

Section 3.3.4. Scalability research of WDO

Data1: Statistical results of 50 dimensions benchmark test functions by several methods.

Function	Item	WDO	DE	PSO	SFO	MA	SSA	CPA	EHVPSO	IGWO	LFD
F1	AVG	1.56E-161	7.86E+04	2.54E+03	7.22E-09	6.49E-35	8.93E-09	2.45E-120	1.92E+01	0.00E+00	1.07E-11
	Best	3.93E-174	7.04E+04	1.23E+03	4.52E-11	6.28E-85	6.73E-09	1.33E-144	5.88E+00	0.00E+00	5.24E-12
	Worst	4.83E-160	8.40E+04	4.18E+03	7.34E-08	1.98E-33	1.27E-08	4.20E-119	5.51E+01	0.00E+00	1.70E-11
	STD	8.68E-161	3.55E+03	6.89E+02	1.47E-08	3.55E-34	1.28E-09	9.54E-120	1.16E+01	0.00E+00	3.03E-12
F2	AVG	1.49E-101	1.52E+12	2.18E+01	1.96E-04	7.81E-30	8.50E-01	1.86E-82	2.82E+01	4.33E-311	9.75E-05
	Best	2.85E-109	6.02E+09	1.24E+01	2.61E-05	4.11E-42	3.02E-03	2.44E-102	1.43E+00	4.33E-314	5.85E-05
	Worst	4.62E-100	1.94E+13	2.85E+01	6.36E-04	2.42E-28	6.24E+00	5.71E-81	5.85E+01	4.33E-310	2.65E-04
	STD	8.30E-101	3.58E+12	3.72E+00	1.37E-04	4.35E-29	1.30E+00	1.03E-81	1.60E+01	0.00E+00	4.14E-05
F3	AVG	3.61E-15	1.01E+05	1.06E+04	3.86E-07	2.23E-01	9.14E-07	1.05E-13	1.62E+04	1.92E-38	4.14E-08
	Best	2.30E-17	7.95E+04	4.72E+03	5.33E-09	4.15E-04	4.37E-07	1.29E-17	5.25E+02	1.11E-59	2.44E-08
	Worst	4.57E-14	1.17E+05	1.68E+04	2.27E-06	1.53E+00	1.26E-06	2.42E-12	9.91E+04	5.94E-37	6.78E-08
	STD	8.77E-15	1.02E+04	2.92E+03	5.63E-07	3.74E-01	1.82E-07	4.33E-13	2.98E+04	1.07E-37	9.65E-09
F4	AVG	3.71E-06	7.74E+01	2.90E+01	7.16E-06	3.86E+01	6.69E+00	5.91E+01	3.79E+01	1.68E-54	2.91E-05
	Best	5.49E-07	7.38E+01	1.83E+01	3.40E-07	2.51E+01	1.94E+00	4.76E+01	1.26E+01	1.67E-62	1.30E-05
	Worst	1.70E-05	8.08E+01	3.86E+01	2.51E-05	8.58E+01	1.56E+01	6.93E+01	5.54E+01	5.10E-53	1.01E-04
	STD	3.88E-06	1.54E+00	4.83E+00	6.75E-06	1.18E+01	2.87E+00	5.02E+00	8.76E+00	9.15E-54	1.85E-05
F5	AVG	2.45E+01	2.24E+08	6.02E+05	2.38E-01	5.18E+01	7.77E+01	8.21E+00	5.17E+02	3.51E+01	3.09E+01
	Best	2.19E+01	1.75E+08	1.17E+05	1.80E-03	2.08E-01	4.08E+01	1.32E-03	2.03E+02	3.39E+01	3.06E+01
	Worst	2.92E+01	2.61E+08	1.59E+06	2.36E+00	9.91E+01	3.70E+02	8.18E+01	1.01E+03	3.63E+01	3.11E+01
	STD	1.18E+00	2.05E+07	4.15E+05	4.45E-01	3.32E+01	7.25E+01	1.89E+01	1.98E+02	6.35E-01	1.40E-01
F6	AVG	3.45E-26	7.82E+04	2.49E+03	4.45E-01	6.14E-18	9.25E-09	1.89E-14	1.87E+01	5.07E-33	3.74E-11
	Best	3.18E-30	6.21E+04	1.03E+03	7.73E-06	1.57E-29	5.91E-09	1.36E-25	8.86E+00	0.00E+00	1.81E-11
	Worst	8.27E-25	8.61E+04	4.75E+03	2.00E+00	1.50E-16	1.44E-08	5.85E-13	6.89E+01	1.54E-32	5.23E-11
	STD	1.49E-25	4.95E+03	7.93E+02	5.66E-01	2.72E-17	1.81E-09	1.05E-13	1.23E+01	5.71E-33	8.51E-12
F7	AVG	7.73E-03	1.65E+02	7.20E-01	7.74E-05	5.84E-03	1.33E-02	1.08E+00	3.93E-02	2.69E-04	8.70E-05
	Best	2.53E-03	1.26E+02	2.50E-01	5.00E-07	2.83E-03	8.06E-03	2.36E-02	1.40E-02	7.55E-05	5.26E-06
	Worst	1.56E-02	1.96E+02	1.32E+00	3.62E-04	9.01E-03	1.92E-02	9.80E+00	7.15E-02	5.73E-04	3.95E-04
	STD	2.83E-03	1.79E+01	2.76E-01	7.53E-05	1.49E-03	3.28E-03	2.12E+00	1.57E-02	1.09E-04	9.02E-05
F8	AVG	-1.93E+04	-6.33E+03	-8.00E+03	-5.45E+03	-1.80E+04	-1.27E+04	-1.30E+04	N/A	-1.72E+04	-5.72E+04
	Best	-2.01E+04	-7.29E+03	-9.14E+03	-6.71E+03	-1.86E+04	-1.42E+04	-1.49E+04	N/A	-1.95E+04	-1.58E+05
	Worst	-1.76E+04	-5.69E+03	-6.67E+03	-4.69E+03	-1.72E+04	-1.05E+04	-1.11E+04	N/A	-1.20E+04	-3.03E+04
	STD	5.23E+02	3.88E+02	6.57E+02	5.29E+02	3.50E+02	9.41E+02	9.40E+02	N/A	1.69E+03	2.84E+04
F9	AVG	7.95E+01	6.04E+02	2.22E+02	2.33E-07	1.28E-01	1.44E+02	1.23E+02	9.38E+01	2.90E+01	3.39E-09
	Best	4.97E+01	5.67E+02	1.36E+02	2.79E-10	1.25E-12	8.56E+01	7.86E+01	4.82E+01	9.95E+00	1.56E-09
	Worst	1.33E+02	6.33E+02	2.87E+02	2.06E-06	9.95E-01	1.93E+02	1.80E+02	2.06E+02	5.67E+01	6.40E-09
	STD	1.92E+01	1.72E+01	2.98E+01	4.30E-07	3.39E-01	2.73E+01	2.79E+01	3.23E+01	1.29E+01	1.04E-09
F10	AVG	5.11E-13	2.00E+01	1.03E+01	2.39E-05	2.22E-09	2.21E+00	1.09E+01	4.52E+00	7.99E-15	5.24E-06
	Best	6.48E-14	1.97E+01	7.82E+00	7.21E-07	1.47E-12	1.56E+00	7.81E+00	3.26E+00	7.99E-15	3.88E-06
	Worst	5.06E-12	2.03E+01	1.18E+01	1.26E-04	3.55E-08	2.72E+00	1.47E+01	6.38E+00	7.99E-15	6.97E-06

F11	STD	1.03E-12	1.20E-01	8.89E-01	2.57E-05	6.94E-09	3.40E-01	1.73E+00	7.03E-01	0.00E+00	8.52E-07
	AVG	8.85E-03	3.16E+02	5.50E+00	1.23E-10	7.33E-02	1.21E-02	1.83E-01	1.15E+00	3.26E-03	1.24E-11
	Best	0.00E+00	2.42E+02	3.19E+00	1.13E-12	1.43E-13	5.06E-09	4.87E-10	1.07E+00	0.00E+00	7.31E-12
	Worst	6.66E-16	6.66E-16	8.70E+00	3.68E-10	2.08E-01	3.93E-02	1.18E+00	1.35E+00	1.97E-02	1.97E-11
F12	STD	1.25E-02	3.15E+01	1.86E+00	1.25E-10	5.45E-02	1.16E-02	2.41E-01	6.56E-02	5.67E-03	3.40E-12
	AVG	2.25E-20	4.10E+08	6.14E+03	6.17E-02	2.01E-03	3.94E+00	6.61E-01	8.05E+00	9.52E-33	2.61E-12
	Best	3.37E-30	3.13E+08	2.34E+01	9.43E-06	6.62E-28	1.81E-11	3.17E-26	1.32E+00	9.42E-33	1.56E-12
	Worst	3.58E-19	4.77E+08	4.57E+04	4.01E-01	6.22E-02	1.05E+01	5.16E+00	1.50E+01	1.02E-32	4.10E-12
F13	STD	8.55E-20	3.99E+07	1.11E+04	9.19E-02	1.12E-02	2.47E+00	1.13E+00	3.64E+00	1.60E-34	6.75E-13
	AVG	2.84E-03	9.46E+08	2.85E+05	6.89E-04	5.32E-03	7.76E-03	1.40E+00	1.50E+01	2.89E-02	3.24E-02
	Best	6.62E-27	7.51E+08	3.50E+03	5.78E-06	1.97E-25	2.14E-10	3.44E-24	4.03E+00	1.35E-32	3.24E-10
	Worst	1.10E-02	1.07E+09	1.24E+06	6.04E-03	4.39E-02	5.48E-02	8.06E+00	9.45E+01	1.98E-01	1.71E-01
	STD	4.89E-03	8.39E+07	3.02E+05	1.22E-03	1.13E-02	1.27E-02	2.11E+00	1.58E+01	5.18E-02	4.47E-02

Data2: Statistical results of 100 dimensions benchmark test functions by several methods.

Function	Item	WDO	DE	PSO	SFO	MA	SSA	CPA	EHVPSO	IGWO	LFD
F1	AVG	1.42E-104	2.01E+05	1.02E+04	6.46E-09	2.66E-62	3.70E-08	2.94E-68	4.94E+01	0.00E+00	3.08E-11
	Best	8.16E-112	1.89E+05	6.17E+03	4.75E-11	1.83E-77	2.93E-08	5.30E-79	1.43E+01	0.00E+00	2.20E-11
	Worst	3.25E-103	2.10E+05	1.60E+04	5.82E-08	8.14E-61	4.61E-08	8.73E-67	1.32E+02	0.00E+00	4.47E-11
	STD	5.88E-104	5.62E+03	2.44E+03	1.33E-08	1.46E-61	4.00E-09	1.57E-67	2.75E+01	0.00E+00	4.94E-12
F2	AVG	1.07E-50	2.97E+34	6.88E+01	1.37E-04	2.89E-36	2.62E+00	4.35E+51	9.94E+01	0.00E+00	1.60E-04
	Best	6.85E-77	6.42E+28	4.75E+01	1.34E-05	5.30E-48	8.63E-02	9.37E+42	2.82E+01	0.00E+00	1.20E-04
	Worst	3.31E-49	3.65E+35	9.07E+01	5.39E-04	6.18E-35	1.05E+01	1.27E+53	1.55E+02	0.00E+00	2.23E-04
	STD	5.94E-50	6.91E+34	1.09E+01	1.48E-04	1.17E-35	2.18E+00	2.28E+52	3.47E+01	0.00E+00	2.00E-05
F3	AVG	8.48E-01	3.65E+05	4.97E+04	2.88E-06	3.66E-08	8.22E-03	1.62E-02	2.17E+05	1.04E-07	5.76E-07
	Best	4.70E-04	2.78E+05	3.25E+04	1.30E-09	8.68E-12	2.09E-03	5.15E-06	6.16E+03	7.33E-14	3.56E-07
	Worst	2.60E+01	4.36E+05	6.78E+04	1.88E-05	3.81E-07	2.22E-02	5.00E-01	5.67E+05	1.43E-06	8.42E-07
	STD	4.67E+00	3.83E+04	1.10E+04	4.80E-06	9.35E-08	4.37E-03	8.98E-02	1.67E+05	2.86E-07	1.30E-07
F4	AVG	6.19E-02	8.73E+01	4.03E+01	1.09E-05	1.20E+01	2.27E+01	7.48E+01	5.15E+01	1.43E+00	1.83E-04
	Best	6.88E-03	8.52E+01	3.12E+01	2.05E-07	5.18E+00	1.23E+01	6.81E+01	3.62E+01	3.39E-02	4.44E-05
	Worst	2.64E-01	8.94E+01	4.74E+01	9.83E-05	1.99E+01	2.93E+01	8.00E+01	6.77E+01	4.72E+00	2.94E-04
	STD	6.44E-02	9.35E-01	3.38E+00	1.95E-05	4.08E+00	3.72E+00	3.37E+00	7.44E+00	1.04E+00	5.97E-05
F5	AVG	7.74E+01	7.22E+08	4.10E+06	4.42E-01	1.10E+01	1.20E+02	2.22E+01	1.01E+03	8.13E+01	7.91E+01
	Best	7.51E+01	6.57E+08	2.17E+06	9.71E-03	3.77E-02	8.95E+01	3.30E-02	4.12E+02	7.97E+01	7.88E+01
	Worst	8.28E+01	7.85E+08	7.26E+06	4.29E+00	2.10E+01	3.09E+02	1.05E+02	2.15E+03	8.31E+01	7.95E+01
	STD	1.58E+00	3.37E+07	1.24E+06	8.33E-01	7.10E+00	5.37E+01	3.07E+01	4.01E+02	9.01E-01	1.36E-01
F6	AVG	2.18E-13	2.00E+05	1.02E+04	7.49E-01	0.00E+00	3.74E-08	3.14E-11	5.11E+01	1.00E-31	4.72E-11
	Best	1.80E-26	1.82E+05	5.75E+03	1.34E-05	0.00E+00	2.93E-08	4.24E-14	2.40E+01	2.16E-32	3.34E-11
	Worst	5.06E-12	2.11E+05	1.42E+04	3.68E+00	0.00E+00	4.36E-08	4.82E-10	1.21E+02	3.76E-31	7.39E-11
	STD	9.39E-13	7.34E+03	2.22E+03	1.01E+00	0.00E+00	4.06E-09	9.19E-11	2.34E+01	8.99E-32	8.89E-12
F7	AVG	2.06E-02	1.06E+03	6.39E+00	2.98E-05	3.34E-03	3.23E-02	1.15E+01	6.40E-02	2.65E-04	5.65E-05
	Best	9.82E-03	8.96E+02	2.86E+00	1.69E-06	1.96E-03	1.95E-02	4.98E-01	2.46E-02	1.30E-04	1.80E-06
	Worst	3.46E-02	1.16E+03	1.07E+01	8.54E-05	6.13E-03	4.53E-02	4.25E+01	1.24E-01	4.54E-04	1.83E-04

