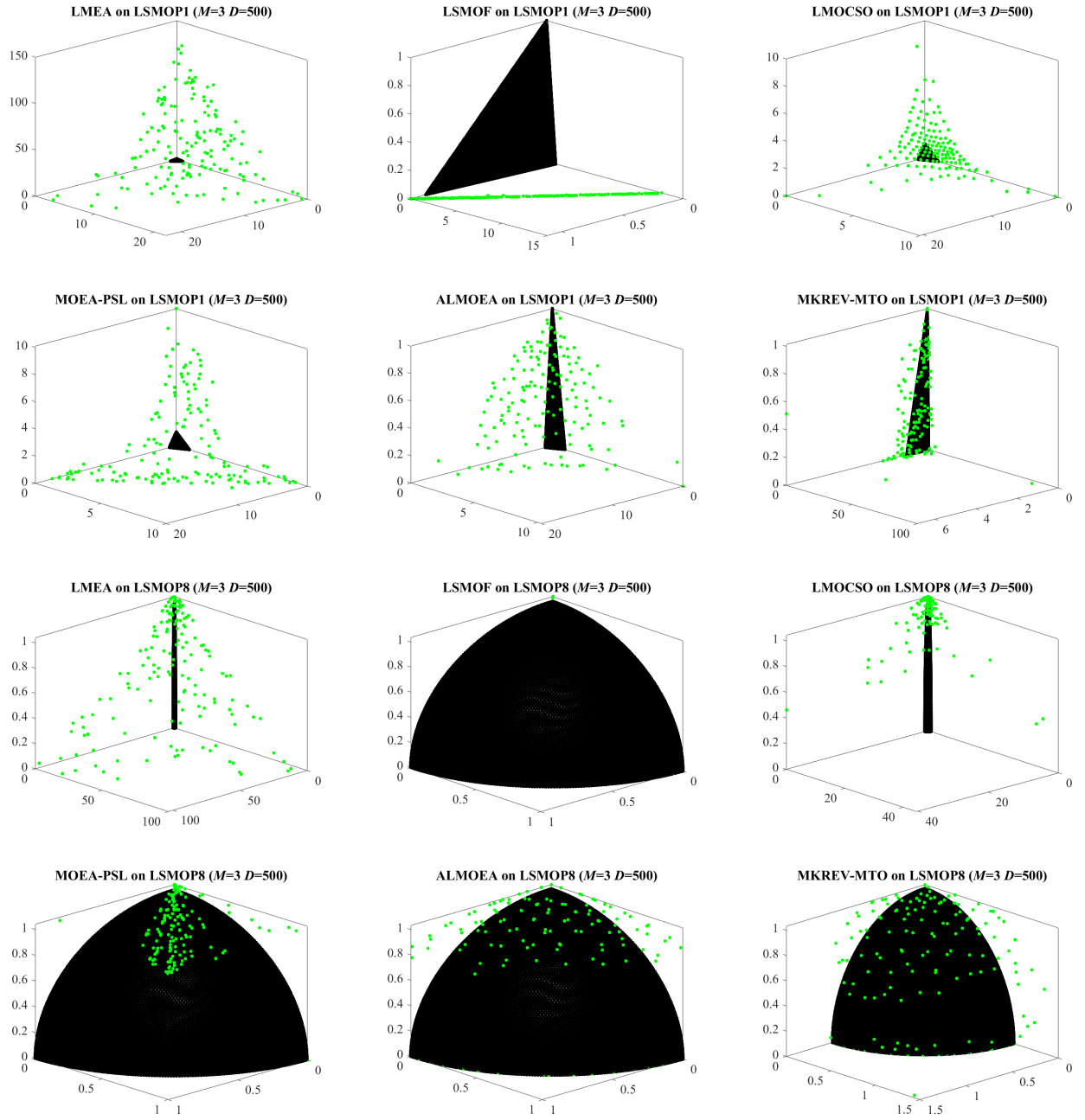
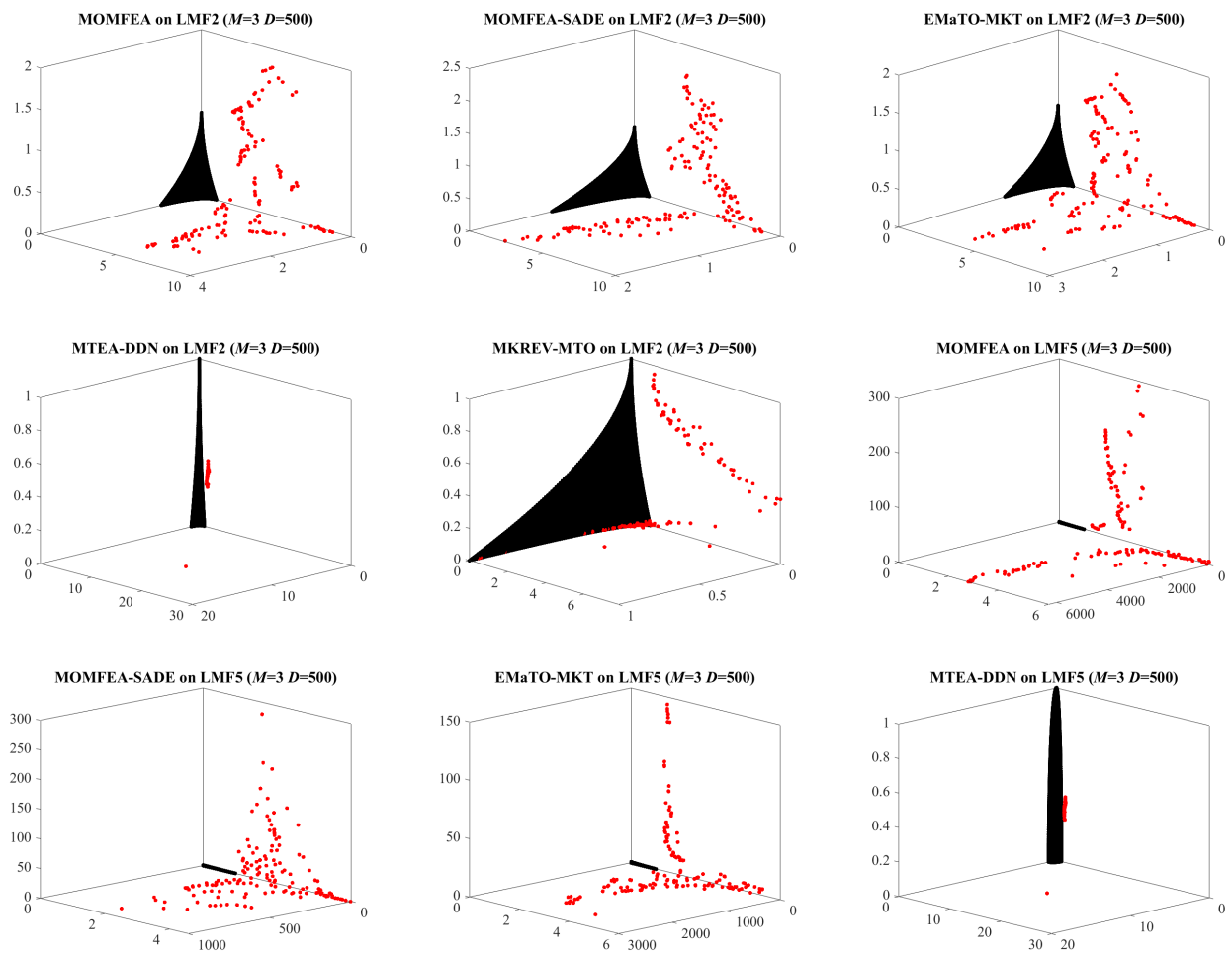
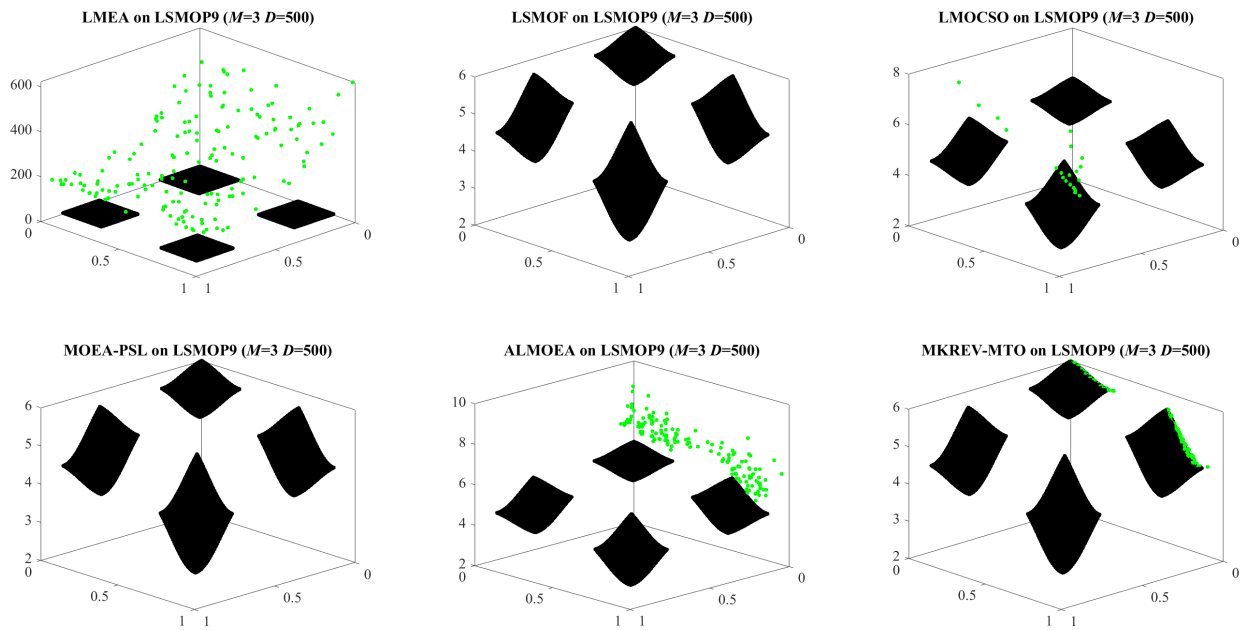


