

Supplementary File for “An Adaptive Trade-off Evolutionary Algorithm with Composite Differential Evolution for Constrained Multi-Objective Optimization”

1. Experimental Study

Table 1: The statistical results of IGD were obtained by ATEA with different setting of τ on CFs 1-7, LIRC MOPs 1-12 and MWs 1-14.

Problem	$\tau=0$	$\tau=0.005$	$\tau=0.5$	$\tau=1$	$\tau=0.05$
	Mean (Std Dev)	Mean (Std Dev)	Mean (Std Dev)	Mean (Std Dev)	Mean (Std Dev)
CF 1	9.0379e-3 (4.64e-3) –	4.8613e-3 (2.26e-3) ≈	3.4431e-3 (5.85e-4) +	3.9064e-3 (8.44e-4) +	5.5926e-3 (1.81e-3)
CF 2	5.1514e-3 (4.10e-4) –	5.3732e-3 (4.67e-4) –	5.4229e-3 (1.64e-3) ≈	4.8273e-3 (1.06e-3) ≈	4.5472e-3 (2.37e-4)
CF 3	1.3900e-1 (8.14e-2) ≈	1.2269e-1 (3.58e-2) ≈	1.5963e-1 (7.48e-2) ≈	1.9665e-1 (1.08e-1) ≈	1.5862e-1 (5.80e-2)
CF 4	4.1027e-2 (1.20e-2) ≈	4.7021e-2 (7.29e-3) –	4.3501e-2 (1.07e-2) ≈	4.5072e-2 (1.29e-2) ≈	3.4922e-2 (9.17e-3)
CF 5	1.6407e-1 (1.03e-1) ≈	3.0835e-1 (1.22e-1) ≈	2.2925e-1 (1.43e-1) ≈	2.4443e-1 (1.68e-1) ≈	2.6507e-1 (1.68e-1)
CF 6	4.9090e-2 (2.87e-2) ≈	3.6581e-2 (1.15e-2) +	3.5374e-2 (5.55e-3) +	3.2360e-2 (7.41e-3) +	4.3437e-2 (1.18e-2)
CF 7	1.6624e-1 (6.47e-2) +	2.1071e-1 (1.19e-1) ≈	2.8143e-1 (1.21e-1) ≈	3.0998e-1 (1.59e-1) ≈	2.8289e-1 (1.24e-1)
LIRC MOP 1	1.6527e-1 (5.63e-2) –	1.0830e-1 (6.58e-2) –	1.3658e-1 (4.29e-2) –	1.3131e-1 (3.72e-2) –	3.6202e-2 (2.83e-2)
LIRC MOP 2	1.6197e-1 (1.08e-1) –	2.9624e-2 (1.75e-2) ≈	1.1024e-1 (2.67e-2) –	1.0778e-1 (3.20e-2) –	2.4442e-2 (4.43e-3)
LIRC MOP 3	1.5934e-1 (1.24e-1) –	3.1426e-1 (2.33e-1) –	2.4112e-1 (6.75e-2) –	2.5200e-1 (3.53e-2) –	3.6796e-2 (2.60e-2)
LIRC MOP 4	1.4482e-1 (9.06e-2) –	1.0951e-1 (6.29e-2) –	2.1300e-1 (3.07e-2) –	2.3137e-1 (3.55e-2) –	3.6820e-2 (2.42e-2)
LIRC MOP 5	7.6416e-3 (8.87e-4) –	7.9448e-3 (9.79e-4) –	9.2283e-1 (4.76e-1) –	1.0405e+0 (3.59e-1) –	6.6424e-3 (3.31e-4)
LIRC MOP 6	7.4767e-3 (1.02e-3) ≈	7.5061e-3 (9.65e-4) –	5.4378e-1 (6.91e-1) –	8.5924e-1 (6.43e-1) –	6.7475e-3 (3.42e-4)
LIRC MOP 7	9.2976e-3 (4.84e-4) ≈	9.1446e-3 (5.50e-4) ≈	1.8579e-1 (5.26e-1) ≈	1.9961e-1 (5.23e-1) ≈	9.0212e-3 (7.79e-4)
LIRC MOP 8	1.0218e-2 (1.57e-3) ≈	9.3361e-3 (6.14e-4) ≈	6.9472e-1 (8.51e-1) –	1.5671e-2 (1.98e-2) ≈	9.2740e-3 (7.43e-4)