F8	STD	5.68E-03	6.83E+01	2.13E+00	2.11E-05	1.14E-03	6.76E-03	1.04E+01	2.84E-02	7.95E-05	4.96E-05
	AVG	-3.79E+04	-8.97E+03	-1.12E+04	-7.73E+03	-1.09E+04	-2.52E+04	-2.40E+04	N/A	-2.97E+04	-8.50E+04
	Best	-3.95E+04	-9.97E+03	-1.40E+04	-9.56E+03	-1.16E+04	-2.88E+04	-2.67E+04	N/A	-3.38E+04	-2.49E+05
	Worst	-3.59E+04	-8.32E+03	-9.96E+03	-6.60E+03	-1.02E+04	-2.19E+04	-2.21E+04	N/A	-2.53E+04	-4.24E+04
F9	STD	8.31E+02	3.78E+02	9.16E+02	7.63E+02	3.04E+02	1.76E+03	1.09E+03	N/A	2.19E+03	4.30E+04
	AVG	1.76E+02	1.38E+03	6.13E+02	3.99E-08	6.42E-02	2.65E+02	2.96E+02	2.65E+02	6.37E+01	1.24E-08
	Best	1.11E+02	1.32E+03	5.52E+02	1.06E-11	0.00E+00	1.35E+02	2.30E+02	1.36E+02	3.28E+01	8.79E-09
	Worst	2.26E+02	1.42E+03	6.96E+02	3.39E-07	9.95E-01	3.75E+02	3.57E+02	7.70E+02	1.03E+02	1.63E-08
F10	STD	3.17E+01	2.30E+01	3.77E+01	7.15E-08	2.48E-01	5.29E+01	3.19E+01	1.12E+02	1.81E+01	2.00E-09
	AVG	5.29E-14	2.05E+01	1.18E+01	2.00E-05	7.65E-12	3.00E+00	1.46E+01	4.31E+00	1.50E-14	3.12E-06
	Best	2.93E-14	2.03E+01	1.01E+01	1.51E-06	7.99E-15	2.14E+00	1.28E+01	3.43E+00	1.15E-14	2.23E-06
	Worst	3.22E-14	2.06E+01	1.37E+01	5.49E-05	1.22E-10	5.08E+00	1.72E+01	5.86E+00	1.87E-14	3.63E-06
F11	STD	1.93E-13	5.73E-02	7.55E-01	1.60E-05	2.42E-11	5.87E-01	1.11E+00	5.24E-01	1.12E-15	2.97E-07
	AVG	3.45E-03	1.81E+03	9.84E+01	3.62E-10	5.25E-02	2.83E-03	9.84E-01	1.48E+00	1.51E-03	3.39E-11
	Best	0.00E+00	1.68E+03	6.05E+01	1.36E-13	0.00E+00	4.55E-08	1.48E-13	1.21E+00	0.00E+00	2.28E-11
	Worst	1.48E-02	1.93E+03	1.30E+02	2.81E-09	1.52E-01	1.72E-02	1.68E+01	2.46E+00	2.46E-02	4.62E-11
F12	STD	5.83E-03	6.42E+01	2.03E+01	6.87E-10	3.86E-02	4.88E-03	3.08E+00	2.88E-01	5.18E-03	5.64E-12
	AVG	5.02E-03	1.51E+09	8.86E+04	6.70E-02	9.85E-30	7.46E+00	4.89E-01	1.00E+01	6.34E-33	2.69E-12
	Best	1.75E-26	1.25E+09	2.29E+03	1.53E-07	1.57E-32	4.89E+00	1.38E-16	3.25E+00	4.95E-33	1.73E-12
	Worst	3.11E-02	1.66E+09	2.03E+05	2.89E-01	2.95E-28	1.17E+01	2.59E+00	2.84E+01	3.59E-32	3.35E-12
F13	STD	1.16E-02	9.81E+07	6.00E+04	9.88E-02	5.29E-29	1.87E+00	7.33E-01	4.60E+00	5.50E-33	4.10E-13
	AVG	4.25E-03	3.06E+09	3.67E+06	1.29E-03	5.61E-03	2.83E+01	1.63E+00	2.32E+01	9.41E-02	2.15E-01
	Best	1.40E-25	2.80E+09	1.61E+06	2.59E-05	1.35E-32	9.68E-10	4.48E-14	7.91E+00	2.71E-32	1.07E-07
	Worst	1.10E-02	3.31E+09	6.50E+06	5.47E-03	4.39E-02	1.14E+02	8.07E+00	6.53E+01	3.95E-01	9.06E-01
	STD	5.44E-03	1.34E+08	1.24E+06	1.31E-03	9.67E-03	4.32E+01	2.21E+00	1.33E+01	1.15E-01	1.82E-01

Section 3.3.5. Further test on 23 famous test functions

Data3: Results of further test on 23 famous test functions.

Function	Item	WDO	DE	PSO	SFO	MA	SSA	CPA	EHVPSO	IGWO	LFD
F1	AVG	5.19E-20	4.20E+04	7.47E+02	6.43E-09	5.40E-05	1.11E-08	9.33E-13	1.29E+03	9.33E-38	2.03E-09
	Best	5.07E-24	3.29E+04	3.73E+02	1.51E-11	1.26E-06	6.03E-09	7.94E-21	2.43E+02	4.87E-40	9.21E-10
	Worst	6.30E-19	4.85E+04	1.20E+03	7.05E-08	4.66E-04	1.70E-08	2.88E-11	3.90E+03	1.25E-36	3.13E-09
	STD	1.38E-19	3.60E+03	2.44E+02	1.66E-08	9.26E-05	2.73E-09	5.16E-12	8.84E+02	2.42E-37	6.71E-10
F2	AVG	4.72E-13	6.54E+05	9.51E+00	2.16E-04	2.87E-03	8.61E-01	5.44E-11	1.80E+01	5.04E-24	6.78E-04
	Best	1.76E-16	3.66E+02	4.58E+00	5.06E-07	9.90E-05	2.69E-03	1.36E-16	6.45E+00	5.95E-25	2.34E-04
	Worst	3.24E-12	2.97E+06	1.47E+01	1.25E-03	1.66E-02	2.87E+00	1.21E-09	3.36E+01	2.39E-23	2.02E-03
	STD	7.79E-13	8.07E+05	2.53E+00	2.70E-04	3.55E-03	8.60E-01	2.22E-10	7.51E+00	4.89E-24	4.02E-04
F3	AVG	9.24E-01	4.98E+04	3.77E+03	1.90E-07	9.40E+03	2.89E+02	2.49E+01	8.92E+03	7.96E-05	1.71E-06
	Best	9.75E-02	2.89E+04	1.47E+03	5.51E-10	5.23E+03	1.55E+01	7.10E-01	2.95E+03	8.47E-08	5.94E-07
	Worst	3.74E+00	5.99E+04	6.68E+03	9.91E-07	1.66E+04	9.48E+02	4.00E+02	2.97E+04	1.72E-03	3.79E-06
	STD	9.31E-01	6.60E+03	1.30E+03	2.78E-07	2.62E+03	2.16E+02	7.09E+01	5.63E+03	3.08E-04	9.35E-07

F4	AVG	1.25E-01	7.15E+01	2.12E+01	1.12E-05	5.37E+01	1.02E+01	4.48E+01	3.34E+01	8.65E-07	3.15E-04
	Best	1.17E-02	6.68E+01	8.80E+00	3.39E-07	3.67E+01	3.37E+00	3.17E+01	2.38E+01	3.77E-08	1.57E-04
	Worst	4.74E-01	7.50E+01	3.06E+01	4.26E-05	7.03E+01	2.02E+01	5.95E+01	4.71E+01	6.12E-06	5.56E-04
	STD	1.11E-01	2.13E+00	4.45E+00	1.22E-05	9.19E+00	4.51E+00	7.15E+00	6.26E+00	1.25E-06	1.08E-04
F5	AVG	2.63E+01	1.07E+08	7.34E+04	1.46E-01	8.25E+01	1.99E+02	7.73E+01	4.29E+05	2.40E+01	2.65E+01
	Best	1.94E+01	6.40E+07	1.20E+04	2.65E-03	1.05E+01	2.22E+01	1.17E-02	1.56E+04	2.31E+01	2.62E+01
	Worst	9.08E+01	1.30E+08	1.92E+05	1.50E+00	5.25E+02	1.46E+03	2.75E+02	4.15E+06	2.47E+01	2.68E+01
	STD	1.20E+01	1.58E+07	5.14E+04	2.83E-01	9.82E+01	3.51E+02	7.78E+01	7.88E+05	3.56E-01	1.45E-01
F6	AVG	1.98E-20	4.27E+04	7.16E+02	2.41E-01	8.60E-05	1.11E-08	4.76E-13	1.35E+03	2.49E-05	4.56E-07
	Best	4.63E-25	3.34E+04	2.14E+02	1.39E-06	3.73E-06	6.77E-09	2.00E-22	1.75E+02	7.73E-06	1.79E-07
	Worst	2.49E-19	4.79E+04	1.65E+03	1.17E+00	1.15E-03	2.38E-08	1.47E-11	5.20E+03	7.18E-05	1.26E-06
	STD	5.84E-20	3.32E+03	3.45E+02	3.35E-01	2.26E-04	3.12E-09	2.63E-12	1.01E+03	1.59E-05	2.35E-07
F7	AVG	1.86E-02	4.67E+01	1.84E-01	4.78E-04	4.10E-02	9.62E-02	2.90E-01	5.31E-01	2.50E-03	9.55E-04
	Best	6.67E-03	2.32E+01	6.02E-02	1.91E-06	2.34E-02	3.02E-02	3.20E-02	4.44E-02	1.09E-03	6.60E-05
	Worst	4.87E-02	6.31E+01	4.28E-01	1.31E-03	8.82E-02	2.40E-01	1.66E+00	1.63E+00	4.82E-03	5.57E-03
	STD	9.36E-03	8.14E+00	9.49E-02	3.51E-04	1.50E-02	4.46E-02	3.59E-01	3.78E-01	9.19E-04	1.07E-03
F8	AVG	-8.59E+03	-4.22E+03	-5.61E+03	-4.10E+03	-9.42E+03	-7.47E+03	-8.57E+03	N/A	-9.02E+03	-2.12E+04
	Best	-1.02E+04	-4.75E+03	-6.90E+03	-5.08E+03	-1.05E+04	-8.90E+03	-1.05E+04	N/A	-1.07E+04	-4.31E+04
	Worst	-7.26E+03	-3.71E+03	-4.62E+03	-3.35E+03	-8.55E+03	-6.00E+03	-7.14E+03	N/A	-6.41E+03	-6.91E+03
	STD	6.19E+02	2.90E+02	4.78E+02	4.04E+02	5.00E+02	7.10E+02	7.89E+02	N/A	1.16E+03	8.05E+03
F9	AVG	3.40E+01	3.46E+02	1.02E+02	4.24E-06	6.83E+01	7.56E+01	6.73E+01	1.55E+02	2.06E+01	6.99E-06
	Best	1.89E+01	3.09E+02	7.25E+01	4.61E-09	2.69E+01	4.18E+01	3.68E+01	1.16E+02	9.99E+00	5.58E-08
	Worst	5.77E+01	3.75E+02	1.30E+02	3.11E-05	1.18E+02	1.38E+02	1.31E+02	1.95E+02	3.75E+01	2.12E-04
	STD	9.13E+00	1.51E+01	1.38E+01	7.65E-06	2.52E+01	2.20E+01	1.75E+01	1.78E+01	6.67E+00	3.80E-05
F10	AVG	1.40E-10	1.98E+01	7.75E+00	4.46E-05	3.84E+00	2.42E+00	7.68E+00	1.18E+01	2.66E-14	7.60E-05
	Best	6.79E-13	1.95E+01	5.08E+00	1.78E-06	1.91E+00	1.55E-02	3.73E+00	7.50E+00	1.51E-14	5.33E-05
	Worst	4.00E-09	2.01E+01	9.93E+00	2.68E-04	1.27E+01	4.30E+00	1.44E+01	1.61E+01	3.29E-14	1.17E-04
	STD	7.17E-10	1.61E-01	1.20E+00	6.56E-05	2.54E+00	7.46E-01	2.87E+00	2.18E+00	4.56E-15	1.40E-05
F11	AVG	1.41E-02	3.77E+02	7.13E+00	7.38E-10	6.86E-01	1.22E-02	3.62E-01	1.29E+01	6.83E-03	6.36E-04
	Best	0.00E+00	2.74E+02	3.68E+00	8.90E-13	2.82E-03	2.21E-08	2.44E-15	4.44E+00	0.00E+00	4.07E-10
	Worst	7.81E-02	4.54E+02	1.36E+01	6.75E-09	1.13E+00	6.14E-02	8.28E+00	4.96E+01	4.18E-02	1.97E-02
	STD	1.83E-02	3.09E+01	2.49E+00	1.60E-09	3.58E-01	1.50E-02	1.47E+00	1.01E+01	1.02E-02	3.54E-03
F12	AVG	2.01E-02	1.72E+08	3.71E+01	1.23E-01	1.42E+00	6.21E+00	2.27E+00	4.18E+04	1.00E-02	6.23E-06
	Best	9.91E-26	6.88E+07	9.28E+00	2.35E-07	4.62E-04	9.22E-01	2.91E-13	1.96E+01	3.88E-07	3.93E-08
	Worst	1.04E-01	2.18E+08	2.68E+02	5.33E-01	3.91E+00	1.31E+01	1.41E+01	4.45E+05	1.04E-01	6.52E-05
	STD	4.16E-02	4.12E+07	5.56E+01	1.52E-01	1.12E+00	3.11E+00	3.27E+00	9.10E+04	3.12E-02	1.45E-05
F13	AVG	1.30E-02	4.14E+08	4.79E+03	4.12E-04	4.61E+00	7.03E-01	1.09E+00	2.08E+05	6.85E-02	1.76E+00
	Best	5.26E-24	2.56E+08	2.23E+01	9.13E-06	2.23E-02	1.01E-09	2.52E-15	4.14E+01	1.85E-05	6.64E-06
	Worst	1.41E-01	5.61E+08	4.89E+04	2.22E-03	1.50E+01	8.57E+00	8.06E+00	1.36E+06	3.51E-01	2.97E+00
	STD	2.69E-02	8.58E+07	1.07E+04	4.47E-04	4.06E+00	2.10E+00	1.67E+00	3.49E+05	1.03E-01	1.38E+00
F14	AVG	1.19E+00	3.68E+00	1.60E+00	8.89E+00	5.79E+00	4.63E+00	6.15E+00	2.89E+00	1.60E+00	3.64E+00
	Best	9.98E-01	9.99E-01	9.98E-01	1.99E+00	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01
	Worst	2.98E+00	1.05E+01	4.95E+00	1.27E+01	1.74E+01	1.74E+01	2.11E+01	1.20E+01	5.12E+00	1.17E+01

