An Adaptive Differential Evolution Algorithm Based on Archive Reuse (Supplementary Materials)

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Abstract

This document provides supplementary information for the main article. It includes the details of the three test suites used in the experiments and the tables of performance evaluation and comparison results referred to but not included in the main article.

Keywords:
Differential evolution(DE), archive update, archive reuse, parameter adaptation

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Table 1: The results of AR-IMadDE and six comparison algorithms in the CEC2020 problem set(5D)

5D	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	1.37E-01	8.11E-02 +	1.46E+01 -	1.71E-01 =	2.39E-01 -	8.24E-02 =	4.35E-01 -
F3	5.18E+00	5.15E+00 +	5.60E+00 -	4.69E+00 =	5.07E+00 +	5.15E+00 +	4.90E+00 +
F4	8.94E-02	1.19E-01 -	1.04E-01 =	1.08E-01 =	9.35E-02 =	1.20E-01 -	9.77E-02 =
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	6.24E-02 =	0.00E+00 =	0.00E+00 =
F6	0.00E+00	0.00E+00 =	0.00E+00 =	1.04E-02 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F7	NAN	0.NAN	NAN	NAN	NAN	NAN	NAN
F8	0.00E+00	0.00E+00 =	2.34E+01 -	6.67E+00 =	0.00E+00 =	0.00E+00 =	3.68E+00 =
F9	2.00E+01	3.00E+01 =	2.33E+01 =	1.07E+02 -	9.82E+01 -	6.16E+00 =	1.00E+02 -
F10	3.08E+02	2.55E+02 +	3.33E+02 =	3.39E+02 =	3.36E+02 -	2.99E+02 =	3.44E+02 -
	-	3/1/5	0/3/6	0/1/8	1/3/5	1/1/7	1/3/5

Table 2: The results of AR-IMadDE and six comparison algorithms in the CEC2020 problem set(10D)

10D	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	1.74E+00	3.98E+00 -	5.86E+00 -	8.92E+00 -	2.95E+00 =	4.44E+00 -	5.75E+00 -
F3	1.12E+01	1.21E+01 -	1.32E+01 -	1.07E+01 +	1.15E+01 -	1.25E+01 -	1.19E+01 -
F4	3.64E-02	9.54E-02 -	2.85E-01 -	2.91E-01 -	2.71E-01 -	4.10E-03 +	2.95E-01 -
F5	3.02E-01	7.86E-01 -	1.11E-01 +	4.86E-02 +	2.78E-01 =	9.37E-01 -	2.22E-01 =
F6	5.16E-02	9.50E-02 =	1.42E-01 -	5.27E-02 -	2.19E-01 -	1.57E-01 -	2.17E-01 -
F7	1.11E-02	1.22E-03 =	2.00E-02 -	1.06E-02 +	1.04E-01 =	1.16E-03 =	2.22E-01 -
F8	7.70E+01	6.52E+01 =	9.26E+01 -	1.00E+02 -	1.00E+02 -	3.58E+00 +	1.00E+02 -
F9	8.00E+01	8.67E+01 =	8.67E+01 =	2.58E+02 -	2.92E+02 -	6.12E+01 =	3.08E+02 -
F10	3.98E+02	3.68E+02 +	3.98E+02 +	4.09E+02 -	4.06E+02 -	3.68E+02 +	4.13E+02 -
-	1/4/5	2/6/2	3/6/1	0/6/4	3/4/3	0/8/2	

Table 3: The results of AR-IMadDE and six comparison algorithms in the CEC2020 problem set (15D)