Fig. S2 The final non-dominated solutions obtained by five EMOs on 2-objective LMF ($D=500$).





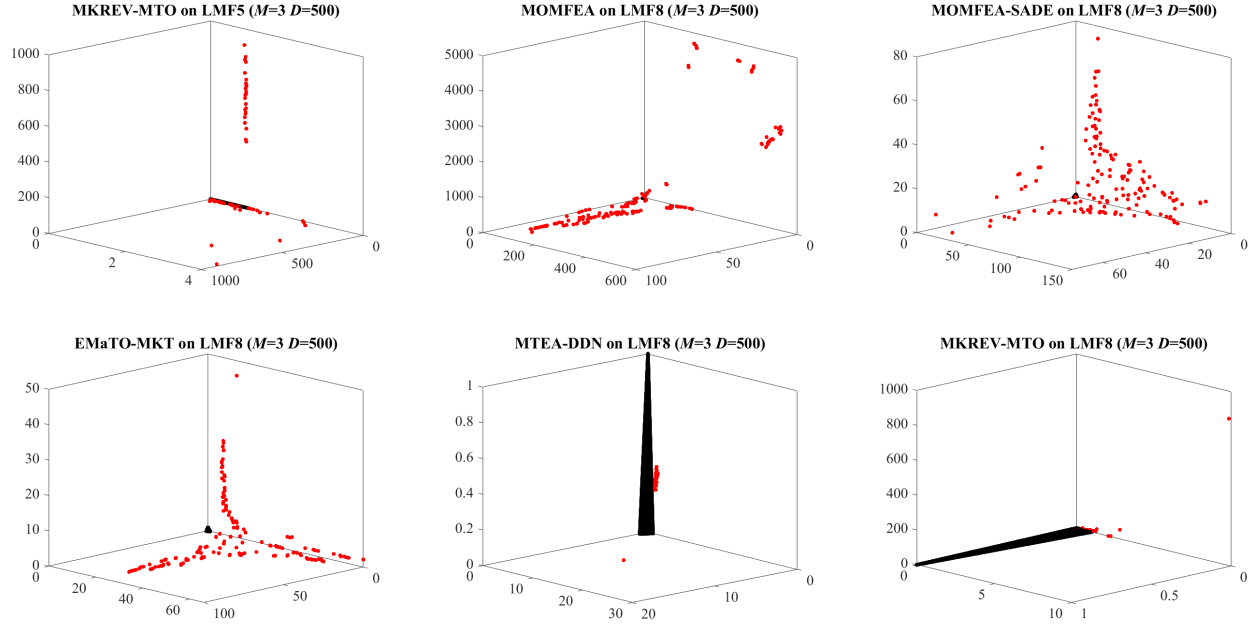


Fig. S4 The final non-dominated solutions obtained by five EMTOAs on 3-objective LMF2, LMF5, and LMF8 with $D=500$.