F15	STD	4.74E-01	2.48E+00	8.72E-01	3.56E+00	4.36E+00	4.51E+00	5.43E+00	2.44E+00	9.60E-01	2.67E+00
	AVG	4.68E-04	7.08E-03	8.04E-04	1.12E-03	6.22E-03	3.72E-03	3.71E-03	8.00E-04	1.30E-03	2.72E-03
	Best	3.07E-04	1.84E-03	3.25E-04	3.22E-04	3.07E-04	4.28E-04	4.15E-04	3.07E-04	3.09E-04	3.29E-04
	Worst	1.59E-03	1.72E-02	1.63E-03	3.36E-03	2.04E-02	2.10E-02	2.04E-02	5.22E-03	2.04E-02	8.39E-03
F16	STD	3.68E-04	3.94E-03	2.93E-04	8.06E-04	8.69E-03	6.62E-03	6.88E-03	9.53E-04	3.55E-03	2.20E-03
	AVG	-1.03E+00	-9.21E-01	-1.03E+00	-9.32E-01	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00
	Best	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00
	Worst	-1.03E+00	-4.23E-01	-1.03E+00	-2.89E-01	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00	-1.03E+00
F17	STD	5.72E-16	1.32E-01	1.25E-03	2.05E-01	5.05E-15	4.04E-13	5.42E-16	1.57E-10	4.26E-07	3.91E-08
	AVG	3.98E-01	4.77E-01	3.98E-01	4.43E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01
	Best	3.98E-01	4.00E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01
	Worst	3.98E-01	8.38E-01	4.00E-01	8.58E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	3.98E-01	4.08E-01
F18	STD	0.00E+00	9.39E-02	4.05E-04	1.06E-01	0.00E+00	6.53E-13	0.00E+00	4.35E-12	1.37E-06	1.83E-03
	AVG	3.00E+00	5.01E+00	3.01E+00	1.25E+01	5.61E+00	3.00E+00	3.87E+00	3.00E+00	3.00E+00	3.33E+00
	Best	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.03E+00
	Worst	3.00E+00	1.01E+01	3.05E+00	8.36E+01	8.40E+01	3.00E+00	3.00E+01	3.00E+00	3.00E+00	4.23E+00
F19	STD	3.16E-15	2.06E+00	1.15E-02	1.77E+01	1.45E+01	2.61E-12	4.85E+00	2.57E-10	1.81E-06	3.19E-01
	AVG	-3.86E+00	-3.81E+00	-3.61E+00	-3.72E+00	-3.86E+00	-3.86E+00	-3.86E+00	-3.61E+00	-3.86E+00	-3.85E+00
	Best	-3.86E+00	-3.85E+00	-3.84E+00	-3.86E+00	-3.86E+00	-3.86E+00	-3.86E+00	-3.85E+00	-3.86E+00	-3.86E+00
	Worst	-3.86E+00	-3.75E+00	-3.24E+00	-3.21E+00	-3.86E+00	-3.84E+00	-3.86E+00	-3.01E+00	-3.86E+00	-3.80E+00
F20	STD	2.56E-15	3.22E-02	1.70E-01	1.55E-01	2.20E-15	4.03E-03	2.61E-15	2.05E-01	1.75E-06	1.58E-02
	AVG	-3.30E+00	-2.85E+00	-1.47E+00	-2.42E+00	-3.27E+00	-3.23E+00	-3.28E+00	-1.52E+00	-3.29E+00	-3.14E+00
	Best	-3.32E+00	-3.04E+00	-2.71E+00	-3.21E+00	-3.32E+00	-3.32E+00	-3.32E+00	-2.62E+00	-3.32E+00	-3.27E+00
	Worst	-3.20E+00	-2.54E+00	-5.65E-01	-1.42E+00	-3.20E+00	-3.10E+00	-3.20E+00	-4.70E-01	-3.20E+00	-2.96E+00
F21	STD	4.77E-02	1.16E-01	6.47E-01	5.29E-01	6.01E-02	7.89E-02	5.89E-02	6.60E-01	5.48E-02	7.89E-02
	AVG	-7.79E+00	-1.97E+00	-1.35E+00	-7.81E+00	-5.31E+00	-6.03E+00	-4.50E+00	-1.45E+00	-8.92E+00	-5.98E+00
	Best	-1.02E+01	-4.20E+00	-2.66E+00	-1.01E+01	-1.02E+01	-1.02E+01	-1.02E+01	-4.16E+00	-1.02E+01	-1.02E+01
	Worst	-2.68E+00	-1.07E+00	-6.53E-01	-5.03E+00	-2.63E+00	-2.63E+00	-2.63E+00	-3.99E-01	-5.05E+00	-1.90E+00
F22	STD	2.91E+00	6.37E-01	5.89E-01	2.09E+00	3.28E+00	3.45E+00	2.95E+00	8.46E-01	2.01E+00	3.09E+00
	AVG	-9.32E+00	-2.24E+00	-1.34E+00	-7.52E+00	-6.12E+00	-7.75E+00	-6.38E+00	-1.24E+00	-9.93E+00	-5.32E+00
	Best	-1.04E+01	-5.37E+00	-3.66E+00	-1.02E+01	-1.04E+01	-1.04E+01	-1.04E+01	-4.15E+00	-1.04E+01	-1.04E+01
	Worst	-2.77E+00	-1.20E+00	-4.22E-01	-4.82E+00	-2.75E+00	-2.75E+00	-1.84E+00	-4.22E-01	-2.76E+00	-2.75E+00
F23	STD	2.55E+00	8.49E-01	7.51E-01	2.21E+00	3.51E+00	3.64E+00	3.75E+00	9.48E-01	1.79E+00	2.39E+00
	AVG	-8.71E+00	-2.27E+00	-1.42E+00	-7.82E+00	-6.21E+00	-7.39E+00	-6.05E+00	-1.30E+00	-1.05E+01	-6.25E+00
	Best	-1.05E+01	-4.70E+00	-3.50E+00	-1.05E+01	-1.05E+01	-1.05E+01	-1.05E+01	-4.63E+00	-1.05E+01	-1.05E+01
	Worst	-2.42E+00	-1.32E+00	-5.76E-01	-5.00E+00	-2.42E+00	-2.42E+00	-2.42E+00	-6.04E-01	-1.05E+01	-2.00E+00
	STD	2.97E+00	7.28E-01	6.73E-01	2.29E+00	3.99E+00	3.59E+00	3.71E+00	7.31E-01	4.88E-03	3.38E+00

Section 3.4.4. Scalability research of WDO

Data4: Statistical results of 50 dimensions CEC2017 benchmark functions by several methods.

Function	Item	WDO	SMA	AO	CMA-ES	EHVPSO	e-QPSO	HGS	COA	JADE	L-SHADE
CF1	AVG	3.78E+03	1.53E+04	2.08E+07	1.55E+04	2.02E+10	8.43E+10	9.68E+07	4.74E+03	2.34E+08	1.00E+02
	Best	1.08E+02	1.82E+02	1.15E+07	5.89E+02	9.45E+09	7.92E+10	3.68E+03	1.05E+02	6.72E+06	1.00E+02
	Worst	1.56E+04	3.19E+04	3.88E+07	8.45E+04	9.05E+10	9.05E+10	1.09E+09	1.81E+04	1.38E+09	1.00E+02
	STD	4.06E+03	1.10E+04	5.62E+06	1.62E+04	1.82E+10	3.13E+09	2.66E+08	4.56E+03	3.15E+08	3.36E-14
CF2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CF3	AVG	3.05E+02	3.00E+02	1.03E+05	5.49E+05	1.46E+06	1.29E+05	7.26E+03	2.93E+04	3.51E+05	3.00E+02
	Best	3.00E+02	3.00E+02	7.75E+04	3.88E+05	1.36E+05	1.19E+05	7.99E+02	1.40E+04	1.61E+05	3.00E+02
	Worst	4.53E+02	3.01E+02	1.48E+05	9.24E+05	2.55E+07	1.39E+05	3.48E+04	7.08E+04	5.45E+05	3.00E+02
	STD	2.75E+01	2.12E-01	1.58E+04	1.15E+05	4.65E+06	5.05E+03	9.83E+03	1.14E+04	7.70E+04	1.76E-13
CF4	AVG	4.73E+02	5.37E+02	6.27E+02	4.24E+02	2.54E+04	1.95E+04	5.54E+02	4.93E+02	7.11E+02	4.68E+02
	Best	4.00E+02	4.50E+02	5.55E+02	4.17E+02	4.00E+03	1.57E+04	4.36E+02	4.00E+02	5.61E+02	4.00E+02
	Worst	5.52E+02	6.10E+02	7.38E+02	4.28E+02	5.02E+04	2.27E+04	6.40E+02	6.13E+02	8.87E+02	5.42E+02
	STD	4.59E+01	4.22E+01	4.78E+01	3.01E+00	1.12E+04	1.76E+03	5.65E+01	4.96E+01	6.67E+01	5.00E+01
CF5	AVG	6.60E+02	6.97E+02	8.28E+02	7.54E+02	9.86E+02	1.12E+03	7.77E+02	6.79E+02	7.46E+02	5.21E+02
	Best	5.99E+02	6.39E+02	7.37E+02	5.08E+02	8.47E+02	1.08E+03	6.99E+02	5.96E+02	6.69E+02	5.15E+02
	Worst	7.06E+02	7.64E+02	9.01E+02	8.27E+02	1.16E+03	1.16E+03	8.38E+02	7.42E+02	8.30E+02	5.29E+02
	STD	2.79E+01	3.52E+01	3.79E+01	1.10E+02	8.17E+01	2.27E+01	3.69E+01	3.95E+01	3.36E+01	3.80E+00
CF6	AVG	6.10E+02	6.11E+02	6.54E+02	6.00E+02	6.72E+02	6.88E+02	6.08E+02	6.00E+02	6.03E+02	6.00E+02
	Best	6.01E+02	6.05E+02	6.38E+02	6.00E+02	6.48E+02	6.80E+02	6.01E+02	6.00E+02	6.02E+02	6.00E+02
	Worst	6.20E+02	6.29E+02	6.67E+02	6.00E+02	6.88E+02	6.95E+02	6.13E+02	6.00E+02	6.05E+02	6.00E+02
	STD	5.66E+00	6.06E+00	7.30E+00	1.01E-12	8.82E+00	3.77E+00	2.90E+00	9.30E-02	8.62E-01	1.18E-02
CF7	AVG	9.28E+02	1.00E+03	1.32E+03	1.06E+03	1.66E+03	1.80E+03	1.17E+03	9.86E+02	1.02E+03	7.72E+02
	Best	8.66E+02	8.88E+02	1.15E+03	1.02E+03	1.28E+03	1.72E+03	9.09E+02	8.89E+02	9.86E+02	7.68E+02
	Worst	1.02E+03	1.12E+03	1.48E+03	1.08E+03	2.09E+03	1.85E+03	1.41E+03	1.08E+03	1.07E+03	7.78E+02
	STD	3.71E+01	5.59E+01	7.93E+01	1.26E+01	2.18E+02	3.22E+01	1.23E+02	4.18E+01	2.11E+01	2.87E+00
CF8	AVG	9.80E+02	9.98E+02	1.14E+03	1.09E+03	1.36E+03	1.48E+03	1.07E+03	9.77E+02	1.04E+03	8.20E+02
	Best	9.27E+02	9.32E+02	1.04E+03	8.08E+02	1.20E+03	1.44E+03	9.95E+02	9.13E+02	9.66E+02	8.13E+02
	Worst	1.17E+03	1.14E+03	1.25E+03	1.14E+03	1.62E+03	1.54E+03	1.18E+03	1.09E+03	1.11E+03	8.26E+02
	STD	5.24E+01	4.35E+01	4.87E+01	7.60E+01	1.07E+02	2.51E+01	4.82E+01	3.69E+01	3.29E+01	3.09E+00
CF9	AVG	1.93E+03	9.30E+03	1.56E+04	9.00E+02	2.46E+04	2.95E+04	1.07E+04	3.97E+03	7.10E+03	9.03E+02
	Best	1.05E+03	4.37E+03	1.16E+04	9.00E+02	1.45E+04	2.64E+04	5.61E+03	1.51E+03	2.53E+03	9.00E+02
	Worst	3.84E+03	1.93E+04	2.06E+04	9.00E+02	4.79E+04	3.29E+04	1.39E+04	8.98E+03	1.14E+04	9.09E+02
	STD	7.15E+02	4.39E+03	2.25E+03	0.00E+00	7.20E+03	1.63E+03	2.17E+03	1.79E+03	2.21E+03	2.23E+00
CF10	AVG	6.87E+03	6.97E+03	7.77E+03	1.44E+04	1.48E+04	1.43E+04	6.02E+03	6.20E+03	8.82E+03	4.01E+03
	Best	5.48E+03	5.10E+03	5.76E+03	1.27E+04	1.07E+04	1.36E+04	4.93E+03	5.05E+03	7.78E+03	3.16E+03
	Worst	9.06E+03	9.02E+03	9.84E+03	1.51E+04	1.75E+04	1.49E+04	7.03E+03	8.12E+03	1.04E+04	4.51E+03
	STD	7.62E+02	9.63E+02	9.54E+02	5.24E+02	2.02E+03	3.32E+02	5.46E+02	7.47E+02	5.42E+02	3.32E+02
CF11	AVG	1.28E+03	1.39E+03	1.47E+03	1.61E+04	1.77E+04	1.51E+04	1.29E+03	1.21E+03	3.16E+04	1.22E+03
	Best	1.18E+03	1.28E+03	1.32E+03	5.28E+03	3.21E+03	1.12E+04	1.22E+03	1.15E+03	4.02E+03	1.17E+03
	Worst	1.43E+03	1.50E+03	1.66E+03	4.06E+04	4.76E+04	1.81E+04	1.41E+03	1.28E+03	1.46E+05	1.26E+03
	STD	5.48E+01	5.97E+01	7.95E+01	7.05E+03	1.28E+04	1.70E+03	4.35E+01	3.32E+01	2.32E+04	2.13E+01