15D	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	1.59E+00	4.77E+00 -	7.60E-01 =	4.98E+01 -	8.42E+00 -	3.14E+00 -	5.60E+00 -
F3	1.57E+01	1.61E+01 -	1.57E+01 +	1.68E+01 -	1.63E+01 -	1.64E+01 -	1.66E+01 -
F4	3.82E-01	4.39E-01 -	3.73E-01 =	5.21E-01 -	3.74E-01 =	4.13E-01 -	3.62E-01 =
F5	3.70E+00	8.81E+00 -	2.09E+00 =	1.89E+00 +	2.10E+00 =	9.66E+00 -	1.34E+00 +
F6	1.57E+00	3.77E+00 -	3.99E+00 -	1.46E+00 =	9.21E-01 +	7.35E+00 -	1.15E+00 +
F7	2.43E-01	3.05E-01 =	6.12E-01 -	2.70E-01 =	8.40E-01 -	9.39E-01 -	4.72E+00 -
F8	1.00E+02	7.85E+01 +	1.00E+02 =	1.00E+02 =	1.00E+02 =	2.21E+00 +	1.00E+02 =
F9	9.67E+01	1.00E+02 =	1.00E+02 =	3.63E+02 -	3.89E+02 -	9.24E+01 =	3.90E+02 -
F10	4.00E+02	4.00E+02 =	4.00E+02 =	4.00E+02 =	4.00E+02 =	4.00E+02 =	4.00E+02 =
-	1/5/4	1/2/7	1/4/5	1/4/5	1/6/3	2/4/4	

Table 4: The results of AR-IMadDE and six comparison algorithms in the CEC2020 problem set (20D)

20D	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	1.31E-01	5.93E-01 -	1.40E-01 =	8.06E+00 -	7.47E-01 -	6.87E-01 -	2.48E+00 -
F3	2.04E+01	2.04E+01 =	2.04E+01 +	2.20E+01 -	2.12E+01 -	2.06E+01 -	2.08E+01 -
F4	4.65E-01	5.69E-01 -	4.38E-01 =	7.29E-01 -	4.84E-01 =	5.18E-01 -	4.75E-01 =
F5	2.06E+00	8.64E+00 -	2.21E+00 =	1.24E+01 -	5.10E+00 -	1.59E+01 -	3.41E+01 -
F6	9.51E-02	2.10E-01 -	1.62E-01 -	2.11E-01 -	1.07E+00 -	3.01E-01 -	3.10E-01 -
F7	8.09E-01	2.61E-01 +	6.74E-01 +	6.51E-01 =	1.15E-01 +	7.06E-01 +	1.07E+00 -
F8	1.00E+02	1.00E+02 =	1.00E+02 =	1.00E+02 =	1.00E+02 =	8.48E+01 +	1.00E+02 =
F9	2.94E+02	1.97E+02 =	2.13E+02 =	4.06E+02 =	4.00E+02 =	9.93E+01 +	4.03E+02 =
F10	4.07E+02	4.08E+02 =	4.14E+02 -	4.06E+02 +	4.14E+02 -	4.00E+02 +	4.14E+02 -
	-	1/4/5	2/2/6	1/5/4	1/5/4	4/5/1	0/6/4

Table 5: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 000)

10D(000)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F3	0.00E+00	0.00E+00 =	0.00E+00 =	1.05E+01 -	8.05E+02 -	0.00E+00 =	1.09E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	2.47E-01 -	2.50E+01 -	0.00E+00 =	1.94E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	9.19E-01 -	0.00E+00 =	0.00E+00 =
F6	0.00E+00	0.00E+00 =	0.00E+00 =	1.53E-02 -	5.26E+00 -	0.00E+00 =	5.57E-02 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	1.23E-04 -	3.37E+00 -	0.00E+00 =	5.12E-04 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.18E+00 -	0.00E+00 =	0.00E+00 =
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.00E+02 -	0.00E+00 =	0.00E+00 =
F10	0.00E+00	0.00E+00 =	0.00E+00 =	4.80E+01 -	3.51E+02 -	0.00E+00 =	4.80E+01 -
	-	0/0/10	0/0/10	0/5/5	0/8/2	0/0/10	0/5/5

Table 6: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 001)