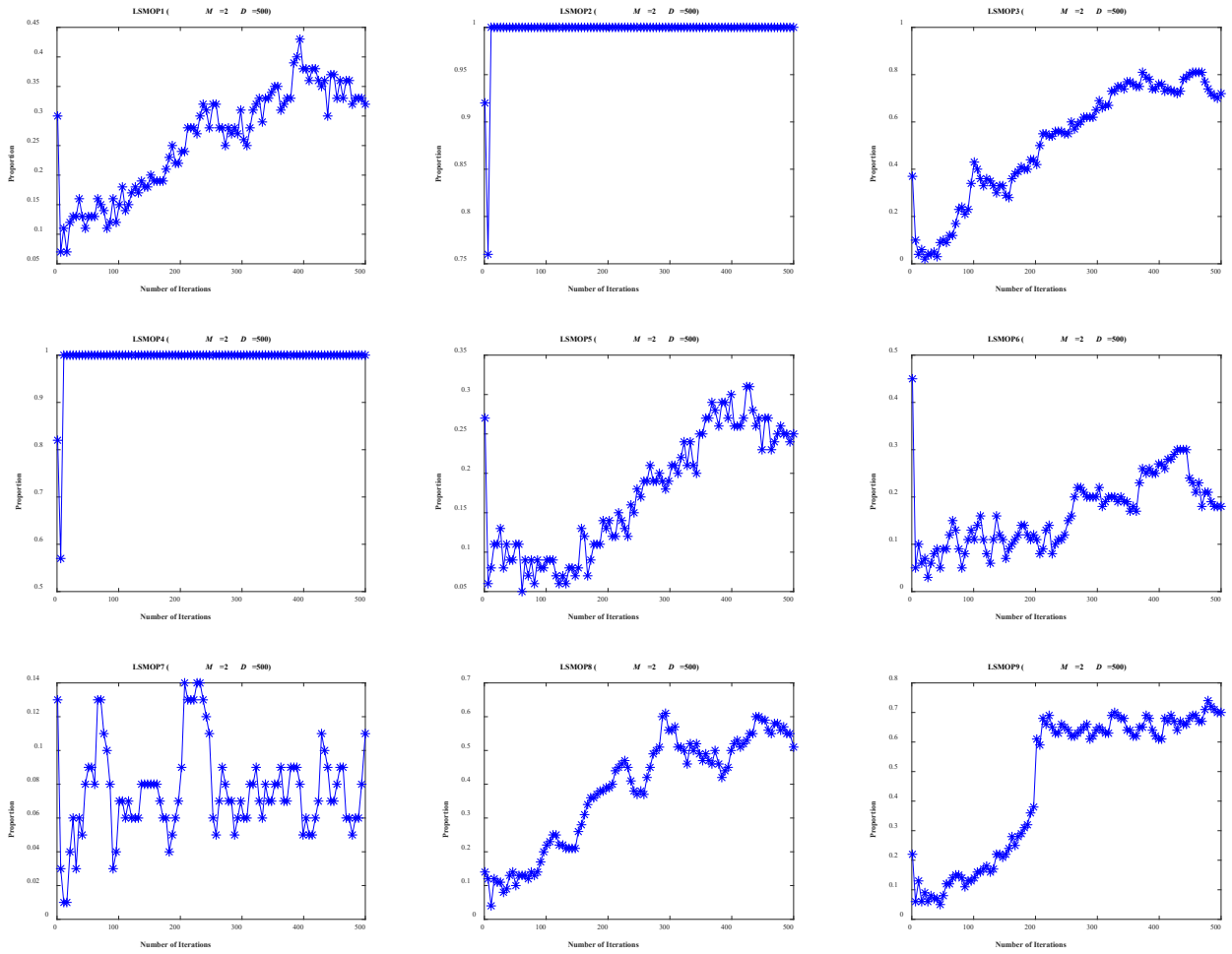


Fig. S5 The proportion of non-dominated solutions in the population obtained by MKREV-MTO on LSMOP ($M=2$, $D=500$).