CF12	AVG	1.91E+05	5.80E+06	7.54E+07	1.96E+07	4.46E+10	4.23E+10	1.45E+07	1.06E+06	1.71E+08	7.55E+03
	Best	4.77E+04	1.53E+06	1.61E+07	1.03E+07	8.71E+09	3.38E+10	4.68E+05	1.73E+05	1.12E+07	2.78E+03
	Worst	4.37E+05	1.16E+07	1.99E+08	4.29E+07	8.54E+10	4.99E+10	7.08E+07	8.80E+06	4.88E+08	2.72E+04
	STD	9.62E+04	2.82E+06	3.94E+07	7.53E+06	2.05E+10	4.23E+09	1.37E+07	1.54E+06	1.01E+08	4.82E+03
CF13	AVG	4.71E+03	3.04E+04	6.96E+05	6.24E+06	2.26E+10	1.90E+10	3.73E+04	7.51E+03	1.65E+08	1.45E+03
	Best	1.67E+03	1.11E+04	3.28E+05	1.49E+06	1.29E+09	8.55E+09	1.16E+04	1.43E+03	2.45E+04	1.37E+03
	Worst	1.70E+04	4.53E+04	1.18E+06	1.35E+07	5.76E+10	2.36E+10	5.78E+04	1.43E+03	4.09E+08	1.79E+03
	STD	3.42E+03	1.15E+04	2.33E+05	2.89E+06	1.30E+10	3.83E+09	1.48E+04	8.71E+03	1.01E+08	8.71E+01
CF14	AVG	1.95E+04	1.35E+05	1.01E+06	7.08E+05	5.09E+07	1.43E+07	1.17E+05	6.47E+04	2.04E+07	1.47E+03
	Best	2.83E+03	2.22E+04	1.85E+05	6.56E+04	2.58E+06	6.67E+06	1.02E+04	1.60E+03	2.21E+03	1.43E+03
	Worst	6.68E+04	2.76E+05	3.83E+06	4.02E+06	1.72E+08	2.41E+07	3.31E+05	1.13E+06	3.25E+08	1.56E+03
	STD	1.39E+04	7.49E+04	7.57E+05	6.63E+05	4.38E+07	4.72E+06	8.57E+04	2.01E+05	5.93E+07	3.03E+01
CF15	AVG	6.16E+03	2.64E+04	1.68E+05	3.76E+06	2.30E+09	2.50E+09	1.90E+04	1.07E+04	4.55E+07	1.62E+03
	Best	1.86E+03	2.08E+03	7.53E+04	1.16E+06	1.56E+05	2.13E+09	2.29E+03	1.58E+03	4.27E+03	1.54E+03
	Worst	2.05E+04	3.40E+04	3.54E+05	1.08E+07	9.06E+09	3.12E+09	3.58E+04	2.80E+04	2.99E+08	1.76E+03
	STD	4.47E+03	1.09E+04	6.64E+04	2.13E+06	2.22E+09	2.56E+08	1.03E+04	7.94E+03	6.00E+07	5.84E+01
CF16	AVG	3.21E+03	3.04E+03	3.83E+03	3.62E+03	7.79E+03	7.51E+03	3.75E+03	3.53E+03	4.11E+03	2.14E+03
	Best	2.24E+03	2.25E+03	2.92E+03	2.69E+03	4.29E+03	6.35E+03	2.92E+03	2.08E+03	3.40E+03	1.85E+03
	Worst	3.83E+03	4.12E+03	4.78E+03	4.38E+03	1.13E+04	8.25E+03	4.95E+03	4.54E+03	4.63E+03	2.46E+03
	STD	4.31E+02	3.55E+02	4.28E+02	4.67E+02	1.52E+03	4.14E+02	4.30E+02	5.81E+02	3.18E+02	1.57E+02
CF17	AVG	2.88E+03	3.08E+03	3.44E+03	3.40E+03	4.81E+03	5.58E+03	3.12E+03	3.00E+03	3.53E+03	2.12E+03
	Best	2.37E+03	2.59E+03	2.48E+03	3.00E+03	3.28E+03	4.48E+03	2.48E+03	2.27E+03	3.06E+03	1.91E+03
	Worst	3.61E+03	3.77E+03	4.15E+03	3.88E+03	1.31E+04	6.28E+03	3.75E+03	3.78E+03	4.05E+03	2.39E+03
	STD	2.84E+02	2.99E+02	4.00E+02	2.48E+02	1.79E+03	3.87E+02	3.03E+02	3.34E+02	2.58E+02	1.23E+02
CF18	AVG	3.26E+04	6.84E+05	4.11E+06	4.19E+06	1.07E+08	5.12E+07	6.71E+05	3.59E+05	1.54E+07	2.05E+03
	Best	5.65E+03	1.70E+05	3.27E+05	1.55E+06	4.55E+06	9.30E+06	1.32E+05	3.38E+04	6.65E+05	1.86E+03
	Worst	7.50E+04	1.26E+06	1.42E+07	1.21E+07	2.94E+08	1.00E+08	2.09E+06	2.52E+06	3.71E+07	2.35E+03
	STD	1.79E+04	3.49E+05	3.25E+06	2.25E+06	8.25E+07	1.87E+07	5.11E+05	5.79E+05	1.00E+07	1.44E+02
CF19	AVG	1.82E+04	1.82E+04	9.46E+05	1.83E+06	6.55E+08	7.97E+08	1.92E+04	1.80E+04	4.84E+06	1.99E+03
	Best	2.17E+03	2.03E+03	1.09E+05	6.60E+05	7.26E+05	4.35E+08	2.47E+03	2.04E+03	1.35E+04	1.96E+03
	Worst	4.14E+04	4.45E+04	2.84E+06	4.57E+06	2.65E+09	1.07E+09	4.45E+04	4.43E+04	1.66E+07	2.08E+03
	STD	1.02E+04	1.66E+04	7.34E+05	9.17E+05	7.60E+08	1.70E+08	1.58E+04	1.33E+04	4.83E+06	3.14E+01
CF20	AVG	2.94E+03	3.09E+03	3.08E+03	3.48E+03	4.19E+03	3.77E+03	3.20E+03	3.15E+03	3.60E+03	2.18E+03
	Best	2.39E+03	2.45E+03	2.68E+03	2.91E+03	3.49E+03	3.45E+03	2.69E+03	2.33E+03	3.19E+03	2.07E+03
	Worst	3.56E+03	3.75E+03	3.80E+03	3.78E+03	5.01E+03	4.11E+03	3.66E+03	3.99E+03	3.97E+03	2.41E+03
	STD	2.58E+02	3.05E+02	2.84E+02	1.90E+02	4.55E+02	1.71E+02	2.54E+02	4.10E+02	1.98E+02	9.97E+01
CF21	AVG	2.46E+03	2.49E+03	2.60E+03	2.49E+03	3.03E+03	2.99E+03	2.55E+03	2.48E+03	2.59E+03	2.32E+03
	Best	2.39E+03	2.39E+03	2.51E+03	2.31E+03	2.81E+03	2.92E+03	2.45E+03	2.41E+03	2.51E+03	2.31E+03
	Worst	2.53E+03	2.56E+03	2.72E+03	2.62E+03	3.39E+03	3.04E+03	2.65E+03	2.59E+03	2.64E+03	2.33E+03
	STD	3.41E+01	3.71E+01	5.91E+01	1.37E+02	1.29E+02	3.08E+01	4.17E+01	4.70E+01	3.29E+01	3.32E+00
CF22	AVG	8.57E+03	8.96E+03	8.25E+03	1.58E+04	1.69E+04	1.58E+04	8.64E+03	8.13E+03	1.06E+04	5.63E+03
	Best	5.81E+03	6.94E+03	2.33E+03	1.50E+04	1.23E+04	1.45E+04	6.64E+03	7.09E+03	8.49E+03	2.30E+03
	Worst	1.04E+04	1.12E+04	1.12E+04	1.67E+04	1.92E+04	1.66E+04	1.05E+04	9.83E+03	1.17E+04	6.46E+03

CF23	STD	1.13E+03	9.60E+02	3.04E+03	3.55E+02	1.67E+03	5.65E+02	9.29E+02	6.65E+02	6.30E+02	1.13E+03
	AVG	2.91E+03	2.94E+03	3.24E+03	2.83E+03	4.24E+03	4.50E+03	3.01E+03	2.96E+03	3.14E+03	2.74E+03
	Best	2.84E+03	2.83E+03	3.05E+03	2.71E+03	3.57E+03	4.29E+03	2.89E+03	2.89E+03	2.97E+03	2.73E+03
	Worst	3.04E+03	3.04E+03	3.54E+03	3.07E+03	4.63E+03	4.68E+03	3.10E+03	3.08E+03	3.89E+03	2.76E+03
CF24	STD	4.73E+01	4.60E+01	9.24E+01	1.45E+02	2.57E+02	7.78E+01	5.56E+01	4.24E+01	2.35E+02	7.45E+00
	AVG	3.06E+03	3.10E+03	3.33E+03	2.97E+03	4.44E+03	4.78E+03	3.30E+03	3.11E+03	3.51E+03	2.92E+03
	Best	2.96E+03	3.02E+03	3.19E+03	2.89E+03	4.21E+03	4.49E+03	3.13E+03	3.03E+03	3.28E+03	2.90E+03
	Worst	3.14E+03	3.20E+03	3.58E+03	3.21E+03	4.79E+03	4.96E+03	3.57E+03	3.30E+03	4.04E+03	2.92E+03
CF25	STD	3.96E+01	4.33E+01	8.49E+01	1.22E+02	1.44E+02	1.31E+02	1.15E+02	6.29E+01	1.57E+02	4.80E+00
	AVG	3.02E+03	3.03E+03	3.12E+03	2.93E+03	8.54E+03	8.95E+03	3.05E+03	3.04E+03	3.20E+03	3.01E+03
	Best	2.96E+03	2.96E+03	3.03E+03	2.93E+03	4.82E+03	8.12E+03	2.96E+03	2.96E+03	3.10E+03	2.96E+03
	Worst	3.06E+03	3.11E+03	3.16E+03	2.93E+03	1.53E+04	9.53E+03	3.11E+03	3.11E+03	3.30E+03	3.08E+03
CF26	STD	3.07E+01	4.40E+01	2.73E+01	1.34E-02	3.76E+03	3.39E+02	3.82E+01	4.18E+01	4.24E+01	3.69E+01
	AVG	5.34E+03	5.47E+03	4.69E+03	6.36E+03	1.51E+04	1.55E+04	6.55E+03	5.89E+03	8.66E+03	3.89E+03
	Best	2.90E+03	2.90E+03	2.92E+03	3.90E+03	8.56E+03	1.40E+04	3.27E+03	5.13E+03	6.05E+03	3.75E+03
	Worst	6.49E+03	7.01E+03	1.18E+04	6.81E+03	2.16E+04	1.65E+04	9.79E+03	6.87E+03	2.38E+04	4.06E+03
CF27	STD	7.55E+02	9.70E+02	2.74E+03	6.25E+02	2.81E+03	5.17E+02	1.60E+03	3.79E+02	4.21E+03	5.86E+01
	AVG	3.42E+03	3.38E+03	3.70E+03	3.20E+03	3.20E+03	6.44E+03	3.45E+03	3.45E+03	3.59E+03	3.25E+03
	Best	3.30E+03	3.26E+03	3.48E+03	3.20E+03	3.20E+03	5.95E+03	3.28E+03	3.25E+03	3.47E+03	3.22E+03
	Worst	3.69E+03	3.62E+03	4.15E+03	3.20E+03	3.20E+03	6.93E+03	3.78E+03	3.72E+03	4.09E+03	3.31E+03
CF28	STD	8.20E+01	8.44E+01	1.58E+02	5.59E-05	1.27E-04	2.82E+02	1.08E+02	1.12E+02	1.29E+02	2.12E+01
	AVG	3.28E+03	3.31E+03	3.38E+03	3.30E+03	3.30E+03	1.03E+04	3.35E+03	3.30E+03	5.33E+03	3.29E+03
	Best	3.26E+03	3.26E+03	3.32E+03	3.30E+03	3.30E+03	9.51E+03	3.26E+03	3.26E+03	3.44E+03	3.26E+03
	Worst	3.31E+03	3.37E+03	3.48E+03	3.30E+03	3.30E+03	1.17E+04	3.60E+03	3.32E+03	1.38E+04	3.31E+03
CF29	STD	2.41E+01	2.35E+01	4.45E+01	7.10E-05	1.20E-04	4.22E+02	7.85E+01	1.20E+01	2.05E+03	2.35E+01
	AVG	4.10E+03	4.37E+03	5.33E+03	5.68E+03	1.81E+04	1.14E+04	4.28E+03	4.20E+03	4.76E+03	3.28E+03
	Best	3.45E+03	3.92E+03	4.30E+03	5.05E+03	5.36E+03	9.17E+03	3.80E+03	3.46E+03	4.21E+03	3.24E+03
	Worst	4.59E+03	5.02E+03	7.19E+03	6.47E+03	1.22E+05	1.39E+04	4.86E+03	4.92E+03	5.30E+03	3.42E+03
CF30	STD	2.95E+02	2.67E+02	5.45E+02	3.87E+02	2.24E+04	1.27E+03	2.92E+02	3.33E+02	2.54E+02	5.46E+01
	AVG	9.99E+05	1.73E+06	3.38E+07	1.59E+07	2.04E+09	1.64E+09	1.69E+06	7.33E+05	4.22E+07	7.30E+05
	Best	7.69E+05	7.30E+05	1.97E+07	7.60E+06	2.53E+08	9.37E+08	6.97E+05	5.82E+05	1.10E+06	5.82E+05
	Worst	1.64E+06	3.10E+06	5.10E+07	4.18E+07	6.70E+09	2.30E+09	3.54E+06	1.65E+06	1.41E+08	1.14E+06
	STD	2.11E+05	4.69E+05	8.07E+06	7.63E+06	1.85E+09	2.95E+08	7.48E+05	2.26E+05	3.62E+07	1.40E+05

Data5: Statistical results of 100 dimensions CEC2017 benchmark functions by several methods.