LIRC MOP 9	1.4313e-2 (2.38e-2) –	6.3325e-3 (1.17e-3) –	5.4035e-1 (4.42e-2) –	4.9891e-1 (9.57e-2) –	4.2489e-3 (3.27e-4)
LIRC MOP 10	8.7500e-3 (1.43e-3) –	8.8977e-3 (1.25e-3) –	2.2343e-1 (7.53e-2) –	2.7555e-1 (9.51e-2) –	7.3040e-3 (3.95e-4)
LIRC MOP 11	3.6571e-3 (1.04e-3) –	1.0651e-2 (2.16e-2) –	1.9341e-1 (6.77e-2) –	1.8807e-1 (6.93e-2) –	2.5046e-3 (5.84e-5)
LIRC MOP 12	1.8973e-2 (2.35e-2) ≈	1.9682e-2 (3.08e-2) ≈	1.2114e-1 (1.01e-1) ≈	1.9736e-1 (8.29e-2) –	1.2696e-2 (5.51e-3)
MW 1	2.1285e-3 (1.09e-4) ≈	2.0925e-3 (7.55e-5) ≈	2.1098e-3 (8.00e-5) ≈	2.1629e-3 (1.08e-4) ≈	2.1482e-3 (5.61e-5)
MW 2	3.7440e-2 (1.90e-2) ≈	4.7789e-2 (3.67e-2) ≈	3.7481e-2 (1.13e-2) ≈	5.1197e-2 (3.04e-2) ≈	3.4468e-2 (1.40e-2)
MW 3	5.8326e-3 (4.31e-4) ≈	5.7914e-3 (3.70e-4) –	5.7089e-3 (3.77e-4) ≈	5.5018e-3 (2.76e-4) ≈	5.4803e-3 (2.23e-4)
MW 4	5.0445e-2 (1.51e-3) ≈	5.2969e-2 (1.65e-3) –	5.1395e-2 (1.50e-3) ≈	5.1003e-2 (1.62e-3) ≈	5.1176e-2 (1.74e-3)
MW 5	4.9578e-3 (2.52e-3) ≈	4.8547e-3 (4.18e-3) ≈	4.8957e-4 (1.79e-4) +	3.4668e-4 (1.24e-4) +	2.8260e-3 (1.49e-3)
MW 6	1.0570e-1 (1.51e-1) ≈	1.2767e-1 (1.79e-1) ≈	1.4224e-1 (1.87e-1) –	2.3661e-1 (2.41e-1) –	3.8923e-2 (2.67e-2)
MW 7	6.0761e-3 (5.36e-4) –	5.9852e-3 (6.91e-4) –	6.0177e-3 (5.48e-4) –	6.0592e-3 (6.83e-4) –	5.4716e-3 (3.27e-4)
MW 8	9.8806e-2 (6.30e-2) –	8.9828e-2 (4.04e-2) –	6.0118e-2 (8.08e-3) –	9.2418e-2 (3.92e-2) –	5.3753e-2 (2.58e-3)
MW 9	5.3655e-3 (3.27e-4) +	5.6073e-3 (4.59e-4) ≈	4.7887e-3 (1.39e-4) +	4.8379e-3 (1.82e-4) +	5.8131e-3 (4.90e-4)
MW 10	1.8249e-1 (1.78e-1) ≈	1.5650e-1 (1.26e-1) ≈	2.8245e-1 (2.24e-1) ≈	1.7875e-1 (8.22e-2) ≈	1.9269e-1 (1.24e-1)
MW 11	6.8635e-3 (3.86e-4) ≈	6.9668e-3 (5.26e-4) ≈	8.1822e-3 (1.41e-3) –	7.7843e-3 (1.05e-3) –	6.8185e-3 (2.78e-4)
MW 12	5.8183e-3 (2.94e-4) –	5.9499e-3 (3.53e-4) –	6.1029e-3 (5.18e-4) –	5.9744e-3 (3.20e-4) –	5.5821e-3 (2.17e-4)
MW 13	1.4248e-1 (7.01e-2) –	1.1925e-1 (5.79e-2) –	1.1532e-1 (5.39e-2) –	2.1638e-1 (1.31e-1) –	7.1118e-2 (3.29e-2)
MW 14	1.2132e-1 (4.12e-3) ≈	1.2380e-1 (8.60e-3) ≈	1.2253e-1 (7.41e-3) ≈	1.2780e-1 (1.00e-2) ≈	1.2150e-1 (5.14e-3)
+/-/≈	2/14/17	1/16/16	4/16/13	4/16/13	

Table 2: The statistical results of HV were obtained by ATEA with different setting of τ on CFs 1-7, LIRCMOPs 1-12 and MWs 1-14.