10D(001)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	1.53E+00 -	0.00E+00 =	2.52E-01 -	6.32E+00 -
F3	0.00E+00	0.00E+00 =	0.00E+00 =	1.08E+01 -	8.05E+02 -	1.60E-01 -	1.21E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	3.65E-01 -	2.50E+01 -	0.00E+00 =	3.54E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	2.26E-01 -	9.19E-01 -	0.00E+00 =	6.31E-01 -
F6	0.00E+00	0.00E+00 =	4.76E-07 =	1.15E-01 -	5.26E+00 -	3.05E-02 -	7.98E-01 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	2.86E-02 -	3.37E+00 -	0.00E+00 =	2.52E-01 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	2.57E-08 =	1.18E+00 -	6.24E-08 =	0.00E+00 =
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.00E+02 -	0.00E+00 =	0.00E+00 =
F10	0.00E+00	1.72E-04 =	0.00E+00 =	6.18E+01 -	3.51E+02 -	1.81E+00 -	6.64E+01 -
	-	0/0/10	0/0/10	0/7/3	0/8/2	0/4/6	0/7/3

Table 7: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 010)

10D(010)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	2.08E-03	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F3	1.09E+01	1.02E+01 =	1.09E+01 =	1.09E+01 =	8.05E+02 -	1.09E+01 =	1.09E+01 =
F4	1.63E-01	2.72E-01 -	1.92E-01 -	2.20E-01 -	2.50E+01 -	3.06E-01 -	1.89E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	9.19E-01 -	0.00E+00 =	0.00E+00 =
F6	1.78E-02	1.79E-02 =	1.87E-02 =	6.39E-03 +	5.26E+00 -	2.96E-02 -	2.02E-02 =
F7	8.86E-04	1.36E-03 =	1.12E-03 =	7.25E-03 -	3.37E+00 -	2.51E-03 -	9.54E-04 =
F8	8.33E+01	4.05E+01 +	8.79E+01 =	8.67E+01 =	1.18E+00 +	7.20E+00 +	1.00E+02 -
F9	9.67E+01	9.33E+01 =	9.33E+01 =	2.63E+02 -	1.00E+02 -	8.53E+01 =	2.93E+02 -
F10	4.00E+02	3.90E+02 =	4.00E+02 =	4.00E+02 =	3.51E+02 +	4.00E+02 =	4.00E+02 =
	-	1/1/8	0/1/9	1/3/6	2/6/2	1/3/6	0/3/7

Table 8: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 011)

10D(011)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	7.09E+00	2.00E+01 =	1.18E+01 =	1.30E+01 =	0.00E+00 +	1.27E+01 -	6.99E+00 =
F3	1.34E+01	1.34E+01 =	1.37E+01 =	1.13E+01 +	8.05E+02 -	1.40E+01 -	1.21E+01 +
F4	1.74E-01	2.25E-01 =	3.54E-01 -	3.56E-01 -	2.50E+01 -	4.96E-02 +	3.67E-01 -
F5	1.10E+00	3.75E+00 -	9.77E-01 =	2.14E-01 +	9.19E-01 =	2.26E+01 -	4.60E-01 +
F6	2.48E-01	3.08E-01 =	2.98E-01 =	6.14E-02 +	5.26E+00 -	5.78E-01 -	3.19E-01 -
F7	8.19E-02	1.03E-01 =	1.64E-01 -	3.20E-02 +	3.37E+00 -	4.63E-01 -	3.43E-01 -
F8	9.18E+01	6.25E+01 +	9.60E+01 =	9.67E+01 =	1.18E+00 +	2.79E+01 +	1.00E+02 =
F9	1.04E+02	9.08E+01 =	9.00E+01 =	2.61E+02 -	1.00E+02 +	8.42E+01 +	3.01E+02 -
F10	3.99E+02	2.79E+02 +	3.98E+02 +	4.13E+02 =	3.51E+02 +	3.88E+02 =	4.09E+02 -
	-	2/1/7	1/2/7	4/2/4	4/4/2	3/6/1	2/5/3

Table 9: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 100)