Function	Item	WDO	SMA	AO	CMA-ES	EHVPSO	e-QPSO	HGS	COA	JADE	L-SHADE
CF1	AVG	5.57E+03	1.42E+04	1.05E+08	1.84E+04	8.87E+10	2.00E+11	5.54E+08	6.73E+03	4.06E+08	1.00E+02
	Best	1.08E+02	2.03E+02	7.11E+07	1.18E+02	6.17E+10	1.89E+11	1.07E+06	1.00E+02	6.03E+07	1.00E+02
	Worst	2.37E+04	6.18E+04	1.34E+08	9.11E+04	1.20E+11	2.09E+11	1.59E+10	3.01E+04	1.81E+09	1.00E+02
	STD	6.35E+03	1.94E+04	1.91E+07	2.13E+04	1.37E+10	4.71E+09	2.84E+09	6.66E+03	3.84E+08	1.06E-12
CF2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CF3	AVG	1.38E+04	4.21E+02	2.21E+05	1.20E+06	5.95E+08	2.83E+05	5.30E+04	2.38E+05	7.50E+05	3.00E+02
	Best	3.11E+03	3.38E+02	1.91E+05	7.59E+05	3.72E+05	2.54E+05	2.82E+04	1.46E+05	5.56E+05	3.00E+02

CF4	Worst	4.09E+04	5.65E+02	2.61E+05	1.70E+06	1.74E+10	2.96E+05	1.50E+05	3.82E+05	1.02E+06	3.00E+02
	STD	1.00E+04	5.87E+01	1.44E+04	2.15E+05	3.12E+09	9.01E+03	3.29E+04	5.11E+04	9.89E+04	3.95E-08
	AVG	6.08E+02	6.52E+02	8.33E+02	4.44E+02	8.63E+04	5.57E+04	8.24E+02	6.45E+02	1.07E+03	5.28E+02
	Best	5.46E+02	6.10E+02	7.08E+02	4.43E+02	2.17E+04	4.63E+04	5.83E+02	5.52E+02	8.89E+02	4.14E+02
CF5	Worst	6.88E+02	7.10E+02	9.52E+02	4.45E+02	1.26E+05	6.55E+04	2.06E+03	7.55E+02	1.30E+03	6.20E+02
	STD	3.70E+01	2.80E+01	6.68E+01	4.93E-01	2.50E+04	4.00E+03	3.47E+02	4.55E+01	1.06E+02	6.00E+01
	AVG	9.39E+02	1.09E+03	1.30E+03	5.28E+02	1.93E+03	1.96E+03	1.24E+03	1.04E+03	1.20E+03	5.51E+02
	Best	8.18E+02	8.61E+02	1.15E+03	5.18E+02	1.56E+03	1.92E+03	1.13E+03	9.00E+02	1.01E+03	5.41E+02
CF6	Worst	1.04E+03	1.25E+03	1.40E+03	5.36E+02	2.46E+03	2.01E+03	1.44E+03	1.21E+03	1.32E+03	5.64E+02
	STD	6.05E+01	9.72E+01	6.53E+01	4.31E+00	2.13E+02	3.03E+01	6.43E+01	8.16E+01	7.01E+01	5.51E+00
	AVG	6.26E+02	6.29E+02	6.65E+02	6.00E+02	6.84E+02	7.03E+02	6.25E+02	6.00E+02	6.04E+02	6.00E+02
	Best	6.08E+02	6.21E+02	6.57E+02	6.00E+02	6.70E+02	6.98E+02	6.15E+02	6.00E+02	6.02E+02	6.00E+02
CF7	Worst	6.47E+02	6.41E+02	6.72E+02	6.00E+02	7.26E+02	7.07E+02	6.39E+02	6.00E+02	6.05E+02	6.00E+02
	STD	7.67E+00	5.66E+00	4.04E+00	3.78E-08	1.08E+01	2.08E+00	5.95E+00	9.82E-02	8.62E-01	8.89E-02
	AVG	1.34E+03	1.56E+03	2.50E+03	8.28E+02	3.54E+03	3.50E+03	1.92E+03	1.59E+03	1.57E+03	8.64E+02
	Best	1.11E+03	1.35E+03	2.20E+03	8.23E+02	2.78E+03	3.34E+03	1.55E+03	1.39E+03	1.48E+03	8.48E+02
CF8	Worst	1.59E+03	1.78E+03	2.82E+03	8.42E+02	4.36E+03	3.67E+03	2.39E+03	1.83E+03	1.73E+03	8.81E+02
	STD	1.23E+02	1.10E+02	1.65E+02	3.90E+00	3.60E+02	7.34E+01	1.92E+02	9.37E+01	5.25E+01	9.11E+00
	AVG	1.21E+03	1.34E+03	1.65E+03	8.28E+02	2.36E+03	2.43E+03	1.52E+03	1.34E+03	1.51E+03	8.49E+02
	Best	1.08E+03	1.19E+03	1.46E+03	8.15E+02	2.07E+03	2.34E+03	1.36E+03	1.19E+03	1.34E+03	8.35E+02
CF9	Worst	1.31E+03	1.54E+03	1.86E+03	8.40E+02	2.68E+03	2.49E+03	1.77E+03	1.54E+03	1.64E+03	8.61E+02
	STD	5.55E+01	9.17E+01	9.03E+01	5.06E+00	1.74E+02	3.29E+01	9.96E+01	7.20E+01	6.95E+01	6.80E+00
	AVG	1.02E+04	2.43E+04	3.94E+04	9.00E+02	7.69E+04	6.72E+04	2.33E+04	1.66E+04	2.98E+04	9.22E+02
	Best	2.39E+03	1.62E+04	3.26E+04	9.00E+02	4.35E+04	6.06E+04	1.62E+04	9.23E+03	2.18E+04	9.11E+02
CF10	Worst	2.05E+04	3.24E+04	4.83E+04	9.00E+02	1.54E+05	7.11E+04	2.74E+04	2.97E+04	4.06E+04	9.37E+02
	STD	5.37E+03	4.82E+03	4.32E+03	0.00E+00	2.96E+04	2.88E+03	2.58E+03	5.00E+03	5.19E+03	7.57E+00
	AVG	1.39E+04	1.48E+04	1.62E+04	2.85E+04	3.19E+04	3.07E+04	1.39E+04	1.44E+04	1.91E+04	9.36E+03
	Best	1.13E+04	1.04E+04	1.33E+04	1.54E+03	2.36E+04	2.98E+04	1.10E+04	1.15E+04	1.74E+04	8.51E+03
CF11	Worst	1.70E+04	1.77E+04	2.12E+04	3.13E+04	3.64E+04	3.12E+04	1.60E+04	1.64E+04	2.05E+04	1.02E+04
	STD	1.24E+03	1.40E+03	1.83E+03	7.20E+03	3.53E+03	3.56E+02	1.13E+03	1.06E+03	7.26E+02	3.75E+02
	AVG	2.00E+03	2.56E+03	1.50E+04	5.75E+05	6.13E+05	1.18E+05	4.27E+03	3.71E+03	1.51E+05	2.00E+03
	Best	1.60E+03	2.11E+03	8.60E+03	3.09E+05	7.20E+04	9.98E+04	1.81E+03	1.37E+03	7.45E+04	1.74E+03
CF12	Worst	2.39E+03	3.00E+03	2.28E+04	9.02E+05	3.72E+06	1.41E+05	1.31E+04	1.78E+04	2.31E+05	2.30E+03
	STD	1.89E+02	2.32E+02	3.55E+03	1.46E+05	6.58E+05	8.70E+03	3.65E+03	4.31E+03	3.81E+04	1.51E+02
	AVG	4.24E+05	2.53E+07	3.01E+08	1.11E+07	1.68E+11	1.30E+11	1.04E+08	2.30E+06	5.46E+08	1.98E+04
	Best	1.24E+05	1.13E+07	5.25E+07	3.66E+06	1.10E+11	1.21E+11	1.13E+07	5.72E+05	4.94E+07	1.07E+04
CF13	Worst	7.60E+05	5.31E+07	5.70E+08	2.38E+07	2.45E+11	1.43E+11	8.04E+08	4.12E+06	1.04E+09	3.71E+04
	STD	1.54E+05	1.06E+07	1.21E+08	5.58E+06	3.26E+10	4.81E+09	1.58E+08	9.84E+05	2.35E+08	7.59E+03
	AVG	8.89E+03	3.96E+04	1.40E+06	4.19E+05	2.61E+10	2.70E+10	5.37E+06	7.01E+03	4.70E+07	2.88E+03
	Best	3.71E+03	1.87E+04	7.36E+05	1.69E+05	2.52E+09	2.33E+10	1.56E+04	1.56E+03	5.13E+05	1.67E+03
CF14	Worst	2.94E+04	6.42E+04	8.83E+06	1.20E+06	4.28E+10	2.98E+10	1.56E+08	2.42E+04	2.27E+08	4.79E+03
	STD	4.53E+03	1.25E+04	1.41E+06	2.35E+05	1.24E+10	1.42E+09	2.80E+07	6.26E+03	5.49E+07	6.94E+02
	AVG	6.73E+04	3.85E+05	3.18E+06	3.10E+06	8.93E+07	3.14E+07	7.63E+05	4.19E+05	2.63E+07	1.80E+03