Problem	$\tau=0$	$\tau=0.005$	$\tau=0.5$	$\tau=1$	$\tau=0.05$
	Mean (Std Dev)	Mean (Std Dev)	Mean (Std Dev)	Mean (Std Dev)	Mean (Std Dev)
CF 1	5.5574e-1 (5.06e-3) \approx	5.6059e-1 (2.19e-3) \approx	5.6184e-1 (7.21e-4) +	5.6123e-1 (1.16e-3) +	5.5913e-1 (2.19e-3)
CF 2	6.7454e-1 (8.15e-4) -	6.7460e-1 (1.16e-3) -	6.7510e-1 (1.09e-3) \approx	6.7531e-1 (1.12e-3) \approx	6.7585e-1 (6.35e-4)
CF 3	2.4879e-1 (4.63e-2) \approx	2.4010e-1 (3.69e-2) -	2.2368e-1 (7.39e-2) -	2.2389e-1 (6.88e-2) \approx	2.3487e-1 (5.28e-2)
CF 4	4.8339e-1 (1.63e-2) \approx	4.7526e-1 (1.04e-2) -	4.7853e-1 (1.27e-2) -	4.7598e-1 (1.80e-2) -	4.9286e-1 (1.14e-2)
CF 5	3.6800e-1 (8.77e-2) \approx	2.8719e-1 (6.64e-2) -	3.2298e-1 (8.89e-2) -	3.0564e-1 (9.80e-2) \approx	3.0638e-1 (9.42e-2)
CF 6	6.6075e-1 (1.49e-2) -	6.7152e-1 (6.78e-3) +	6.6791e-1 (4.35e-3) +	6.7183e-1 (6.22e-3) +	6.5720e-1 (1.07e-2)
CF 7	5.1524e-1 (6.33e-2) +	4.5867e-1 (1.31e-1) \approx	4.4809e-1 (1.19e-1) \approx	4.0762e-1 (1.10e-1) \approx	4.2945e-1 (9.04e-2)
LIRCMOP 1	1.6048e-1 (2.31e-2) -	1.9667e-1 (1.69e-2) -	1.6747e-1 (2.33e-2) -	1.7121e-1 (1.72e-2) -	2.2623e-1 (1.08e-2)
LIRCMOP 2	2.7696e-1 (5.71e-2) -	3.4725e-1 (9.93e-3) \approx	3.1295e-1 (1.63e-2) -	3.1112e-1 (1.10e-2) -	3.5000e-1 (2.14e-3)
LIRCMOP 3	1.5358e-1 (3.19e-2) -	1.1735e-1 (4.47e-2) -	1.2205e-1 (1.76e-2) -	1.1721e-1 (9.05e-3) -	1.9422e-1 (9.21e-3)
LIRCMOP 4	2.4348e-1 (4.45e-2) -	2.5994e-1 (3.35e-2) -	2.2475e-1 (1.26e-2) -	2.2028e-1 (1.40e-2) -	3.0101e-1 (6.94e-3)
LIRCMOP 5	2.9094e-1 (4.26e-4) -	2.9084e-1 (4.36e-4) -	5.6690e-2 (1.20e-1) -	2.8384e-2 (8.98e-2) -	2.9136e-1 (1.35e-4)
LIRCMOP 6	1.9623e-1 (5.49e-4) -	1.9638e-1 (2.82e-4) -	1.1738e-1 (1.01e-1) -	6.4537e-2 (9.21e-2) -	1.9669e-1 (1.98e-4)
LIRCMOP 7	2.9361e-1 (1.74e-4) \approx	2.9353e-1 (3.64e-4) \approx	2.5873e-1 (9.14e-2) \approx	2.5507e-1 (9.17e-2) \approx	2.9362e-1 (3.23e-4)
LIRCMOP 8	2.9300e-1 (9.08e-4) \approx	2.9345e-1 (3.00e-4) \approx	1.6822e-1 (1.45e-1) -	2.9048e-1 (9.54e-3) \approx	2.9349e-1 (3.54e-4)
LIRCMOP 9	5.6235e-1 (6.90e-3) -	5.6459e-1 (9.93e-4) -	3.2911e-1 (2.80e-2) -	3.6008e-1 (5.59e-2) -	5.6676e-1 (1.36e-4)
LIRCMOP 10	7.0504e-1 (8.77e-4) -	7.0506e-1 (7.07e-4) -	6.0306e-1 (4.48e-2) -	5.7154e-1 (5.70e-2) -	7.0609e-1 (2.54e-4)
LIRCMOP 11	6.9317e-1 (8.65e-4) -	6.9055e-1 (8.22e-3) -	5.9176e-1 (2.09e-2) -	5.8537e-1 (2.74e-2) -	6.9396e-1 (1.25e-5)
LIRCMOP 12	6.1411e-1 (7.82e-3) \approx	6.1355e-1 (1.26e-2) \approx	5.6481e-1 (5.11e-2) \approx	5.3284e-1 (3.53e-2) -	6.1470e-1 (3.04e-3)
MW 1	4.8986e-1 (5.41e-5) \approx	4.8988e-1 (3.54e-5) \approx	4.8987e-1 (4.34e-5) \approx	4.8985e-1 (4.65e-5) \approx	4.8985e-1 (3.26e-5)
MW 2	5.2864e-1 (2.68e-2) \approx	5.1536e-1 (5.06e-2) \approx	5.2824e-1 (1.63e-2) \approx	5.0970e-1 (4.11e-2) \approx	5.3269e-1 (2.01e-2)
MW 3	5.4419e-1 (4.22e-4) \approx	5.4413e-1 (3.39e-4) \approx	5.4388e-1 (4.71e-4) \approx	5.4414e-1 (2.33e-4) \approx	5.4419e-1 (2.76e-4)