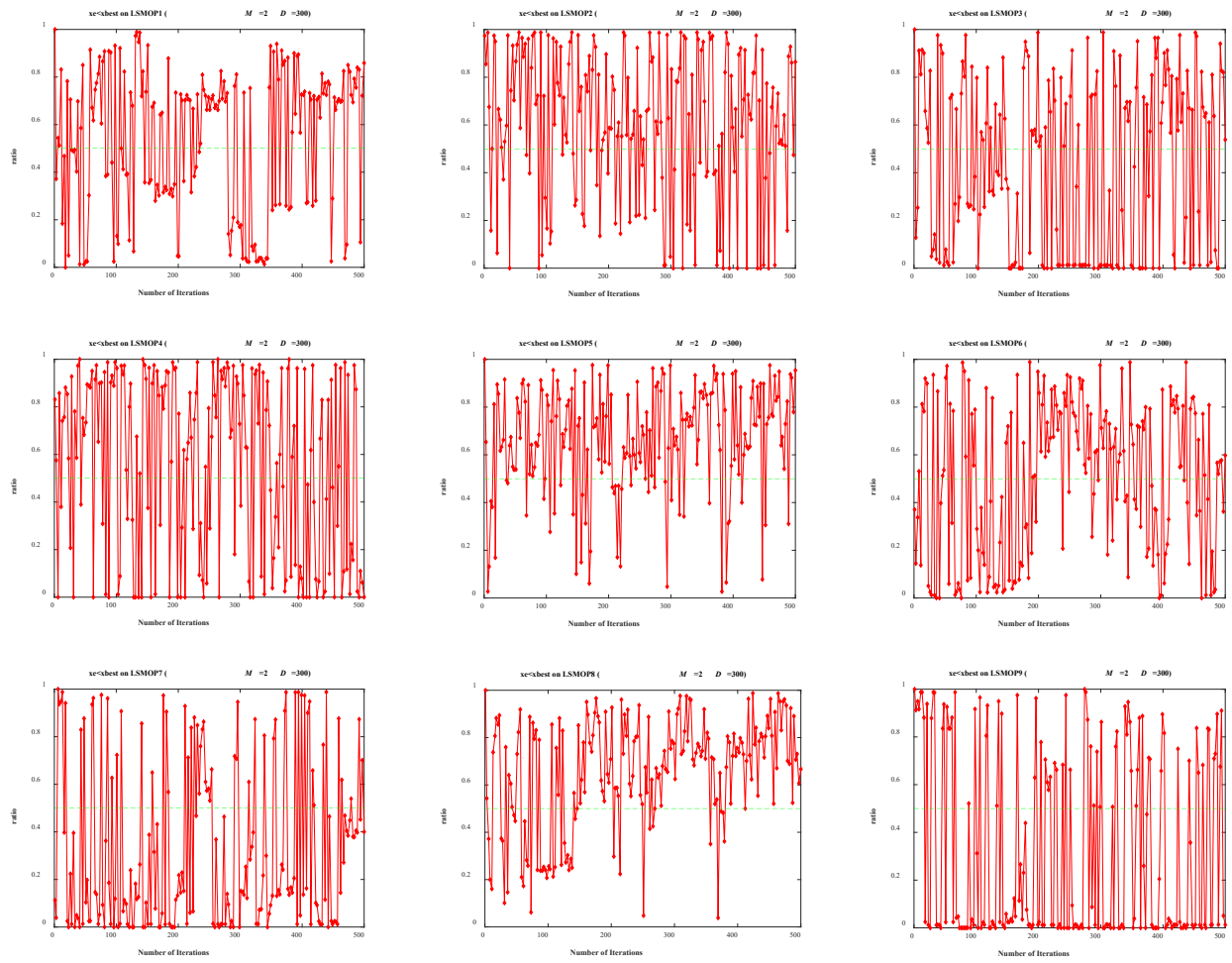
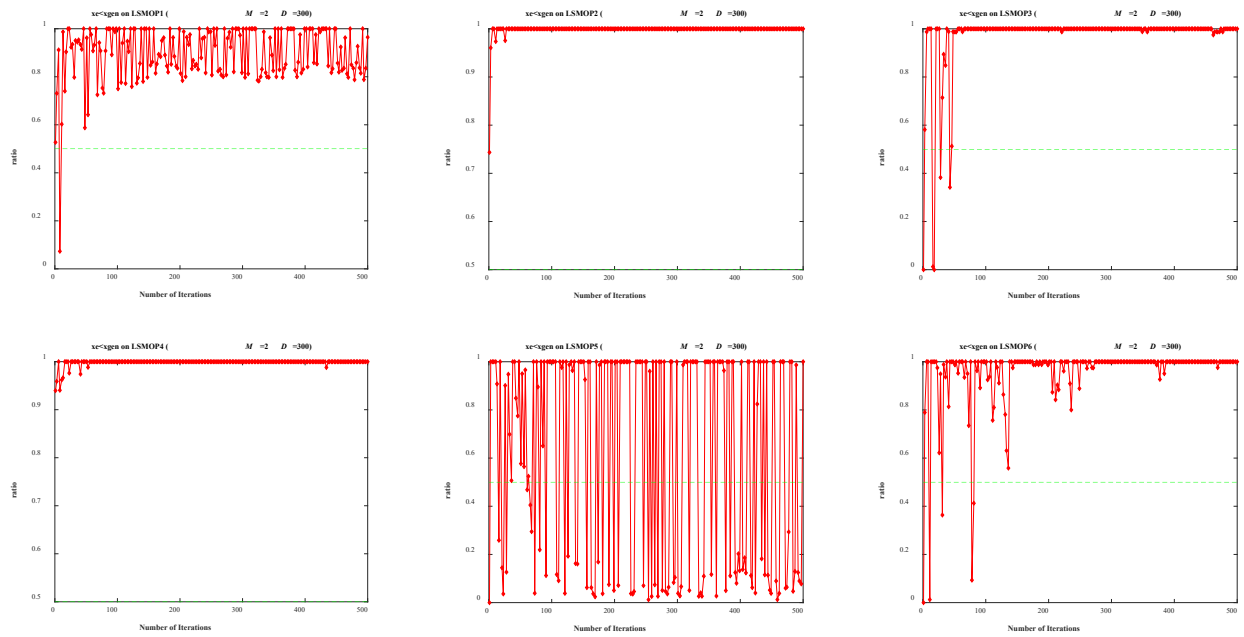


Fig. S6 The ratio of x_{best} to the population changes during evolution.



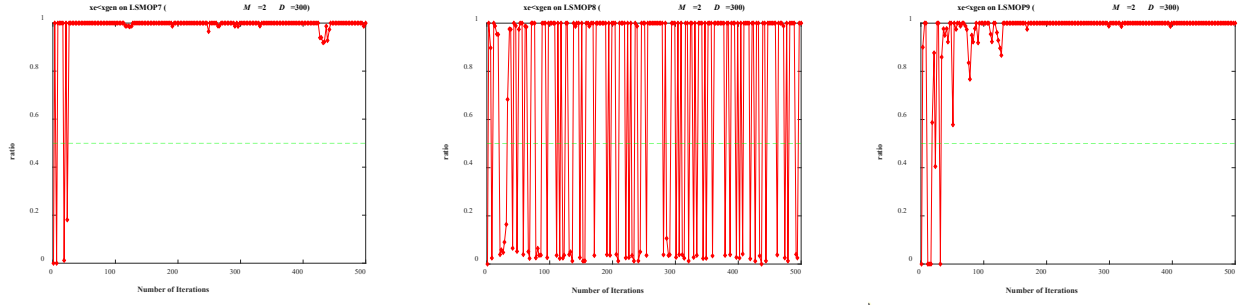


Fig. S7 The ratio of $x_e \times x_{gen}$ to the population changes during evolution.