10D(100)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	3.33E-13 -	0.00E+00 =	0.00E+00 =
F3	0.00E+00	0.00E+00 =	0.00E+00 =	1.05E+01 -	1.09E+01 -	0.00E+00 =	1.09E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	2.19E-01 -	2.10E-01 -	0.00E+00 =	1.95E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	6.94E-03 =	0.00E+00 =	0.00E+00 =
F6	0.00E+00	0.00E+00 =	0.00E+00 =	1.29E-02 -	1.51E-01 -	0.00E+00 =	5.71E-02 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	1.38E-04 -	1.47E-02 -	0.00E+00 =	6.40E-04 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F10	0.00E+00	0.00E+00 =	0.00E+00 =	4.80E+01 -	4.80E+01 -	0.00E+00 =	4.80E+01 -
	-	0/0/10	0/0/10	0/5/5	0/6/4	0/0/10	0/5/5

Table 10: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 101)

10D(101)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	1.53E+00 -	1.16E+01 -	1.98E-01 -	6.54E+00 -
F3	0.00E+00	0.00E+00 =	0.00E+00 =	1.07E+01 -	1.17E+01 -	1.38E-01 -	1.22E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	3.59E-01 -	3.49E-01 -	0.00E+00 =	3.57E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	1.73E-01 -	4.88E-01 -	0.00E+00 =	6.47E-01 -
F6	0.00E+00	0.00E+00 =	2.14E-04 =	1.02E-01 -	5.56E-01 -	3.86E-02 -	8.39E-01 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	2.89E-02 -	2.45E-01 -	0.00E+00 =	2.20E-01 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	2.28E-04 =	0.00E+00 =
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F10	0.00E+00	0.00E+00 =	0.00E+00 =	6.18E+01 -	4.31E+01 -	4.37E-02 -	6.64E+01 -
	-	0/0/10	0/0/10	0/7/3	0/7/3	0/4/6	0/7/3

Table 11: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 110)

10D(110)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	4.16E-03 =	0.00E+00 =	1.04E-02 -	0.00E+00 =	0.00E+00 =
F3	1.09E+01	1.09E+01 =	1.09E+01 =	1.09E+01 =	1.09E+01 =	1.09E+01 =	1.09E+01 =
F4	1.78E-01	2.77E-01 -	1.90E-01 =	2.21E-01 -	2.02E-01 -	3.17E-01 -	1.90E-01 =
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	2.08E-02 =	0.00E+00 =	0.00E+00 =
F6	1.49E-02	1.84E-02 =	1.77E-02 =	5.07E-03 +	4.65E-02 -	3.18E-02 -	2.08E-02 =
F7	8.78E-04	1.33E-03 =	1.83E-03 =	7.37E-03 -	1.39E-03 =	7.26E-03 -	1.18E-03 -
F8	8.33E+01	5.00E+01 +	9.40E+01 =	8.67E+01 =	1.00E+02 -	1.06E+00 +	1.00E+02 -
F9	9.00E+01	9.67E+01 =	9.33E+01 =	2.63E+02 -	3.00E+02 -	8.63E+01 =	2.93E+02 -
F10	4.00E+02	3.73E+02 =	4.00E+02 =	4.00E+02 =	4.00E+02 =	4.00E+02 =	4.00E+02 =
	-	1/1/8	0/0/10	1/3/6	0/5/5	1/3/6	0/3/7

Table 12: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (10D, 111)