MW 4	8.3042e-1 (1.90e-3) \approx	8.2754e-1 (2.89e-3) \approx	8.2999e-1 (1.99e-3) \approx	8.2965e-1 (2.52e-3) \approx	8.2911e-1 (1.99e-3)
MW 5	3.2278e-1 (1.10e-3) \approx	3.2261e-1 (1.82e-3) \approx	3.2442e-1 (9.93e-5) +	3.2451e-1 (8.72e-5) +	3.2335e-1 (6.91e-4)
MW 6	2.4537e-1 (5.97e-2) -	2.5028e-1 (5.57e-2) -	2.3494e-1 (6.38e-2) -	2.0184e-1 (8.57e-2) -	2.8086e-1 (2.78e-2)
MW 7	4.1239e-1 (1.91e-4) -	4.1236e-1 (2.47e-4) -	4.1243e-1 (2.97e-4) \approx	4.1236e-1 (2.53e-4) -	4.1257e-1 (1.21e-4)
MW 8	4.2024e-1 (1.09e-1) -	4.3429e-1 (7.59e-2) -	4.9403e-1 (2.16e-2) -	4.2965e-1 (7.76e-2) -	5.1121e-1 (6.46e-3)
MW 9	3.9669e-1 (1.75e-3) \approx	3.9736e-1 (2.75e-3) +	4.0027e-1 (9.78e-4) +	3.9983e-1 (1.00e-3) +	3.9488e-1 (2.37e-3)
MW 10	3.3200e-1 (9.41e-2) \approx	3.4530e-1 (7.31e-2) \approx	2.8533e-1 (1.06e-1) +	3.3006e-1 (4.52e-2) +	3.2422e-1 (6.73e-2)
MW 11	4.4717e-1 (2.39e-4) +	4.4712e-1 (4.22e-4) +	4.4724e-1 (3.05e-4) +	4.4736e-1 (1.78e-4) +	4.4688e-1 (3.61e-4)
MW 12	6.0334e-1 (2.93e-4) \approx	6.0304e-1 (5.85e-4) -	6.0304e-1 (6.94e-4) -	6.0310e-1 (5.37e-4) -	6.0352e-1 (3.03e-4)
MW 13	4.0373e-1 (4.26e-2) -	4.1767e-1 (3.76e-2) -	4.1815e-1 (3.51e-2) -	3.5446e-1 (6.71e-2) -	4.4552e-1 (1.59e-2)
MW 14	4.5640e-1 (4.11e-3) \approx	4.5535e-1 (2.95e-3) -	4.5781e-1 (4.15e-3) \approx	4.5550e-1 (3.45e-3) \approx	4.5869e-1 (2.88e-3)
+/-/ \approx	2/13/18	2/13/18	5/14/14	5/14/14	

Table 3: The statistical tests of confidence interval and p-value for IGD were obtained by ATEA on CFs 1-7, LIRCMOPs 1-12 and MWs 1-14.

Problem	ATEA vs. NSGAII		ATEA vs. MOEA/CES		ATEA vs. tSP		ATEA vs. CTAEA		ATEA vs. SP		ATEA vs. PPS	
	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value
CF 1	[7.6504e-03, 1.1716e-02]	1.8207e-04	[2.0747e-04, 5.5454e-03]	1.2122e-01	[5.3461e-03, 2.6059e-03]	2.4613e-04	[3.1247e-02, 3.8495e-02]	1.8207e-04	[6.0996e-03, 9.8718e-03]	1.8207e-04	[5.1215e-03, 2.3343e-03]	2.4613e-04
CF 2	[1.4241e-02, 1.4624e-02]	1.8207e-04	[2.8883e-03, 6.7927e-03]	1.8207e-04	[1.0095e-04, 5.4585e-04]	1.4047e-01	[2.3271e-02, 3.3820e-02]	1.8207e-04	[3.0233e-02, 4.6337e-02]	1.8207e-04	[6.9442e-04, 2.0630e-04]	5.7544e-03
CF 3	[8.8466e-03, 2.2071e-02]	2.1113e-02	[4.8334e-01, 8.6767e-01]	1.8207e-04	[2.5802e-02, 9.6760e-02]	2.1229e-01	[3.1146e-02, 1.4747e-01]	4.5864e-03	[4.8871e-03, 1.1159e-01]	2.1113e-02	[1.3920e-02, 1.6441e-01]	2.5748e-02
CF 4	[4.4826e-02, 1.2230e-01]	1.8207e-04	[4.8705e-02, 1.2383e-01]	1.8207e-04	[1.7852e-03, 3.4462e-02]	3.7635e-02	[3.4911e-02, 5.9411e-02]	1.8207e-04	[5.3979e-02, 1.1187e-01]	1.8207e-04	[3.4774e-02, 5.2632e-01]	5.2632e-01
CF 5	[2.1748e-01, 1.0568e-01]	6.7758e-01	[4.8655e-01, 1.0741e+00]	1.8207e-04	[1.9591e-01, 1.1928e-01]	9.6983e-01	[2.1565e-01, 9.2581e-02]	1.0000e+00	[1.2076e-01, 2.0414e-01]	2.7341e-01	[1.7298e-01, 1.6293e-01]	6.2318e-01
CF 6	[1.8017e-02, 7.5496e-02]	1.3110e-03	[2.0044e-02, 5.7477e-02]	1.0000e-03	[7.6890e-03, 6.0145e-02]	6.2318e-01	[3.3353e-02, 1.6716e-01]	5.8284e-04	[1.4168e-02, 6.4145e-02]	1.6088e-03	[1.1528e-02, 2.9916e-02]	1.5888e-01