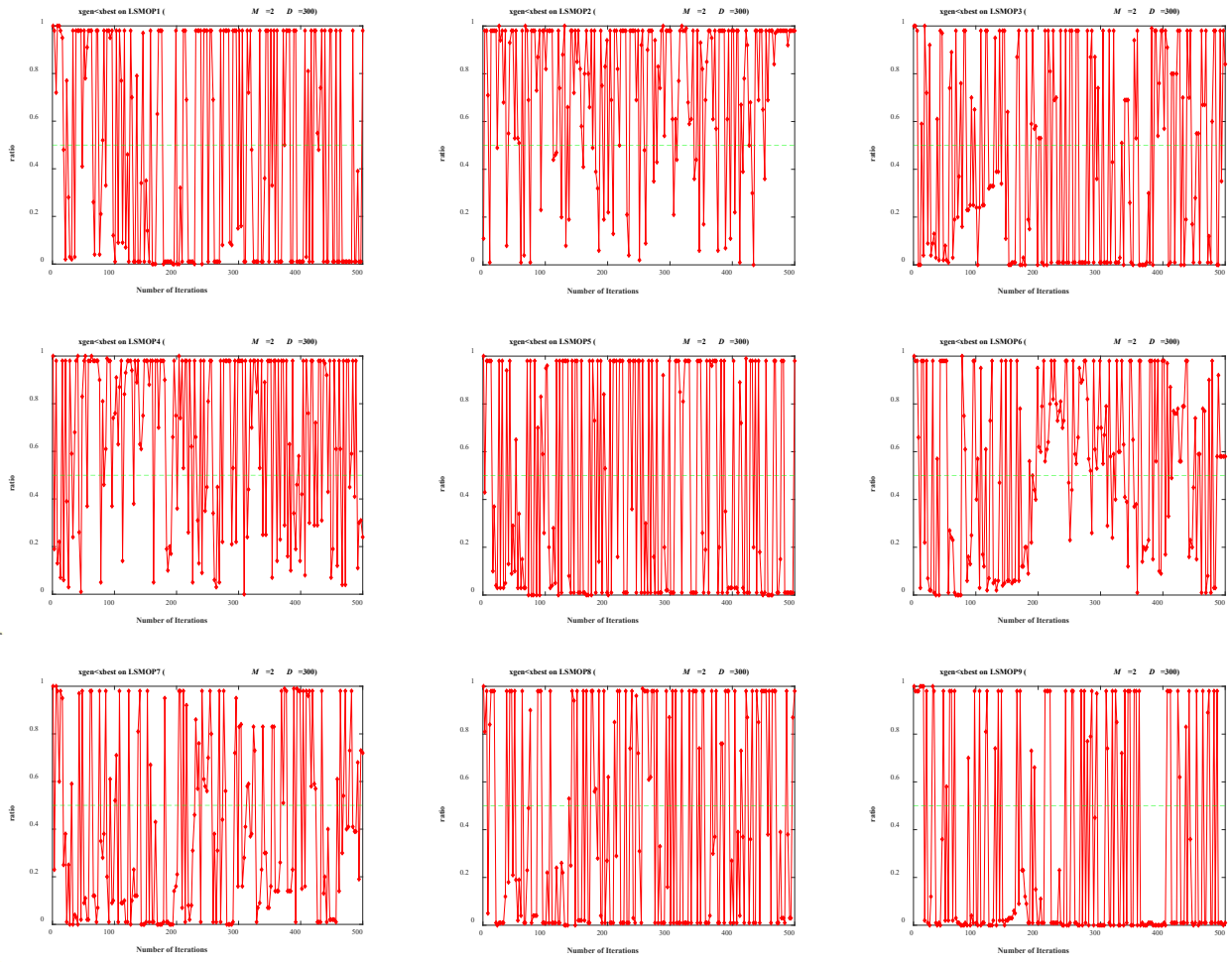


Fig. S8 The ratio of $x_{gen} \times x_{best}$ to the population changes during evolution.