10D(111)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	6.82E+00	1.05E+01 -	1.39E+01 =	1.29E+01 =	2.75E+01 =	1.63E+01 -	6.58E+00 =
F3	1.38E+01	1.38E+01 =	1.40E+01 =	1.13E+01 +	1.18E+01 +	1.39E+01 =	1.20E+01 +
F4	1.62E-01	1.86E-01 =	3.71E-01 -	3.82E-01 -	3.74E-01 -	4.67E-02 +	3.44E-01 -
F5	1.43E+00	3.88E+00 -	9.32E-01 =	2.80E-01 +	6.28E-01 =	2.10E+01 -	4.62E-01 +
F6	2.38E-01	3.60E-01 -	3.51E-01 -	6.64E-02 +	6.72E-01 -	6.20E-01 -	3.30E-01 -
F7	7.20E-02	1.83E-01 -	1.66E-01 -	3.23E-02 +	4.22E-01 -	4.37E-01 -	3.62E-01 -
F8	9.39E+01	6.62E+01 +	9.21E+01 =	9.67E+01 =	1.00E+02 -	2.44E+01 +	1.00E+02 =
F9	1.08E+02	9.41E+01 =	9.00E+01 +	2.60E+02 -	3.01E+02 -	8.16E+01 +	3.01E+02 -
F10	3.99E+02	2.79E+02 +	3.98E+02 +	4.13E+02 =	3.66E+02 +	3.84E+02 =	4.09E+02 -
	-	2/4/4	2/3/5	4/2/4	2/5/3	3/5/2	2/5/3

Table 13: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 000)

20D(000)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	1.04E-03 =	2.75E+01 -	0.00E+00 =	0.00E+00 =
F3	0.00E+00	0.00E+00 =	0.00E+00 =	2.02E+01 -	1.18E+01 -	0.00E+00 =	2.02E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	5.82E-01 -	3.74E-01 -	0.00E+00 =	4.06E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	6.28E-01 -	0.00E+00 =	0.00E+00 =
F6	0.00E+00	0.00E+00 =	0.00E+00 =	2.50E-01 -	6.72E-01 -	2.06E-02 -	6.37E-01 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	6.29E-02 -	4.22E-01 -	2.62E-03 -	2.32E-01 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.00E+02 -	0.00E+00 =	0.00E+00 =
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	3.01E+02 -	0.00E+00 =	0.00E+00 =
F10	0.00E+00	0.00E+00 =	0.00E+00 =	4.88E+01 -	3.66E+02 -	5.00E-04 -	4.88E+01 -
	-	0/0/10	0/0/10	0/5/5	0/9/1	0/3/7	0/5/5

Table 14: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 001)

20D(001)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	2.31E+00 -	2.75E+01 -	2.30E-01 -	2.63E+00 -
F3	0.00E+00	0.00E+00 =	0.00E+00 =	2.11E+01 -	1.18E+01 -	7.57E-02 -	2.17E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	7.90E-01 -	3.74E-01 -	0.00E+00 =	5.56E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	4.08E+00 -	6.28E-01 -	0.00E+00 =	4.14E+00 -
F6	0.00E+00	0.00E+00 =	0.00E+00 =	4.38E-01 -	6.72E-01 -	9.28E-02 -	2.83E+00 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	3.90E-01 -	4.22E-01 -	6.03E-08 =	1.11E+00 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	5.47E+01 -	1.00E+02 -	2.63E+02 -	5.53E+00 -
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	3.01E+02 -	0.00E+00 =	0.00E+00 =
F10	0.00E+00	4.48E-04 =	0.00E+00 =	6.26E+01 -	3.66E+02 -	6.02E+01 -	6.24E+01 -
	-	0/0/10	0/0/10	0/8/2	0/9/1	0/5/5	0/8/2

Table 15: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 010)

20D(010)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	2.75E+01 -	0.00E+00 =	0.00E+00 =
F3	2.02E+01	2.02E+01 =	2.02E+01 =	2.02E+01 =	1.18E+01 +	2.02E+01 =	2.02E+01 =
F4	4.14E-01	5.51E-01 -	4.60E-01 -	5.66E-01 -	3.74E-01 =	8.11E-01 -	4.34E-01 =
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	6.28E-01 -	0.00E+00 =	0.00E+00 =
F6	5.76E-02	7.71E-02 =	6.23E-02 =	9.49E-02 =	6.72E-01 -	2.04E-01 -	9.25E-02 -
F7	4.26E-02	3.86E-02 =	2.52E-02 +	3.54E-02 +	4.22E-01 -	1.86E-01 -	6.34E-02 -
F8	1.00E+02	9.41E+01 =	1.00E+02 =	1.00E+02 =	1.00E+02 -	9.61E+01 =	1.00E+02 =
F9	2.88E+02	1.80E+02 +	2.40E+02 +	3.00E+02 =	3.01E+02 -	1.01E+02 +	3.94E+02 -
F10	4.00E+02	4.00E+02 =	4.00E+02 =	4.68E+02 -	3.66E+02 +	4.00E+02 =	4.86E+02 -
	-	1/1/8	2/1/7	1/2/7	2/6/2	1/3/6	0/4/6