CF 7	[8.7987e-02, 1.8334e-01]	5.2025e-01	[5.2588e-01, 1.2886e+00]	1.8207e-04	[1.5987e-01, 6.0965e-02]	3.4470e-01	[8.3919e-02, 2.3630e-01]	6.7758e-01	[5.9621e-02, 1.0942e-01]	9.6983e-01	[1.2377e-01, 7.3086e-02]	8.5011e-01
LIRCMOP 1	[2.2685e-01, 2.8419e-01]	1.8207e-04	[3.4216e-02, 1.3686e-01]	1.7002e-03	[2.4280e-01, 2.9099e-01]	1.8207e-04	[5.8079e-02, 1.9478e-01]	5.8284e-04	NaN	NaN	[3.1675e-02, 1.0782e-02]	2.4613e-04
LIRCMOP 2	[2.0248e-01, 2.2770e-01]	1.8207e-04	[9.5465e-02, 1.0878e-01]	1.8207e-04	[2.3438e-01, 2.5715e-01]	1.8207e-04	[6.1874e-02, 9.7965e-02]	1.8207e-04	[3.1979e-01, 3.4987e-01]	4.1258e-02	[1.9437e-02, 1.3603e-02]	2.0225e-03
LIRCMOP 3	[2.4681e-01, 1.3274e-01]	1.8207e-04	[1.0526e-01, 2.0551e-01]	5.8284e-04	[2.8854e-01, 2.2778e-01]	1.8207e-04	[2.0717e-01, 2.6985e-01]	2.7970e-04	[3.3121e-01, 4.1886e-01]	4.1258e-02	[3.9088e-02, 5.8705e-02]	2.5748e-02
LIRCMOP 4	[2.2692e-01, 2.8270e-01]	1.8207e-04	[2.2680e-02, 2.7349e-01]	3.7488e-03	[2.0965e-01, 3.0039e-01]	1.8207e-04	[3.3188e-01, 2.3743e-01]	2.7970e-04	NaN	NaN	[3.2408e-02, 1.7882e-02]	2.8273e-03
LIRCMOP 5	[1.2038e+00, 1.2148e+00]	1.7801e-04	[2.6048e+00, 5.4403e+00]	1.7801e-04	[1.1505e+00, 1.2129e+00]	1.7801e-04	[1.2044e+00, 1.2138e+00]	1.7801e-04	[2.9121e-01, 1.2073e+00]	1.7801e-04	[4.3275e-04, 1.3846e-04]	9.6983e-01
LIRCMOP 6	[1.3387e+00, 1.3392e+00]	1.8207e-04	[3.4303e+00, 6.0394e+00]	1.8207e-04	[3.4504e-01, 1.3401e+00]	1.8207e-04	[3.3388e+00, 1.3395e+00]	1.8207e-04	[3.5558e-01, 1.1392e+00]	1.8207e-04	[1.6543e-04, 9.8622e-04]	4.5864e-03
LIRCMOP 7	[1.0607e-01, 1.6418e-01]	1.8207e-04	[3.4297e+00, 4.7930e+00]	1.8207e-04	[2.1273e-01, 1.6738e+00]	2.4613e-04	[1.2392e-01, 1.5566e-01]	1.8207e-04	[1.0646e-01, 1.4490e-01]	1.8207e-04	[9.9074e-02, 1.2907e-01]	1.8207e-04
LIRCMOP 8	[1.9119e-01, 1.6731e-01]	1.8207e-04	[5.5104e+00, 5.2806e+00]	1.8207e-04	[4.6671e-01, 1.6737e+00]	5.8284e-04	[2.9668e-01, 1.6733e+00]	1.8207e-04	[1.8401e-01, 2.4064e-01]	1.8207e-04	[2.8356e-01, 1.2629e-01]	5.8284e-04
LIRCMOP 9	[1.4741e-01, 8.2968e-01]	1.8207e-04	[6.7075e-01, 9.3273e-01]	1.8207e-04	[3.7016e-01, 4.4513e-01]	1.8207e-04	[3.9928e-01, 4.4499e-01]	1.8207e-04	[7.4692e-04, 8.2008e-01]	1.8207e-04	[3.9341e-01, 3.6402e-01]	1.8207e-04
LIRCMOP 10	[8.2558e-01, 8.2669e-01]	1.8207e-04	[4.0936e-01, 5.9085e-01]	1.8207e-04	[4.0284e-01, 4.0384e-01]	1.8207e-04	[4.1626e-01, 4.0410e-01]	1.8207e-04	[4.0413e-01, 8.2651e-01]	1.8207e-04	[8.1554e-04, 5.9456e-04]	3.4470e-01
LIRCMOP 11	[7.4927e-01, 7.4947e-01]	1.8207e-04	[1.5625e-01, 4.2642e-01]	1.8207e-04	[2.7881e-01, 4.2410e-01]	1.8207e-04	[1.6598e-01, 1.7648e-01]	1.8207e-04	[3.9126e-01, 7.9298e-01]	1.8207e-04	[6.9748e-02, 2.7971e-01]	2.4613e-04
LIRCMOP 12	[5.3737e-01, 8.4124e-01]	1.8207e-04	[2.6792e-01, 1.1384e+00]	1.8207e-04	[2.3023e-01, 5.5815e-01]	1.8207e-04	[9.9118e-02, 1.6954e-01]	1.8207e-04	[3.5997e-01, 8.4678e-01]	1.8207e-04	[1.0951e-01, 1.1255e-01]	1.8207e-04