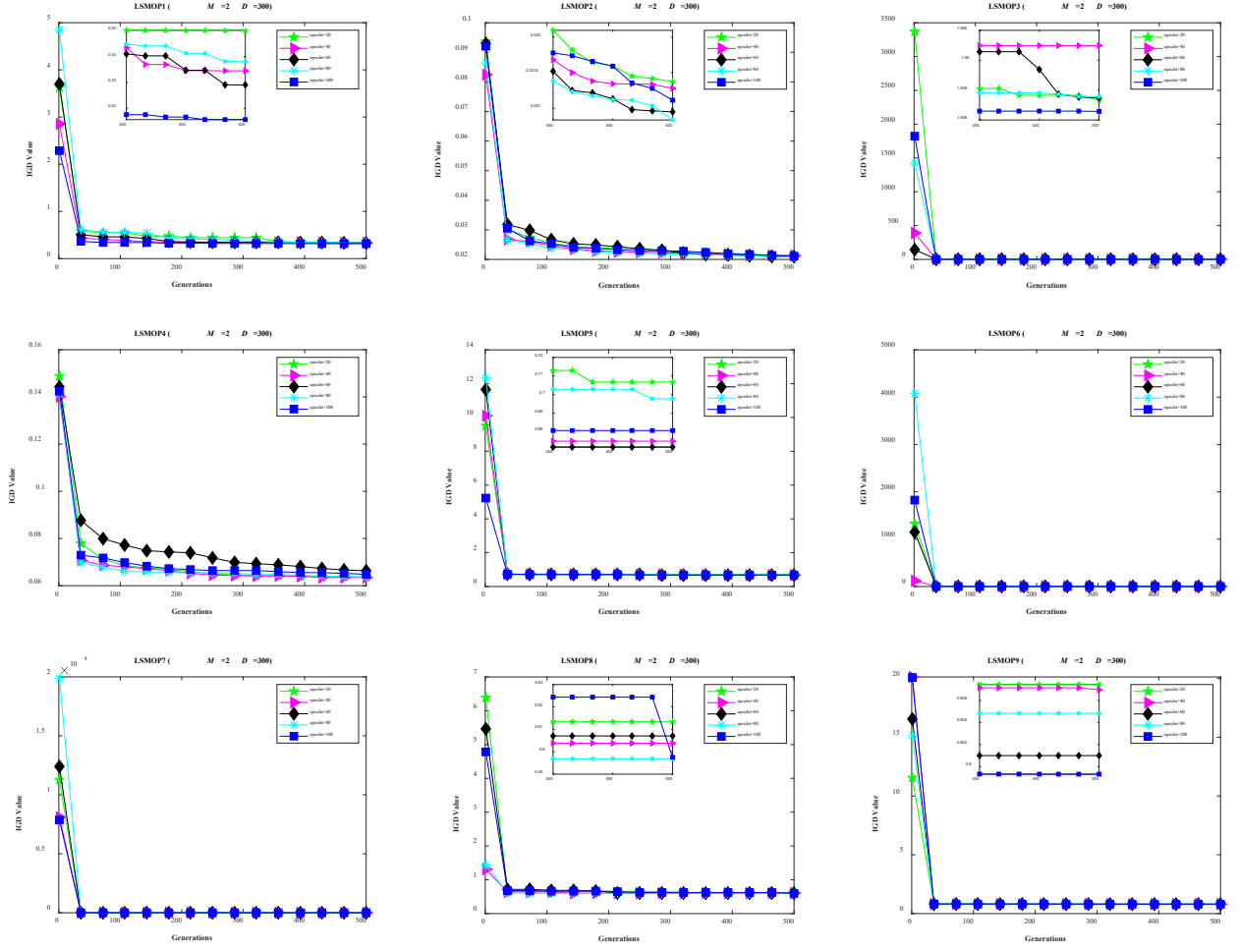
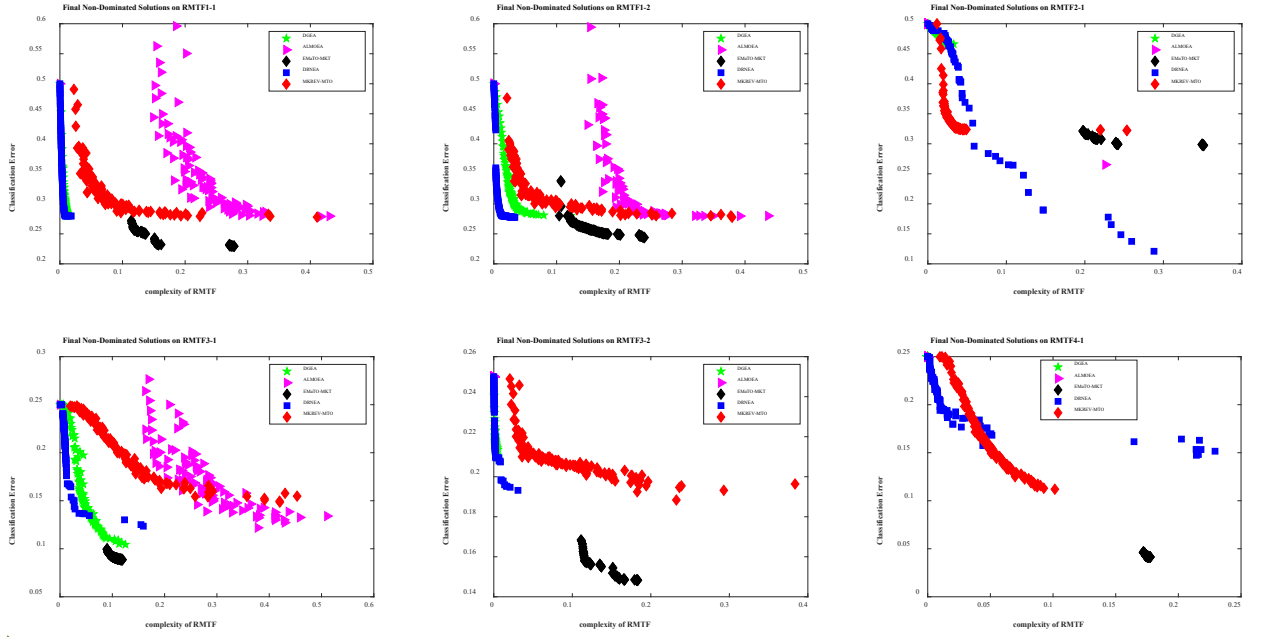


Fig. S9 The average IGD results obtained by MKREV-MTO with different *epochs* on LSMOP.