CF15	Best	2.45E+04	9.44E+04	1.74E+06	1.00E+06	7.50E+06	1.56E+07	1.47E+05	5.46E+03	2.58E+06	1.63E+03
	Worst	1.58E+05	9.45E+05	6.14E+06	6.74E+06	3.91E+08	3.91E+07	4.01E+06	2.35E+06	7.78E+07	2.20E+03
	STD	3.38E+04	2.15E+05	1.09E+06	1.39E+06	8.45E+07	5.10E+06	7.07E+05	5.90E+05	1.95E+07	1.02E+02
	AVG	3.93E+03	1.70E+04	3.19E+05	5.78E+05	1.24E+10	1.41E+10	5.92E+04	9.35E+03	2.96E+07	1.79E+03
CF16	Best	1.87E+03	4.70E+03	1.84E+05	2.32E+05	1.89E+06	8.92E+09	7.81E+03	1.70E+03	9.43E+04	1.69E+03
	Worst	1.23E+04	3.37E+04	6.65E+05	1.62E+06	2.16E+10	1.74E+10	6.36E+05	8.94E+04	1.05E+08	1.92E+03
	STD	2.63E+03	1.12E+04	1.07E+05	2.99E+05	5.34E+09	1.99E+09	1.53E+05	1.64E+04	2.78E+07	5.85E+01
	AVG	5.25E+03	5.36E+03	7.07E+03	2.09E+03	2.06E+04	1.66E+04	6.56E+03	6.08E+03	7.28E+03	3.29E+03
CF17	Best	3.90E+03	4.32E+03	5.32E+03	1.82E+03	1.08E+04	1.56E+04	4.98E+03	4.50E+03	6.23E+03	2.65E+03
	Worst	6.52E+03	6.88E+03	9.33E+03	2.66E+03	3.44E+04	1.78E+04	7.53E+03	7.22E+03	8.14E+03	3.79E+03
	STD	5.82E+02	6.18E+02	9.56E+02	1.93E+02	4.70E+03	5.15E+02	6.58E+02	6.52E+02	5.03E+02	3.17E+02
	AVG	4.84E+03	5.24E+03	5.91E+03	2.77E+03	2.65E+06	1.62E+06	5.27E+03	4.92E+03	6.20E+03	2.96E+03
CF18	Best	3.45E+03	4.04E+03	4.94E+03	2.19E+03	9.72E+03	4.74E+05	4.01E+03	3.69E+03	5.07E+03	2.41E+03
	Worst	5.88E+03	6.47E+03	7.88E+03	5.10E+03	1.30E+07	3.26E+06	6.82E+03	5.80E+03	6.92E+03	3.28E+03
	STD	6.10E+02	5.90E+02	5.90E+02	6.29E+02	3.66E+06	6.54E+05	7.04E+02	5.19E+02	4.53E+02	1.76E+02
	AVG	1.42E+05	9.52E+05	3.14E+06	5.73E+06	1.83E+08	3.83E+07	1.01E+06	1.11E+06	3.61E+07	2.11E+03
CF19	Best	5.98E+04	4.07E+05	1.28E+06	1.84E+06	2.68E+07	3.21E+07	3.66E+05	2.45E+05	3.31E+06	1.98E+03
	Worst	2.66E+05	1.75E+06	5.11E+06	1.29E+07	4.03E+08	8.19E+07	2.47E+06	5.18E+06	6.99E+07	2.27E+03
	STD	4.98E+04	4.08E+05	1.10E+06	2.26E+06	9.79E+07	9.14E+06	5.57E+05	1.08E+06	1.65E+07	7.40E+01
	AVG	4.67E+03	2.40E+04	4.37E+06	3.82E+05	1.42E+10	1.40E+10	3.25E+04	6.62E+03	2.24E+07	2.12E+03
CF20	Best	2.11E+03	2.52E+03	9.13E+05	1.61E+05	3.36E+09	8.75E+09	3.52E+03	2.04E+03	9.58E+04	2.05E+03
	Worst	1.81E+04	4.20E+04	1.30E+07	6.35E+05	2.28E+10	1.68E+10	1.40E+05	3.66E+04	9.30E+07	2.22E+03
	STD	3.52E+03	1.48E+04	2.50E+06	1.21E+05	4.87E+09	1.59E+09	2.88E+04	7.73E+03	2.40E+07	4.14E+01
	AVG	4.76E+03	4.72E+03	5.30E+03	4.80E+03	8.42E+03	7.06E+03	5.27E+03	5.04E+03	6.05E+03	3.34E+03
CF21	Best	3.83E+03	4.04E+03	4.49E+03	2.08E+03	6.37E+03	6.78E+03	4.22E+03	3.89E+03	5.35E+03	2.90E+03
	Worst	5.62E+03	5.55E+03	6.62E+03	6.42E+03	9.51E+03	7.34E+03	6.36E+03	6.10E+03	6.75E+03	3.68E+03
	STD	4.53E+02	3.80E+02	4.83E+02	1.05E+03	7.15E+02	1.81E+02	4.90E+02	5.47E+02	3.24E+02	1.97E+02
	AVG	2.75E+03	2.84E+03	3.40E+03	2.35E+03	4.58E+03	4.32E+03	2.98E+03	2.87E+03	3.11E+03	2.37E+03
CF22	Best	2.61E+03	2.70E+03	3.16E+03	2.34E+03	4.31E+03	4.12E+03	2.84E+03	2.71E+03	3.00E+03	2.36E+03
	Worst	2.88E+03	2.95E+03	3.74E+03	2.35E+03	5.01E+03	4.44E+03	3.18E+03	2.98E+03	3.20E+03	2.39E+03
	STD	6.11E+01	7.40E+01	1.62E+02	3.66E+00	1.92E+02	6.96E+01	8.49E+01	7.15E+01	5.45E+01	7.64E+00
	AVG	1.67E+04	1.67E+04	1.95E+04	3.01E+04	3.69E+04	3.32E+04	1.63E+04	1.70E+04	2.17E+04	1.16E+04
CF23	Best	1.39E+04	1.36E+04	1.64E+04	3.64E+03	3.04E+04	3.17E+04	1.38E+04	1.40E+04	2.01E+04	1.02E+04
	Worst	1.95E+04	1.94E+04	2.16E+04	3.29E+04	3.88E+04	3.43E+04	1.90E+04	2.05E+04	2.26E+04	1.24E+04
	STD	1.30E+03	1.20E+03	1.45E+03	7.07E+03	1.70E+03	7.31E+02	1.24E+03	1.44E+03	5.39E+02	4.87E+02
	AVG	3.26E+03	3.22E+03	3.94E+03	2.85E+03	6.07E+03	6.79E+03	3.22E+03	3.17E+03	3.97E+03	2.88E+03
CF24	Best	3.15E+03	3.09E+03	3.79E+03	2.84E+03	5.41E+03	5.90E+03	3.11E+03	3.00E+03	3.28E+03	2.85E+03
	Worst	3.46E+03	3.37E+03	4.11E+03	2.87E+03	6.70E+03	7.12E+03	3.44E+03	3.31E+03	5.13E+03	2.91E+03
	STD	7.99E+01	7.06E+01	1.03E+02	9.42E+00	2.75E+02	2.75E+02	8.35E+01	7.69E+01	6.60E+02	1.88E+01
	AVG	3.79E+03	3.80E+03	5.00E+03	3.28E+03	8.45E+03	1.09E+04	3.89E+03	3.88E+03	5.17E+03	3.35E+03
	Best	3.66E+03	3.63E+03	4.54E+03	3.27E+03	7.31E+03	9.92E+03	3.76E+03	3.72E+03	3.99E+03	3.33E+03
	Worst	3.95E+03	3.94E+03	5.48E+03	3.29E+03	9.37E+03	1.16E+04	4.08E+03	4.06E+03	7.94E+03	3.40E+03
	STD	7.25E+01	6.95E+01	2.66E+02	4.79E+00	5.19E+02	3.79E+02	7.09E+01	8.83E+01	1.14E+03	1.75E+01

CF25	AVG	3.26E+03	3.30E+03	3.49E+03	3.24E+03	1.98E+04	1.95E+04	3.66E+03	3.29E+03	3.80E+03	3.22E+03
	Best	3.11E+03	3.16E+03	3.34E+03	3.16E+03	7.56E+03	1.83E+04	3.25E+03	3.16E+03	3.59E+03	3.12E+03
	Worst	3.37E+03	3.41E+03	3.59E+03	3.27E+03	5.63E+04	2.12E+04	5.01E+03	3.40E+03	4.53E+03	3.29E+03
	STD	7.38E+01	6.23E+01	6.87E+01	3.08E+01	1.34E+04	7.25E+02	4.87E+02	6.48E+01	1.71E+02	4.49E+01
CF26	AVG	1.04E+04	1.13E+04	1.90E+04	5.31E+03	5.67E+04	4.81E+04	1.34E+04	1.25E+04	1.84E+04	6.38E+03
	Best	8.98E+03	9.97E+03	4.08E+03	4.75E+03	2.46E+04	4.57E+04	4.80E+03	1.05E+04	1.33E+04	5.95E+03
	Worst	1.28E+04	1.29E+04	2.57E+04	5.65E+03	8.03E+04	5.08E+04	1.93E+04	1.42E+04	4.23E+04	6.68E+03
	STD	9.45E+02	7.15E+02	6.71E+03	1.75E+02	1.18E+04	1.24E+03	2.40E+03	9.09E+02	8.56E+03	1.65E+02
CF27	AVG	3.58E+03	3.50E+03	3.90E+03	3.20E+03	3.20E+03	1.15E+04	3.52E+03	3.55E+03	3.62E+03	3.37E+03
	Best	3.41E+03	3.38E+03	3.62E+03	3.20E+03	3.20E+03	9.44E+03	3.40E+03	3.38E+03	3.53E+03	3.33E+03
	Worst	3.73E+03	3.63E+03	4.58E+03	3.20E+03	3.20E+03	1.23E+04	3.77E+03	3.76E+03	3.75E+03	3.42E+03
	STD	6.52E+01	5.74E+01	1.94E+02	8.88E-05	1.61E-04	6.82E+02	8.41E+01	9.20E+01	4.71E+01	2.19E+01
CF28	AVG	3.35E+03	3.40E+03	3.57E+03	3.30E+03	3.30E+03	3.24E+04	3.85E+03	3.78E+03	8.35E+03	3.32E+03
	Best	3.30E+03	3.34E+03	3.48E+03	3.30E+03	3.30E+03	2.99E+04	3.36E+03	3.33E+03	3.72E+03	3.28E+03
	Worst	3.40E+03	3.48E+03	3.64E+03	3.30E+03	3.30E+03	3.39E+04	1.58E+04	1.56E+04	1.59E+04	3.37E+03
	STD	2.37E+01	3.51E+01	4.21E+01	1.19E-04	1.74E-04	9.57E+02	2.22E+03	2.19E+03	4.11E+03	2.60E+01
CF29	AVG	6.48E+03	6.78E+03	8.93E+03	4.72E+03	2.54E+05	7.98E+04	6.70E+03	6.41E+03	9.69E+03	4.34E+03
	Best	5.70E+03	5.57E+03	7.04E+03	3.85E+03	1.78E+04	4.26E+04	5.24E+03	5.37E+03	6.44E+03	3.80E+03
	Worst	7.62E+03	8.08E+03	1.04E+04	6.99E+03	1.94E+06	1.25E+05	8.09E+03	7.35E+03	1.23E+04	4.79E+03
	STD	4.40E+02	7.20E+02	8.27E+02	8.92E+02	3.81E+05	2.26E+04	6.78E+02	4.78E+02	1.83E+03	2.68E+02
CF30	AVG	1.20E+04	1.19E+05	3.77E+07	8.21E+05	2.94E+10	2.32E+10	3.35E+05	9.68E+03	5.06E+07	5.65E+03
	Best	6.59E+03	4.13E+04	1.40E+07	4.52E+05	5.13E+09	1.73E+10	2.80E+04	6.02E+03	2.91E+05	5.30E+03
	Worst	3.74E+04	2.06E+05	7.08E+07	1.86E+06	4.96E+10	2.70E+10	3.46E+06	2.09E+04	1.22E+08	6.08E+03
	STD	5.82E+03	4.29E+04	1.38E+07	3.23E+05	9.78E+09	1.98E+09	6.55E+05	4.71E+03	3.51E+07	2.27E+02

Section 3.4.5. Further test on CEC2017

Data6: Results of further test on CEC2017.

Function	Item	WDO	SMA	AO	CMA-ES	EHVPSO	e-QPSO	HGS	COA	JADE	L-SHADE
CF1	AVG	1.87E+03	1.09E+04	3.21E+09	2.63E+05	2.10E+10	4.33E+10	1.71E+07	2.46E+05	2.81E+10	1.05E+02
	Best	1.00E+02	3.75E+03	1.72E+09	4.92E+04	9.69E+09	3.37E+10	1.41E+03	2.17E+04	9.17E+08	1.00E+02
	Worst	6.58E+03	2.71E+04	6.45E+09	1.01E+06	5.81E+10	5.14E+10	4.13E+08	1.13E+06	5.67E+10	1.43E+02
	STD	1.90E+03	6.83E+03	1.04E+09	2.15E+05	1.07E+10	3.83E+09	7.46E+07	2.93E+05	1.77E+10	1.04E+01
CF2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CF3	AVG	1.37E+04	6.27E+03	6.91E+04	2.77E+05	1.96E+05	7.92E+04	2.89E+04	1.40E+05	2.16E+05	3.65E+03
	Best	2.52E+03	8.62E+02	4.16E+04	1.38E+05	5.17E+04	6.63E+04	9.89E+03	6.05E+04	9.28E+04	3.01E+02
	Worst	2.94E+04	1.72E+04	8.48E+04	4.08E+05	1.23E+06	8.80E+04	6.70E+04	1.89E+05	3.47E+05	1.03E+05
	STD	6.59E+03	4.42E+03	8.01E+03	7.15E+04	2.07E+05	6.20E+03	1.29E+04	2.86E+04	5.49E+04	1.85E+04
CF4	AVG	4.82E+02	5.06E+02	9.43E+02	4.26E+02	6.65E+03	7.13E+03	5.19E+02	5.03E+02	5.59E+03	4.79E+02
	Best	4.00E+02	4.84E+02	7.06E+02	4.25E+02	2.48E+03	5.25E+03	4.71E+02	4.20E+02	8.91E+02	4.59E+02
	Worst	5.23E+02	6.27E+02	1.44E+03	4.27E+02	1.40E+04	8.79E+03	7.17E+02	6.28E+02	1.59E+04	5.11E+02
	STD	3.08E+01	2.75E+01	2.11E+02	4.54E-01	2.72E+03	8.63E+02	4.89E+01	3.69E+01	3.11E+03	1.26E+01