MW 1	[2.3126e-04, 9.2077e-05]	6.2303e-03	NaN	NaN	[1.5933e-01, 1.5950e-01]	1.5473e-01	[1.8939e-04, 9.2726e-05]	3.2984e-04	[2.2117e-04, 3.5915e-05]	1.0112e-02	[4.422e-04, 5.0370e-04]	7.6931e-04
MW 2	[2.1268e-02, 4.5221e-03]	2.7304e-01	[1.4480e-02, 1.2229e-01]	1.7002e-03	[1.4673e-02, 1.0925e-01]	6.2303e-03	[2.9855e-02, 9.6720e-01]	3.7635e-02	[2.1787e-02, 6.3059e-03]	2.4132e-01	[2.5417e-02, 1.5900e-01]	1.3149e-03
MW 3	[1.1533e-05, 5.5601e-06]	5.7951e-03	[1.1545e-03, 5.6011e-03]	1.6001e-03	[9.3293e-03, 9.1603e-03]	4.2894e-04	[5.0111e-02, 1.0525e+00]	5.8183e-01	[3.6243e-02, 7.7880e-01]	7.2842e-03	[2.2510e-03, 9.1218e-01]	3.2843e-04
MW 4	[1.9846e-03, 7.4464e-03]	2.2022e-03	[6.2740e-03, 3.0771e-01]	4.1258e-02	[1.6449e-01, 1.6941e-01]	1.5473e-01	[5.9503e-03, 2.9730e-03]	1.8207e-04	[3.5886e-03, 8.9318e-03]	4.3964e-04	[7.0807e-04, 3.9713e-03]	9.1055e-03
MW 5	[1.9665e-03, 3.0848e-01]	2.5748e-02	[1.7415e-01, 1.7871e-01]	1.5473e-01	[7.0146e-01, 7.7471e-01]	1.5473e-01	[4.0544e-03, 7.7824e-03]	1.8207e-04	[7.8934e-01, 7.4187e-01]	1.8207e-04	[7.7240e-04, 7.9232e-01]	1.8207e-04
MW 6	[1.91											

Table 4: The statistical tests of confidence interval and p-value for HV were obtained by ATEA on CFs 1-7, LIRCMOPs 1-12 and MWs 1-14.

Problem	ATEA vs. NSGAII		ATEA vs. MOEA/CHS		ATEA vs. ToP		ATEA vs. CTAEA		ATEA vs. SP		ATEA vs. PPS	
	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value	Confidence interval	p-value
CF 1	-1.4272e-02, -1.0090e-02	1.8267e-04	-1.5133e-03, 3.8129e-04	1.4047e-01	3.5322e-03, 6.6530e-03	2.4613e-04	-4.6516e-02, -3.7786e-02	1.8267e-04	-1.2800e-02, -8.9417e-03	1.8267e-04	3.0156e-03, 6.4176e-03	2.4613e-04
CF 2	-8.1829e-02, -2.2446e-02	1.8267e-04	-1.1723e-02, -6.5660e-03	1.8267e-04	-2.5643e-01, -9.1411e-04	4.3984e-04	7.5073e-02, -3.4302e-02	1.8267e-04	-8.7897e-02, -3.3565e-02	1.8267e-04	-2.3753e-03, 1.1753e-03	6.2118e-01
CF 3	-1.0439e-01, -1.6411e-02	7.2846e-03	-2.6454e-01, -1.8831e-01	1.3173e-04	-1.0470e-01, -6.2439e-03	2.5748e-02	-1.0818e-01, -2.5282e-02	4.5864e-03	-1.1874e-01, -1.1677e-02	2.1134e-02	-9.8684e-02, -7.8626e-02	1.4019e-02
CF 4	-1.2577e-01, -5.5121e-02	1.8267e-04	-1.5023e-01, -7.1858e-02	1.8267e-04	-4.5188e-02, -4.5399e-03	9.1085e-03	-8.0838e-02, -5.6532e-02	1.8267e-04	-1.3715e-01, -5.7711e-02	1.8267e-04	-5.2446e-02, 2.0490e-02	3.0749e-01
CF 5	-9.0508e-02, -1.1030e-01	1.0000E+00	-4.0750e-01, -2.1168e-01	8.7450e-05	-1.0353e-01, 6.8235e-02	5.7673e-01	-6.5298e-02, -1.1288e-01	9.0572e-01	-1.1428e-01, 7.2173e-02	2.7304e-01	-8.3777e-02, 9.7336e-02	9.0272e-01
CF 6	-3.6888e-02, -1.2298e-02	1.3149e-03	-4.0769e-02, -1.5539e-02	5.8284e-04	-1.5721e-02, 1.2315e-02	9.6985e-01	-3.9719e-02, -1.0255e-02	5.7954e-03	-3.5341e-02, -7.9528e-03	3.6105e-03	-2.8026e-02, 5.5656e-03	7.5602e-02