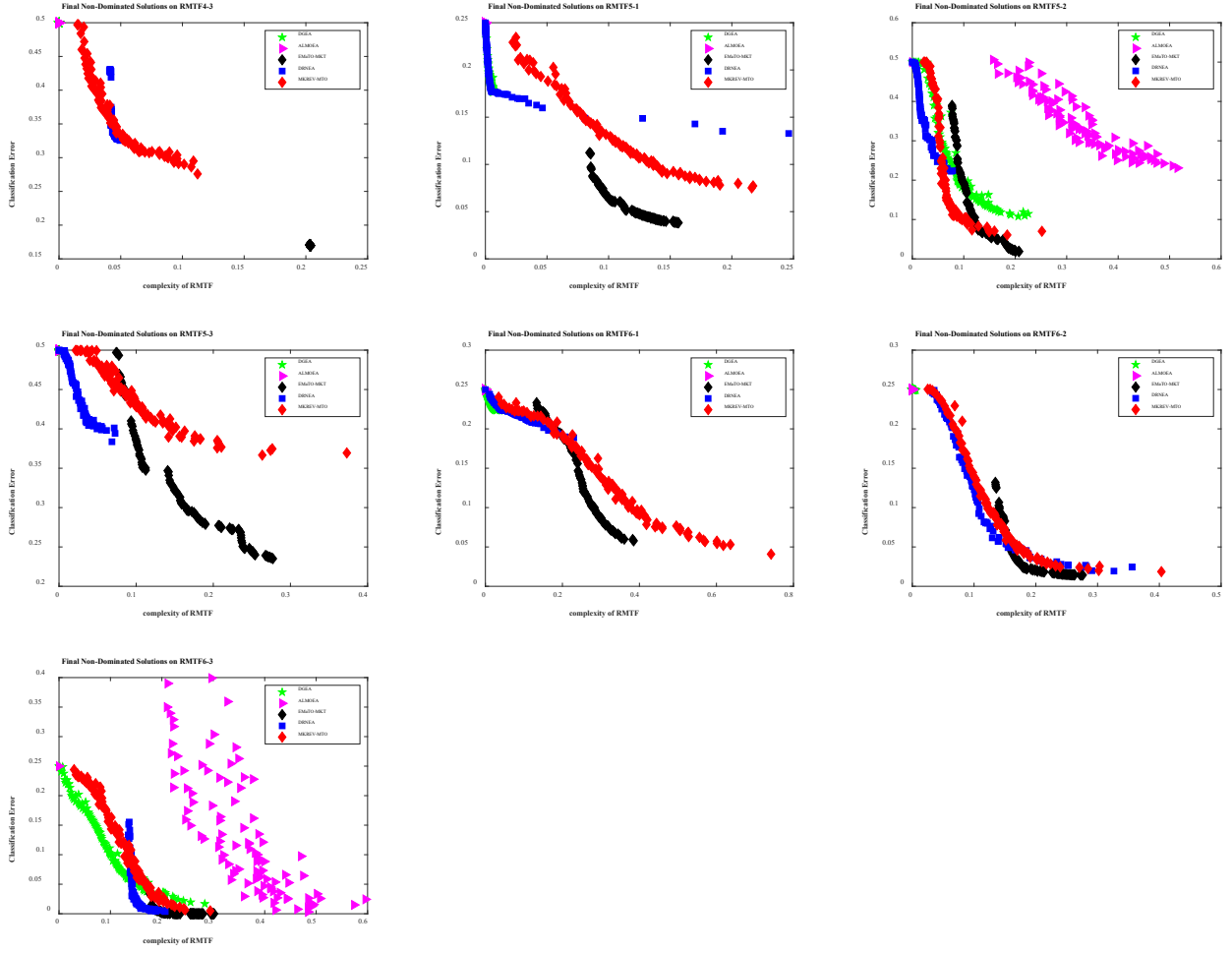
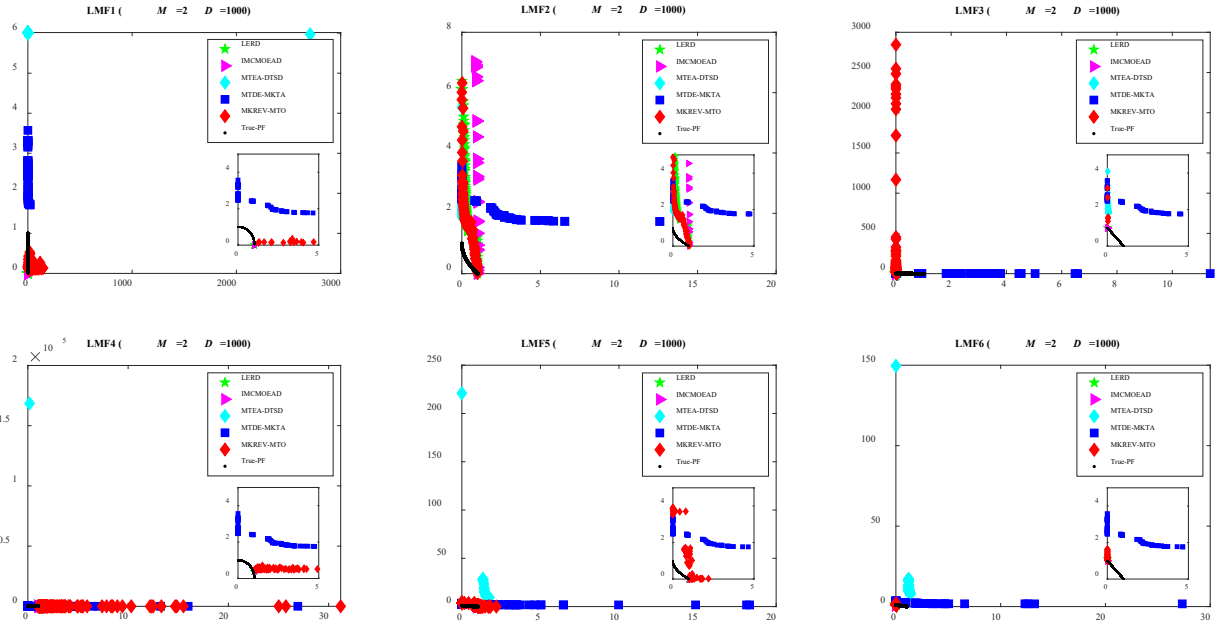


Fig. S10 The final non-dominated solutions gained by MKREV-MTO and its four competitors on RMFT.



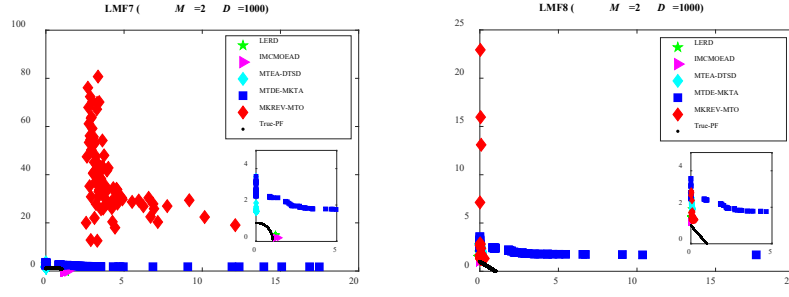
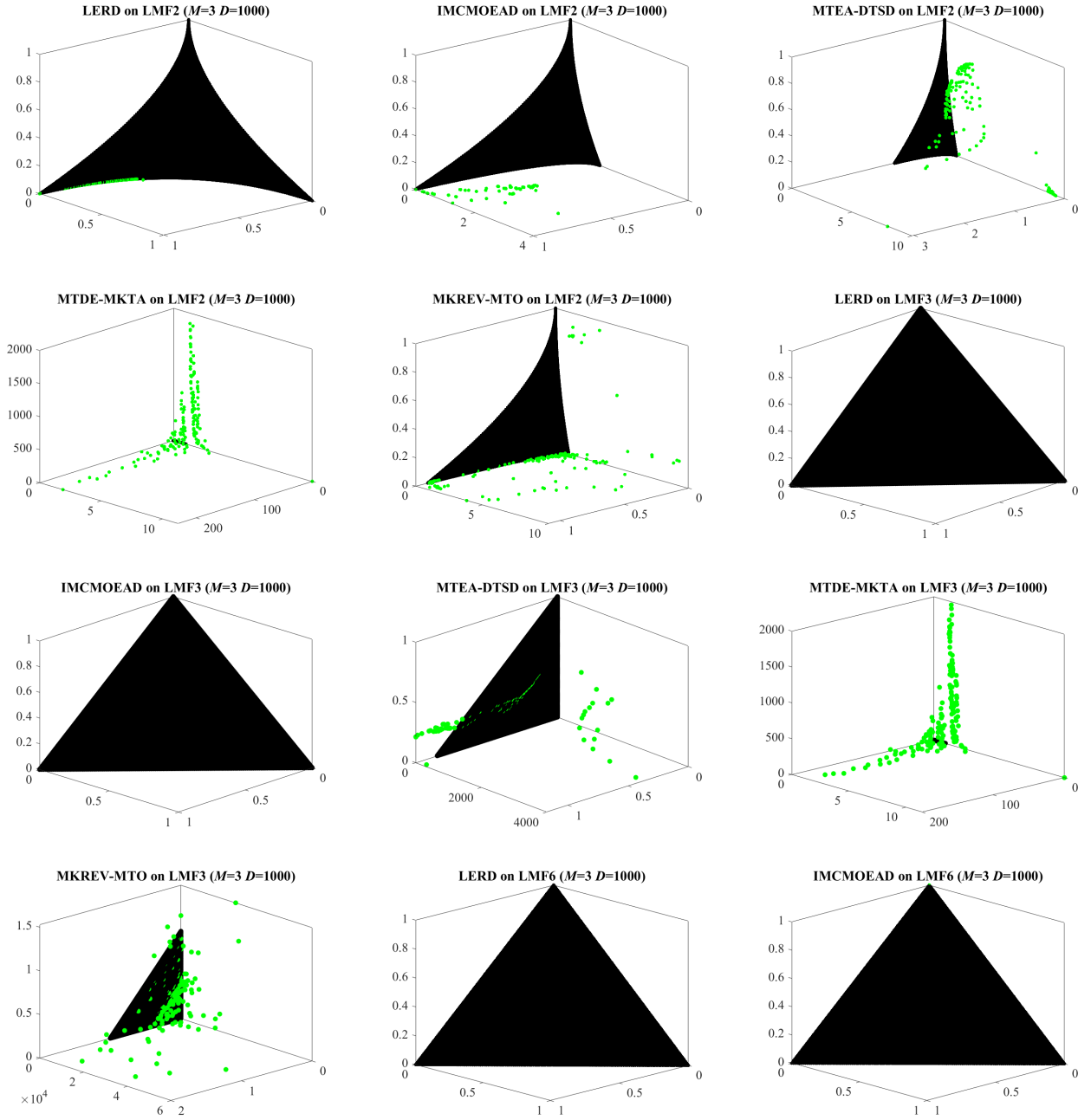