Table 16: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 011)

20D(011)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.37E-08 -	0.00E+00 =
F2	2.27E+00	5.16E+00 -	2.73E+00 =	1.31E+01 -	2.75E+01 -	1.87E+01 -	2.44E+00 =
F3	2.14E+01	2.17E+01 =	2.11E+01 +	2.30E+01 -	1.18E+01 +	2.29E+01 -	2.18E+01 =
F4	6.07E-01	7.79E-01 -	6.16E-01 =	8.23E-01 -	3.74E-01 +	1.08E+00 -	5.62E-01 +
F5	1.17E+01	3.02E+01 -	2.36E+01 -	1.07E+01 +	6.28E-01 +	2.31E+02 -	4.95E+01 =
F6	2.53E-01	5.33E-01 -	3.45E-01 -	2.78E-01 =	6.72E-01 -	8.79E-01 -	5.40E-01 -
F7	3.13E+00	6.17E+00 -	3.36E+00 -	2.21E+00 =	4.22E-01 +	1.04E+02 -	9.60E-01 =
F8	1.00E+02	1.00E+02 =	1.00E+02 =	1.00E+02 =	1.00E+02 -	1.00E+02 =	1.00E+02 =
F9	3.81E+02	1.95E+02 +	3.26E+02 +	4.05E+02 -	3.01E+02 +	9.90E+01 +	4.03E+02 -
F10	4.07E+02	4.10E+02 -	4.14E+02 -	4.06E+02 +	3.66E+02 +	4.10E+02 -	4.14E+02 -
	-	1/6/3	2/4/4	2/4/4	6/3/1	1/8/1	1/3/6

Table 17: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 100)

20D(100)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.82E-13 =	0.00E+00 =	0.00E+00 =
F3	0.00E+00	0.00E+00 =	0.00E+00 =	2.02E+01 -	2.02E+01 -	0.00E+00 =	2.02E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	5.24E-01 -	4.23E-01 -	0.00E+00 =	4.17E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F6	0.00E+00	0.00E+00 =	0.00E+00 =	1.73E-01 -	1.96E+00 -	1.47E-02 -	6.48E-01 -
F7	0.00E+00	1.99E-09 =	0.00E+00 =	7.51E-02 -	5.29E-01 -	1.86E-03 -	2.22E-01 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	4.24E-13 -	0.00E+00 =	0.00E+00 =
F10	0.00E+00	0.00E+00 =	0.00E+00 =	4.88E+01 -	4.88E+01 -	3.70E-04 -	4.88E+01 -
	-	0/0/10	0/0/10	0/5/5	0/6/4	0/3/7	0/5/5

Table 18: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 101)

20D(101)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	2.43E+00 -	5.27E+02 -	2.59E-01 -	2.80E+00 -
F3	0.00E+00	0.00E+00 =	0.00E+00 =	2.14E+01 -	2.50E+01 -	2.16E-02 -	2.17E+01 -
F4	0.00E+00	0.00E+00 =	0.00E+00 =	7.56E-01 -	9.69E-01 -	0.00E+00 =	5.64E-01 -
F5	0.00E+00	0.00E+00 =	0.00E+00 =	4.58E+00 -	4.22E+00 -	0.00E+00 =	4.19E+00 -
F6	0.00E+00	0.00E+00 =	0.00E+00 =	4.56E-01 -	3.66E+00 -	8.68E-02 -	2.86E+00 -
F7	0.00E+00	0.00E+00 =	0.00E+00 =	3.95E-01 -	1.34E+00 -	4.39E-09 =	7.99E-01 -
F8	0.00E+00	0.00E+00 =	0.00E+00 =	5.62E+01 -	0.00E+00 =	2.04E+02 -	5.53E+00 -
F9	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	3.79E-13 -	0.00E+00 =	0.00E+00 =
F10	0.00E+00	0.00E+00 =	0.00E+00 =	6.26E+01 -	4.94E+01 -	5.68E+01 -	6.24E+01 -
	-	0/0/10	0/0/10	0/8/2	0/8/2	0/5/5	0/8/2