CF5	AVG	5.91E+02	6.28E+02	7.29E+02	6.70E+02	8.33E+02	8.85E+02	6.53E+02	5.92E+02	8.28E+02	5.22E+02
	Best	5.63E+02	5.70E+02	6.30E+02	6.52E+02	7.42E+02	8.41E+02	5.81E+02	5.39E+02	7.30E+02	5.12E+02
	Worst	6.30E+02	6.93E+02	8.36E+02	6.87E+02	9.23E+02	9.25E+02	7.22E+02	6.85E+02	1.01E+03	5.28E+02
	STD	2.10E+01	3.40E+01	4.40E+01	9.30E+00	4.79E+01	1.93E+01	3.65E+01	3.05E+01	7.37E+01	3.79E+00
CF6	AVG	6.11E+02	6.12E+02	6.58E+02	6.00E+02	6.66E+02	6.80E+02	6.08E+02	6.02E+02	6.75E+02	6.00E+02
	Best	6.03E+02	6.03E+02	6.39E+02	6.00E+02	6.42E+02	6.72E+02	6.02E+02	6.00E+02	6.41E+02	6.00E+02
	Worst	6.26E+02	6.26E+02	6.75E+02	6.00E+02	6.95E+02	6.91E+02	6.21E+02	6.04E+02	7.13E+02	6.00E+02
	STD	4.82E+00	6.15E+00	8.24E+00	5.35E-02	1.04E+01	3.96E+00	5.43E+00	8.94E-01	1.47E+01	8.82E-03
CF7	AVG	8.20E+02	8.91E+02	1.16E+03	9.03E+02	1.39E+03	1.35E+03	9.65E+02	8.42E+02	1.43E+03	7.54E+02
	Best	7.71E+02	8.27E+02	1.02E+03	8.70E+02	1.21E+03	1.29E+03	8.48E+02	8.00E+02	1.02E+03	7.47E+02
	Worst	8.53E+02	9.88E+02	1.27E+03	9.27E+02	1.81E+03	1.42E+03	1.10E+03	8.84E+02	2.14E+03	7.64E+02
	STD	1.88E+01	3.91E+01	5.74E+01	1.31E+01	1.33E+02	2.80E+01	6.58E+01	2.35E+01	3.25E+02	4.31E+00
CF8	AVG	8.79E+02	9.20E+02	1.00E+03	9.70E+02	1.08E+03	1.13E+03	9.34E+02	8.89E+02	1.12E+03	8.22E+02
	Best	8.46E+02	8.58E+02	9.40E+02	9.28E+02	1.01E+03	1.09E+03	8.73E+02	8.46E+02	1.01E+03	8.15E+02
	Worst	9.38E+02	1.01E+03	1.08E+03	9.90E+02	1.17E+03	1.16E+03	9.98E+02	9.46E+02	1.23E+03	8.29E+02
	STD	2.22E+01	3.99E+01	3.19E+01	1.33E+01	4.10E+01	1.56E+01	2.93E+01	2.39E+01	5.76E+01	3.50E+00
CF9	AVG	1.34E+03	3.68E+03	7.97E+03	9.01E+02	7.95E+03	9.98E+03	4.69E+03	1.77E+03	1.01E+04	9.01E+02
	Best	9.91E+02	1.20E+03	4.82E+03	9.00E+02	3.70E+03	7.75E+03	2.67E+03	1.11E+03	3.00E+03	9.00E+02
	Worst	2.02E+03	6.21E+03	1.16E+04	9.01E+02	1.31E+04	1.16E+04	6.94E+03	3.28E+03	1.72E+04	9.05E+02
	STD	2.66E+02	1.34E+03	1.60E+03	9.56E-02	2.29E+03	9.28E+02	9.30E+02	4.89E+02	4.05E+03	1.16E+00
CF10	AVG	4.59E+03	4.96E+03	6.31E+03	8.20E+03	8.08E+03	8.59E+03	4.51E+03	4.39E+03	8.12E+03	3.55E+03
	Best	2.79E+03	3.77E+03	4.96E+03	7.33E+03	5.58E+03	7.85E+03	3.26E+03	3.31E+03	7.58E+03	2.92E+03
	Worst	6.07E+03	6.36E+03	8.03E+03	8.87E+03	1.03E+04	9.29E+03	5.69E+03	5.50E+03	8.82E+03	4.09E+03
	STD	7.30E+02	6.19E+02	7.85E+02	3.35E+02	1.14E+03	3.76E+02	5.94E+02	5.67E+02	3.12E+02	3.49E+02
CF11	AVG	1.18E+03	1.27E+03	4.92E+03	3.01E+03	6.64E+03	7.88E+03	1.26E+03	1.20E+03	2.02E+04	1.16E+03
	Best	1.12E+03	1.16E+03	2.75E+03	1.89E+03	2.31E+03	4.67E+03	1.15E+03	1.14E+03	5.00E+03	1.12E+03
	Worst	1.26E+03	1.35E+03	9.44E+03	6.79E+03	2.07E+04	1.06E+04	1.65E+03	1.30E+03	4.00E+04	1.23E+03
	STD	3.11E+01	4.91E+01	1.60E+03	1.02E+03	4.51E+03	1.23E+03	9.19E+01	4.38E+01	8.98E+03	3.02E+01
CF12	AVG	2.06E+05	3.41E+06	2.88E+08	1.73E+07	4.76E+09	7.57E+09	4.68E+06	1.05E+06	5.05E+09	1.28E+04
	Best	2.03E+04	1.37E+05	4.17E+07	6.20E+06	1.20E+09	6.15E+09	2.58E+05	1.38E+05	9.65E+07	2.99E+03
	Worst	5.74E+05	1.07E+07	1.10E+09	4.01E+07	1.19E+10	8.88E+09	1.22E+07	3.40E+06	1.30E+10	2.66E+04
	STD	1.36E+05	2.47E+06	2.29E+08	7.51E+06	2.64E+09	8.49E+08	3.37E+06	1.01E+06	3.18E+09	7.27E+03
CF13	AVG	1.45E+04	4.20E+04	2.70E+07	6.12E+06	1.29E+09	3.82E+09	3.88E+04	3.50E+04	5.44E+09	1.47E+03
	Best	1.42E+03	8.31E+03	5.61E+05	1.85E+06	1.79E+06	8.04E+08	1.01E+04	2.12E+03	7.15E+06	1.34E+03
	Worst	5.77E+04	9.00E+04	3.66E+08	1.38E+07	7.81E+09	5.83E+09	9.13E+04	1.61E+05	1.31E+10	1.73E+03
	STD	1.44E+04	2.40E+04	6.84E+07	2.83E+06	1.79E+09	1.07E+09	2.66E+04	3.36E+04	3.46E+09	9.83E+01
CF14	AVG	1.45E+04	1.42E+05	9.73E+05	1.60E+05	9.48E+05	1.98E+06	2.22E+05	1.20E+04	1.24E+07	1.44E+03
	Best	2.10E+03	2.46E+03	2.19E+04	3.49E+04	1.96E+03	7.61E+05	1.30E+04	1.48E+03	1.78E+03	1.43E+03
	Worst	7.71E+04	5.89E+05	2.76E+06	4.85E+05	3.88E+06	2.87E+06	1.16E+06	2.74E+05	4.47E+07	1.47E+03
	STD	1.58E+04	1.39E+05	7.41E+05	1.04E+05	1.29E+06	5.69E+05	2.24E+05	4.88E+04	9.84E+06	9.10E+00
CF15	AVG	4.55E+03	2.41E+04	1.91E+05	1.93E+06	3.49E+06	2.58E+08	1.70E+04	1.17E+04	1.43E+09	1.57E+03
	Best	1.64E+03	2.28E+03	2.58E+04	2.07E+05	9.40E+03	7.75E+07	1.74E+03	1.61E+03	4.71E+04	1.52E+03
	Worst	1.75E+04	4.44E+04	4.37E+05	4.73E+06	4.45E+07	3.81E+08	4.29E+04	4.29E+04	5.37E+09	1.69E+03

CF16	STD	3.37E+03	1.33E+04	1.18E+05	1.08E+06	1.00E+07	8.56E+07	1.58E+04	1.42E+04	1.17E+09	4.75E+01
	AVG	2.59E+03	2.60E+03	3.48E+03	2.95E+03	4.62E+03	5.71E+03	2.86E+03	2.80E+03	4.59E+03	2.08E+03
	Best	2.25E+03	2.06E+03	2.45E+03	2.67E+03	3.32E+03	4.78E+03	2.04E+03	2.04E+03	3.56E+03	1.65E+03
	Worst	3.29E+03	3.12E+03	4.68E+03	3.26E+03	6.96E+03	6.36E+03	3.50E+03	3.43E+03	5.59E+03	2.43E+03
CF17	STD	2.54E+02	2.88E+02	5.11E+02	1.63E+02	7.25E+02	3.88E+02	3.44E+02	3.14E+02	5.96E+02	1.82E+02
	AVG	2.08E+03	2.35E+03	2.43E+03	2.35E+03	2.68E+03	3.44E+03	2.41E+03	2.19E+03	3.90E+03	1.79E+03
	Best	1.76E+03	1.88E+03	2.01E+03	2.12E+03	2.05E+03	2.87E+03	2.03E+03	1.76E+03	2.83E+03	1.75E+03
	Worst	2.37E+03	2.76E+03	2.79E+03	2.65E+03	3.19E+03	4.00E+03	2.89E+03	2.69E+03	1.11E+04	1.92E+03
CF18	STD	1.47E+02	2.31E+02	1.85E+02	1.06E+02	3.10E+02	3.35E+02	2.23E+02	2.48E+02	1.47E+03	3.49E+01
	AVG	1.89E+05	1.41E+06	7.82E+06	2.19E+06	1.47E+07	1.53E+07	2.06E+06	3.22E+05	8.02E+07	1.95E+03
	Best	2.30E+04	2.63E+05	3.79E+05	6.41E+05	2.77E+05	5.79E+06	7.13E+04	4.12E+04	1.03E+07	1.86E+03
	Worst	7.94E+05	6.28E+06	3.44E+07	6.07E+06	1.01E+08	3.82E+07	8.38E+06	1.91E+06	2.43E+08	2.14E+03
CF19	STD	1.76E+05	1.64E+06	7.71E+06	1.35E+06	2.15E+07	7.09E+06	2.13E+06	4.30E+05	5.84E+07	7.40E+01
	AVG	6.05E+03	2.90E+04	4.16E+06	1.65E+06	7.03E+06	1.25E+08	2.07E+04	2.19E+04	1.21E+09	1.94E+03
	Best	1.99E+03	2.10E+03	4.50E+05	4.06E+05	5.82E+04	2.32E+07	2.16E+03	1.95E+03	2.73E+06	1.91E+03
	Worst	2.06E+04	5.66E+04	1.32E+07	4.44E+06	4.57E+07	2.47E+08	5.65E+04	5.65E+04	5.08E+09	2.01E+03
CF20	STD	4.72E+03	2.23E+04	3.75E+06	9.99E+05	9.24E+06	5.22E+07	2.07E+04	2.14E+04	1.25E+09	2.05E+01
	AVG	2.31E+03	2.60E+03	2.65E+03	2.57E+03	2.85E+03	2.92E+03	2.58E+03	2.51E+03	3.23E+03	2.14E+03
	Best	2.10E+03	2.27E+03	2.32E+03	2.30E+03	2.47E+03	2.68E+03	2.05E+03	2.05E+03	2.79E+03	2.06E+03
	Worst	2.58E+03	3.01E+03	3.02E+03	2.79E+03	3.28E+03	3.06E+03	2.99E+03	2.91E+03	3.54E+03	2.34E+03
CF21	STD	1.38E+02	1.89E+02	2.04E+02	1.35E+02	2.01E+02	8.99E+01	2.20E+02	2.24E+02	1.68E+02	8.28E+01
	AVG	2.38E+03	2.42E+03	2.51E+03	2.46E+03	2.63E+03	2.67E+03	2.44E+03	2.40E+03	2.64E+03	2.32E+03
	Best	2.34E+03	2.36E+03	2.44E+03	2.44E+03	2.53E+03	2.63E+03	2.37E+03	2.34E+03	2.52E+03	2.32E+03
	Worst	2.43E+03	2.48E+03	2.57E+03	2.47E+03	2.83E+03	2.71E+03	2.55E+03	2.46E+03	2.75E+03	2.33E+03
CF22	STD	1.94E+01	3.08E+01	3.00E+01	9.57E+00	7.06E+01	1.74E+01	3.36E+01	3.00E+01	7.49E+01	4.59E+00
	AVG	2.30E+03	5.87E+03	3.63E+03	9.75E+03	8.91E+03	6.91E+03	5.18E+03	5.22E+03	9.08E+03	2.30E+03
	Best	2.30E+03	2.30E+03	2.61E+03	9.14E+03	5.12E+03	6.32E+03	2.30E+03	2.30E+03	6.13E+03	2.30E+03
	Worst	2.30E+03	7.63E+03	8.21E+03	1.02E+04	1.12E+04	7.71E+03	7.45E+03	7.15E+03	1.04E+04	2.30E+03
CF23	STD	1.79E+00	9.75E+02	1.53E+03	2.80E+02	2.03E+03	3.48E+02	1.68E+03	1.52E+03	1.10E+03	8.44E-01
	AVG	2.76E+03	2.76E+03	3.00E+03	2.83E+03	3.37E+03	3.68E+03	2.79E+03	2.75E+03	3.15E+03	2.67E+03
	Best	2.71E+03	2.72E+03	2.88E+03	2.80E+03	3.13E+03	3.53E+03	2.74E+03	2.71E+03	2.96E+03	2.66E+03
	Worst	2.82E+03	2.81E+03	3.13E+03	2.85E+03	3.71E+03	3.82E+03	2.83E+03	2.80E+03	3.40E+03	2.68E+03
CF24	STD	2.98E+01	2.46E+01	6.95E+01	1.01E+01	1.28E+02	7.22E+01	2.82E+01	2.11E+01	1.01E+02	5.32E+00
	AVG	2.94E+03	2.94E+03	3.14E+03	2.99E+03	3.62E+03	3.95E+03	3.05E+03	2.92E+03	3.26E+03	2.84E+03
	Best	2.88E+03	2.87E+03	3.03E+03	2.96E+03	3.39E+03	3.60E+03	2.95E+03	2.87E+03	3.17E+03	2.83E+03
	Worst	3.01E+03	3.03E+03	3.30E+03	3.01E+03	3.77E+03	4.16E+03	3.23E+03	3.01E+03	3.35E+03	2.85E+03
CF25	STD	3.30E+01	3.60E+01	7.04E+01	1.16E+01	9.96E+01	1.26E+02	5.56E+01	3.59E+01	3.59E+01	5.50E+00
	AVG	2.90E+03	2.89E+03	3.08E+03	2.88E+03	3.98E+03	3.90E+03	2.89E+03	2.91E+03	5.11E+03	2.89E+03
	Best	2.88E+03	2.88E+03	2.96E+03	2.88E+03	3.21E+03	3.62E+03	2.88E+03	2.89E+03	3.05E+03	2.89E+03
	Worst	2.94E+03	2.94E+03	3.21E+03	2.88E+03	7.12E+03	4.16E+03	2.93E+03	2.94E+03	1.21E+04	2.89E+03
CF26	STD	1.79E+01	1.19E+01	6.14E+01	3.71E-01	7.83E+02	1.20E+02	1.12E+01	1.87E+01	1.85E+03	1.39E-01
	AVG	4.52E+03	4.79E+03	6.21E+03	5.03E+03	9.07E+03	9.55E+03	5.08E+03	4.79E+03	8.76E+03	3.75E+03
	Best	2.80E+03	4.30E+03	4.20E+03	4.73E+03	7.07E+03	8.61E+03	2.91E+03	4.25E+03	6.87E+03	3.61E+03