CF 7	-1.4224e-01, 6.1687e-02	4.2736e-01	-4.5267e-01, -3.1460e-01	1.4939e-04	-9.0343e-02, 8.5356e-02	6.7758e-01	-1.4938e-01, 9.9935e-02	8.5011e-01	-1.0457e-01, 5.2755e-02	3.4470e-01	-8.2406e-02, 6.5718e-02	9.6985e-01
LIRCMOP 1	-1.2342e-01, -1.0395e-01	1.8267e-04	-7.3791e-02, -1.3098e-02	1.3149e-03	-1.2621e-01, -1.0883e-01	1.8267e-04	-9.7600e-02, -4.3657e-02	1.8267e-04	NaN	NaN	-4.3033e-03, 1.0096e-02	3.2843e-04
LIRCMOP 2	-1.2343e-01, -1.0129e-01	1.8267e-04	-8.6661e-02, -5.7013e-02	1.8267e-04	-1.3767e-01, -1.1876e-01	1.8267e-04	-4.0793e-02, -3.2558e-02	1.8267e-04	-1.2690e-01, -1.2028e-01	4.1235E-02	7.3434e-03, 1.1112e-02	1.3149E-03
LIRCMOP 3	-1.0332e-01, -8.3736e-02	1.8267e-04	-7.5061e-02, -4.4157e-02	3.2984e-04	-1.0727e-01, -9.5673e-02	1.8267e-04	-9.7043e-02, -7.4435e-02	2.9707e-04	-1.3884e-01, -1.0787e-01	4.1235E-02	3.3407e-03, 9.6062e-03	2.1134E-02
LIRCMOP 4	-1.2652e-01, -1.0139e-01	1.8267e-04	-1.0395e-01, -8.8989e-03	2.8803e-03	-1.3371e-01, -1.1977e-01	1.8267e-04	-1.0696e-01, -5.1035e-02	2.9707e-04	NaN	NaN	9.9226e-03, 1.6142e-02	2.8273E-03
LIRCMOP 5	-5.9143e-01, -2.9130e-01	6.2044E+05	-2.9143e-01, -2.9115e-01	1.0788E-04	-2.9146e-01, -2.9126e-01	8.5119E+05	-2.9144e-01, -2.9155e-01	8.5119E+05	-2.9140e-01, -1.3295e-01	1.4500E-04	1.2335e-04, 5.9596e-04	1.7090E-02
LIRCMOP 6	-1.9687e-01, -1.9656e-01	1.8267e-04	-1.9687e-01, -1.9656e-01	6.3884E+05	-1.9683e-01, -1.3982e-01	1.3173E-04	-1.9688e-01, -1.9654e-01	8.7450E+05	-1.9686e-01, -1.0029e-01	1.3173E-04	2.6732e-04, 6.7255e-04	1.7684E-04
LIRCMOP 7	-6.1017e-02, -4.6506e-02	1.8267e-04	-2.9387e-01, -2.9356e-01	6.3864E+05	-2.9388e-01, -5.3546e-02	1.3173E-04	-5.6726e-02, -4.8278e-02	1.8267e-04	-4.6472e-02, -4.3804e-02	1.8267e-04	-5.0430e-03, -4.4436e-02	1.8267E-04
LIRCMOP 8	-2.9364e-01, -6.5284e-02	1.4939E-04	-2.9376e-01, -2.9324e-01	6.3864E+05	-2.9302e-01, -8.4059e-02	1.4939E-04	-2.9316e-01, -6.4257e-02	1.7601E-04	-7.0395e-02, -6.7157e-02	1.8267E-04	-4.7288e-02, -3.6082e-04	1.7257E-02
LIRCMOP 9	-4.1947e-01, -3.2948e-01	1.8267e-04	-4.0847e-01, -2.8106e-01	1.8267e-04	-3.1475e-01, -1.2881e-01	1.8267e-04	-1.9715e-01, -1.5411e-01	1.8267e-04	-4.1955e-01, -3.5926e-01	1.8267E-04	-1.0898e-01, -1.0844e-01	1.8267E-04
LIRCMOP 10	-5.8741e-01, -5.8670e-01	1.8267e-04	-3.9391e-01, -2.3293e-01	1.8267e-04	-2.1525e-01, -2.1456e-01	1.8267e-04	-2.1558e-01, -8.4223e-02	1.8267e-04	-5.8728e-01, -2.1697e-01	1.8267E-04	-1.2181e-04, 9.5043e-04	7.5602E-02
LIRCMOP 11	-4.0628e-01, -4.6544e-01	1.8267e-04	-3.1002e-01, -1.0446e-01	1.8267e-04	-2.9490e-01, -1.7644e-01	1.8267e-04	-7.7298e-02, -6.1367e-02	1.8267E-04	-4.6573e-01, -3.8323e-01	1.8267E-04	-1.7665e-03, -3.3066e-02	1.8267E-04
LIRCMOP 12	-4.2312e-01, -2.3994e-01	1.8267e-04	-1.4102e-01, -1.4859e-01	1.8267e-04	-1.8285e-01, -9.7732e-02	1.8267e-04	-8.1179e-03, -5.1172e-02	1.8267E-04	-4.2398e-01, -1.8800e-01	1.8267E-04	-5.3346e-02, -4.8966e-02	1.8267E-04
MW 1	5.9149e-05, 1.4333e-04	4.8488E+03	NaN	NaN	-1.7689e-01, -1.7678e-01	1.5473E-01	-1.1759e-03, 5.5274e-04	1.8267E-04	4.9958e-05, 1.3438e-04	4.8488E+03	-1.1698e-03, -8.6626e-04	7.6013E-04