Fig. S11 The final non-dominated solutions gained by MKREV-MTO and its four competitors on 2-objective LMF ($D=1000$).



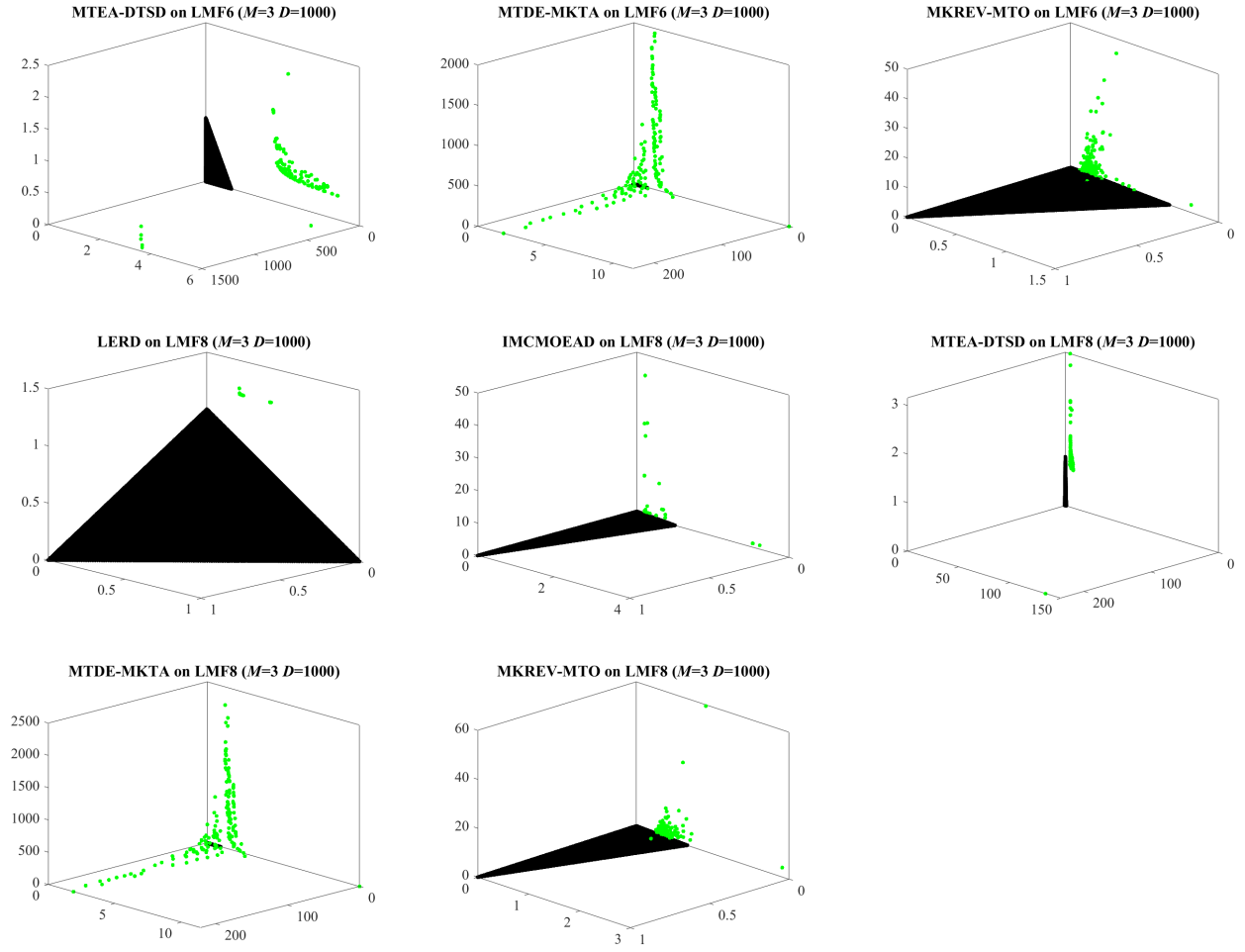


Fig. S12 The final non-dominated solutions gained by MKREV-MTO and its four competitors on 3-objective LMF2, LMF3, LMF6, and LMF8 with $D=1000$.