Table 19: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 110)

20D(110)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F2	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	1.21E-13 =	0.00E+00 =	0.00E+00 =
F3	2.02E+01	2.02E+01 =	2.02E+01 =	2.02E+01 =	2.02E+01 =	2.02E+01 =	2.02E+01 =
F4	4.16E-01	5.55E-01 -	4.55E-01 -	5.69E-01 -	4.36E-01 =	8.05E-01 -	4.19E-01 =
F5	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =
F6	4.79E-02	8.42E-02 -	5.97E-02 -	9.80E-02 -	1.54E+00 -	2.18E-01 -	9.59E-02 -
F7	3.93E-02	3.51E-02 =	3.16E-02 =	3.15E-02 +	4.92E-01 -	1.87E-01 -	7.06E-02 -
F8	1.00E+02	1.00E+02 =	1.00E+02 =	1.00E+02 =	1.00E+02 =	9.66E+01 =	1.00E+02 =
F9	2.95E+02	1.80E+02 +	2.40E+02 +	3.00E+02 =	3.37E+02 -	1.01E+02 +	3.94E+02 -
F10	4.00E+02	4.00E+02 =	4.00E+02 =	4.68E+02 -	4.00E+02 =	4.00E+02 =	4.86E+02 -
	-	1/2/7	1/2/7	1/3/6	0/3/7	1/3/6	0/4/6

Table 20: The results of AR-IMadDE and six comparison algorithms in the CEC2021 problem set (20D, 111)

20D(111)	AR-IMadDE	APGSK-IMODE	MadDE	EA4eig	APSM-jSO	IMODE	LSHADE
F1	0.00E+00	0.00E+00 =	0.00E+00 =	0.00E+00 =	0.00E+00 =	8.27E-09 -	0.00E+00 =
F2	2.91E+00	4.42E+00 =	2.30E+00 =	1.34E+01 -	8.05E+02 -	1.74E+01 -	2.49E+00 =
F3	2.14E+01	2.16E+01 -	2.10E+01 +	2.30E+01 -	2.50E+01 -	2.28E+01 -	2.16E+01 =
F4	5.69E-01	7.87E-01 -	6.16E-01 =	7.88E-01 -	9.19E-01 -	1.11E+00 -	5.70E-01 =
F5	1.05E+01	3.05E+01 -	2.17E+01 -	9.14E+00 +	5.26E+00 +	2.23E+02 -	5.63E+01 =
F6	2.69E-01	4.81E-01 -	4.10E-01 -	3.91E-01 =	3.37E+00 -	8.36E-01 -	5.45E-01 -
F7	4.07E+00	8.41E+00 -	2.15E+00 =	1.21E+00 =	1.18E+00 =	9.54E+01 -	9.82E-01 =
F8	1.00E+02	9.81E+01 =	1.00E+02 =	1.00E+02 =	1.00E+02 -	9.77E+01 =	1.00E+02 =
F9	4.02E+02	2.09E+02 +	3.27E+02 +	4.05E+02 -	3.51E+02 +	1.00E+02 +	4.03E+02 -
F10	4.07E+02	4.10E+02 -	4.14E+02 -	4.06E+02 +	6.41E+02 -	4.09E+02 -	4.14E+02 -
	-	1/6/3	2/3/5	2/4/4	2/6/2	1/8/1	0/3/7