MW 2	-6.9972e-03, 3.0919e-02	2.7304E-01	-1.5608e-01, -1.9917e-02	1.3149E+03	-1.4635e-02, -2.1759e-02	6.2300E-03	8.8423e-04, 2.4239e-02	3.7635E-02	-9.5773e-03, 3.1392e-02	2.7304E-01	-1.0239e-03, -3.4989e-02	1.3149E+03
MW 3	-1.5313e-03, 7.9579e-04	3.2984E+04	-5.3658e-03, -1.5144e-03	7.6013E-04	-5.4413e-01, -1.9431e-02	4.3665E-04	9.0252e-04, 1.4138e-03	1.8267E-04	-1.3147e-03, -6.5298e-04	3.2984E+04	-1.0431e-03, -5.1957e-05	3.7635E-03
MW 4	-6.2426e-03, -1.1202e-03	5.7954E+03	-3.9662e-01, -1.3858e-02	4.1235E-02	-1.8720e-01, -1.8118e-01	1.5473E-01	-1.8720e-01, -1.8118e-01	1.8267E-04	-1.1932e-02, -5.5488e-03	1.8267E-04	-1.1813e-02, -3.3611e-03	1.8267E-04
MW 5	-1.6248e-01, -3.1312e-04	3.1209E-02	-1.9774e-01, -1.9539e-01	1.5473E-01	-2.7465e-02, -2.7230e-01	1.5473E-01	-4.7140e-03, -3.3642e-03	1.8267E-04	-2.3311e-01, -2.3265e-01	1.8267E-04	-2.3228e-01, -5.0702e-03	1.8267E-04
MW 6	-2.9900e-02, 2.6221e-02	8.5011E-01	-2.1935e-01, -1.4811e-01	5.8284E-04	-2.6833e-01, -5.7823e-02	4.3095E-04	8.4375e-03, 4.0515e-02	7.2646E+03	-2.0516e-02, 3.1821e-02	7.3073E-01	-2.8273e-01, -1.7412e-01	3.1307E-04
MW 7	-6.9677e-04, -3.4857e-04	1.8267E-04	-8.3283e-03, -4.2319e-03	2.9707E-04	-1.5038e-02, -1.2916e-02	1.8267E-04	-3.2686e-03, -2.2455e-03	1.8267E-04	-1.6909e-01, -1.7788e-03	1.8267E-04	-4.0830e-04, -1.7672e-04	1.7092E-03
MW 8	-1.8444e-02, -2.2100e-03	3.1209E-02	-1.6653e-01, -7.3987e-02	1.8267E-04	-3.5882e-01, -4.4894e-02	4.4867E-04	-1.4436e-03, 1.8142e-02	1.7257E-02	-2.7866e-02, -1.2354e-02	3.2984E+04	-2.6341e-01, -1.7565e-02	2.6843E+03
MW 9	-4.3511e-03, 2.8736e-03	1.0000E+00	-3.9911e-01, -4.0184e-02	4.1235E-02	-3.9222e-01, -4.3556e-02	2.9432E-03	-3.7498e-03, 1.0764e-04	1.6197E-01	-9.4096e-02, -6.0367e-02	1.6195E-04	-1.4157e-02, -6.1628e-03	1.8267E-04
MW 10	-4.2990e-02, 1.0295e-01	4.2598E-01	-4.2598e-01, 5.4437e-02	3.3292E-01	-1.6494e-02, 1.0337e-01	5.5818E-01	-1.6494e-02, 1.9073e-01	2.6433E+03	-9.5357e-02, 1.2730e-01	3.1935E-01	-3.0104e-01, 9.3165e-01	4.4967E-01
MW 11	6.7330e-04, 1.2026e-03	2.4613E-04	-1.4191e-02, -4.8549e-03	1.8267E-04	-1.7502e-01, -7.4298e-03	1.8267E-04	-2.9628e-03, -1.6777e-03	1.8267E-04	-1.7374e-01, -1.5786e-03	1.8267E-04	-4.8507e-04, 9.4949e-04	4.3864E-04
MW 12	3.5405e-04, 8.8871e-04	1.8267E-04	-6.0372e-01, -7.0785e-03	1.4248E-02	-6.0371e-01, -3.3451e-01	1.2603E-03	-2.8508e-03, -2.0656e-03	1.8267E-04	-4.8182e-03, -6.0942e-04	4.3864E-04	-2.4447e-03, -1.1397e-03	2.4613E-04
MW 13	-4.2235e-02, 4.6195e-03	1.8588E-01	-1.7037e-01, -8.4390e-02	1.8267E-04	-3.3531e-01, -9.2005e-02	2.7705E-04	-1.1193e-02, 2.9714e-02	1.8588E-01	-2.5523e-01, -2.0600e-01	1.8267E-04	-1.7295e-01, -6.0898e-02	1.8267E-04
MW 14	-1.0685e-02, -3.5913e-03	2.2022E+03	-2.4104e-02, -1.4363e-02	1.8267E-04	-2.7283e-01, -2.2674e-02	1.8267E-04	6.6130e-03, 1.2184e-02	1.8267E-04	-0.8798e-03, 2.2113e-03	4.5864E+03	-7.2361e-03, -2.4944e-03	5.3903E-02