CF27	Worst	6.28E+03	5.55E+03	8.39E+03	5.22E+03	1.22E+04	1.04E+04	6.15E+03	5.55E+03	1.06E+04	3.95E+03
	STD	1.01E+03	3.09E+02	1.37E+03	1.28E+02	1.10E+03	4.58E+02	8.42E+02	3.31E+02	9.40E+02	9.19E+01
	AVG	3.27E+03	3.23E+03	3.46E+03	3.20E+03	3.20E+03	4.31E+03	3.24E+03	3.23E+03	3.42E+03	3.21E+03
	Best	3.24E+03	3.21E+03	3.32E+03	3.20E+03	3.20E+03	4.02E+03	3.20E+03	3.20E+03	3.29E+03	3.19E+03
CF28	Worst	3.33E+03	3.28E+03	3.64E+03	3.20E+03	3.20E+03	4.56E+03	3.29E+03	3.30E+03	3.63E+03	3.23E+03
	STD	2.45E+01	1.48E+01	8.18E+01	5.72E-05	1.41E-04	1.28E+02	1.77E+01	1.94E+01	6.76E+01	7.41E+00
	AVG	3.19E+03	3.26E+03	3.73E+03	3.30E+03	3.30E+03	5.52E+03	3.28E+03	3.28E+03	6.04E+03	3.18E+03
	Best	3.10E+03	3.21E+03	3.48E+03	3.30E+03	3.30E+03	5.05E+03	3.20E+03	3.22E+03	3.88E+03	3.10E+03
CF29	Worst	3.27E+03	3.35E+03	4.06E+03	3.30E+03	3.30E+03	5.78E+03	3.44E+03	3.45E+03	8.00E+03	3.26E+03
	STD	3.91E+01	3.67E+01	1.62E+02	8.92E-05	2.71E-02	1.72E+02	7.30E+01	4.43E+01	1.21E+03	6.01E+01
	AVG	3.69E+03	3.95E+03	4.75E+03	4.38E+03	4.80E+03	6.44E+03	3.93E+03	3.82E+03	5.57E+03	3.41E+03
	Best	3.43E+03	3.52E+03	4.15E+03	3.95E+03	3.89E+03	5.31E+03	3.47E+03	3.40E+03	4.48E+03	3.37E+03
CF30	Worst	3.99E+03	4.75E+03	5.47E+03	4.94E+03	6.50E+03	7.23E+03	4.22E+03	4.29E+03	8.38E+03	3.44E+03
	STD	1.76E+02	2.38E+02	3.63E+02	2.37E+02	6.06E+02	5.05E+02	1.69E+02	2.78E+02	8.47E+02	2.06E+01
	AVG	7.60E+03	5.34E+04	3.44E+07	2.52E+06	5.00E+07	7.55E+08	1.24E+05	1.58E+04	7.76E+08	5.59E+03
	Best	5.98E+03	1.85E+04	3.96E+06	7.29E+05	4.02E+05	1.41E+08	1.06E+04	6.01E+03	1.58E+07	5.08E+03
	Worst	1.24E+04	2.31E+05	2.30E+08	6.35E+06	6.06E+08	1.34E+09	4.63E+05	3.76E+04	2.45E+09	6.82E+03
	STD	1.44E+03	3.89E+04	4.12E+07	1.42E+06	1.12E+08	2.64E+08	1.45E+05	7.53E+03	6.94E+08	4.76E+02

Section 4. Test on constrained problems and engineering optimization problems

Problem (1): Inequality-constrained problem

This is a minimization problem. And the case contains seven decision variables and four inequality constraints, consider $\mathbf{X} = \{x_1, x_2, \dots, x_7\}$, it is described as follow:

$$\text{Min } f(\mathbf{X}) = (x_1 - 10)^2 + 5(x_2 - 12)^2 + x_3^4 + 3(x_4 - 11)^2 + 10x_5^6 + 7x_6^2 + x_7^2 - 4x_6x_7 - 10x_6 - 8x_7$$

subject to :

$$g_1(\mathbf{X}) = 127 - 2x_1^2 - 3x_2^4 - x_3 - 4x_4^2 - 5x_5 \geq 0, \quad g_2(\mathbf{X}) = 282 - 7x_1 - 3x_2 - 10x_3^2 - x_4 + x_5 \geq 0$$

$$g_3(\mathbf{X}) = 196 - 23x_1 - x_2^2 - 6x_6^2 + 8x_7 \geq 0, \quad g_4(\mathbf{X}) = -4x_1^2 - x_2^2 + 3x_1x_2 - 2x_3^2 - 5x_6 + 11x_7 \geq 0 \quad (1)$$

$$-10 \leq x_m \leq 10, m = 1, 2, \dots, 7$$

Problem (2): Equality constrained problem

This is a minimization problem with n decision variables and an equality constraint. Consider $\mathbf{X} = \{x_1, x_2, \dots, x_n\}$, the specific description is as follows:

$$\text{Min } f(X) = -(\sqrt{n})^n \cdot \prod_{m=1}^n x_m$$

subject to :

$$h(X) = \sum_{m=1}^n x_m^2 = 1, \quad 0 \leq x_m \leq 1, m = 1, 2, \dots, n \quad (2)$$

where n is taken as 10 in this paper. At this time, the optimal solution of problem 2 can be expressed as $\mathbf{X} = (\frac{1}{\sqrt{n}}, \frac{1}{\sqrt{n}}, \dots, \frac{1}{\sqrt{n}})$.

Problem (3): Three-bar truss design problem

Three-bar truss design is a common nonlinear optimization problem. It has three linear inequality constraints and two continuous decision variables. The ultimate goal of this problem is to design a three-bar truss with the smallest total weight. At the same time, the effects of stress, deflection and buckling need to be considered. In this problem, the areas A_1 and A_3 of bar 1 and bar 3 are the same. The two decision variables are A_1 and A_2 , which can be expressed as $\mathbf{X} = \{x_1, x_2\} = \{A_1, A_2\}$. The specific mathematical method can be described as follows:

$$\text{Min } f(\mathbf{X}) = (2\sqrt{2}x_1 + x_2) \cdot l$$

subject to :

$$\begin{aligned} g_1(\mathbf{X}) &= \frac{\sqrt{2}x_1 + x_2}{\sqrt{2}x_1^2 + 2x_1x_2}P - \sigma \leq 0, \quad g_2(\mathbf{X}) = \frac{x_2}{\sqrt{2}x_1^2 + 2x_1x_2}P - \sigma \leq 0 \\ g_3(\mathbf{X}) &= \frac{1}{\sqrt{2}x_2 + x_1}P - \sigma \leq 0, \quad 0 \leq x_m \leq 1, m = 1, 2 \end{aligned} \quad (3)$$

$$l = 100\text{cm}, P = 2\text{KN/cm}^2, \sigma = 2\text{KN/cm}^2$$

Problem (4): Speed reducer design problem

On speed reducer design problem, the goal is to minimize the weight of the reducer. The constraint conditions need to consider four aspects: bending stress of the gear teeth, surface stress, transverse deflections

of the shafts and stresses in the shafts. In addition, there are seven decision variables involved on this problem, namely: the face width (b), module of teeth (m), number of teeth in the pinion (z), length of the first shaft between bearings (l_1), length of the second shaft between bearings (l_2), and the diameter of first (d_1) and second shafts (d_2), respectively. Among them, the third decision variable z is an integer value. Consider $\mathbf{X} = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7\} = \{b, m, z, l_1, l_2, d_1, d_2\}$, the mathematical expression of this problem is as follows:

$$\begin{aligned}
\text{Min } f(\mathbf{X}) &= 0.7854x_1x_2^2(3.3333x_3^2 + 14.9334x_3 - 43.0934) \\
&\quad - 1.508x_1(x_6^2 + x_7^2) + 7.4777(x_6^3 + x_7^2) + 0.7854(x_4x_6^2 + x_5x_7^2) \\
\text{subject to :} \\
g_1(\mathbf{X}) &= \frac{27}{x_1x_2^2x_3} - 1 \leq 0, \quad g_2(\mathbf{X}) = \frac{397.5}{x_1x_2^2x_3^2} - 1 \leq 0 \\
g_3(\mathbf{X}) &= \frac{1.93x_4^3}{x_2x_6^4x_3} - 1 \leq 0, \quad g_4(\mathbf{X}) = \frac{1.93x_5^3}{x_2x_7^4x_3} - 1 \leq 0 \\
g_5(\mathbf{X}) &= \frac{[(745x_4/x_2x_3)^2 + 16.9 \cdot 10^{16}]^{1/2}}{110x_6^2} - 1 \leq 0, \quad g_6(\mathbf{X}) = \frac{[(745x_5/x_2x_3)^2 + 157.5 \cdot 10^{16}]^{1/2}}{185x_7^3} - 1 \leq 0 \quad (4) \\
g_7(\mathbf{X}) &= \frac{x_2x_3}{40} - 1 \leq 0, \quad g_8(\mathbf{X}) = \frac{5x_2}{x_1} - 1 \leq 0 \\
g_9(\mathbf{X}) &= \frac{x_1}{12x_2} - 1 \leq 0, \quad g_{10}(\mathbf{X}) = \frac{1.5x_6 + 1.9}{x_4} - 1 \leq 0, \quad g_{11}(\mathbf{X}) = \frac{1.1x_7 + 1.9}{x_5} - 1 \leq 0 \\
2.6 \leq x_1 \leq 3.6, & 0.7 \leq x_2 \leq 0.8, 17 \leq x_3 \leq 28, 7.3 \leq x_4 \leq 8.3, 7.3 \leq x_5 \leq 8.3, 2.9 \leq x_6 \leq 3.9, 5.0 \leq x_7 \leq 5.5
\end{aligned}$$

Problem (5): Pressure vessel design problem

The pressure vessel problem is proposed by Kannan and Kramer. The ultimate goal is to minimize the total cost of material, forming and welding of cylindrical vessels. There are four decision variables for this problem: thickness of the shell (T_s), thickness of the head (T_h), inner radius (R) and length of the cylindrical section of the vessel (L). It should be noted that T_s and T_h are generally integer multiples of 0.0625 in, and R and L are continuous decision variables. Consider $\mathbf{X} = \{x_1, x_2, x_3, x_4\} = \{T_s, T_h, R, L\}$, the specific mathematical model is described as follows:

$$\text{Min } f(\mathbf{X}) = 0.6224x_1x_3x_4 + 1.7781x_2x_3^2 + 3.1661x_1^2x_4 + 19.84x_1^2x_3$$

subject to :

$$\begin{aligned}
g_1(\mathbf{X}) &= -x_1 + 0.0193x_3 \leq 0, \quad g_2(\mathbf{X}) = -x_2 + 0.00954x_3 \leq 0 \\
g_3(\mathbf{X}) &= -\pi x_3^2 x_4 - 4/3\pi x_3^3 + 1296,000 \leq 0, \quad g_4(\mathbf{X}) = x_4 - 240 \leq 0 \\
0 &\leq x_m \leq 100, m = 1, 2; \quad 10 \leq x_m \leq 200, m = 3, 4
\end{aligned} \tag{5}$$

Problem (6): Tension/compression spring design problem

The tension/compression spring design problem is first described by Arora, and the goal is to minimize the weight of the tension/compression spring. Among them, there are three decision variables: the wire diameter (d), the average coil diameter (D) and the number of active coils (P). In addition, the goal of optimization is limited by shear stress, surge frequency, minimum deflection, et al. Consider $\mathbf{X} = \{x_1, x_2, x_3\} = \{d, D, P\}$. The mathematical expression of this problem is described as:

$$\begin{aligned}
\text{Min } f(\mathbf{X}) &= (x_3 + 2)x_2x_1^2 \\
\text{subject to :} \\
g_1(\mathbf{X}) &= 1 - x_2^3x_3/71785x_1^4 \leq 0 \\
g_2(\mathbf{X}) &= 4x_2^2 - x_1x_2/12,566(x_2x_1^3 - x_1^4) + 1/5108x_1^2 - 1 \leq 0 \\
g_3(\mathbf{X}) &= 1 - 140.45x_1/x_2^2x_3 \leq 0, \quad g_4(\mathbf{X}) = x_2 + x_1/1.5 - 1 \leq 0 \\
0.05 &\leq x_1 \leq 2.00, \quad 0.25 \leq x_2 \leq 1.30, \quad 2.00 \leq x_3 \leq 15.00
\end{aligned} \tag{6}$$

Problem (7): Welded beam design problem

Welded beam design is a commonly used engineering benchmark problem, which is proposed by literature. The design goal of this problem is to design a welded beam with the lowest manufacturing cost by finding the global optimal solution. There are four optimization variables: thickness of weld (h), length of the clamped bar (l) height of the bar (t), and thickness of the bar (b). The constraints of the welded beam design problem are the shear stress (τ) and bending stress (σ) in the beam, buckling load (P_b) on the bar, and end deflection (δ) of the beam. Consider $\mathbf{X} = \{x_1, x_2, x_3, x_4\} = \{h, l, t, b\}$, the specific mathematical model is described as follows:

$$\text{Min } f(\mathbf{X}) = 1.10471x_1^2x_2 + 0.04811x_3x_4(14 + x_2)$$

subject to :

$$g_1(\mathbf{X}) = \tau(x) - \tau_{max} \leq 0, \quad g_2(\mathbf{X}) = \sigma(x) - \sigma_{max} \leq 0, \quad g_3(\mathbf{X}) = x_1 - x_4 \leq 0$$

$$g_4(\mathbf{X}) = 0.10471x_1^2 + 0.04811x_3x_4(14 + x_2) \leq 0, \quad g_5(\mathbf{X}) = 0.125 - x_1 \leq 0$$

$$g_6(\mathbf{X}) = \delta(x) - \delta_{max} \leq 0, \quad g_7(\mathbf{X}) = P - P_c(x) \leq 0$$

$$0.1 \leq x_m \leq 2, m = 1, 4, \quad 0.1 \leq x_m \leq 10, m = 2, 3$$

$$\tau(\mathbf{X}) = \sqrt{(\tau')^2 + (\tau'')^2 + (l\tau'\tau'')/\sqrt{0.25(l^2 + (h+t)^2)}} \quad (7)$$

$$\tau' = \frac{P}{\sqrt{2}x_1x_2}, \tau'' = \frac{MR}{J}, \quad M = P(L + \frac{x_2}{2}), R = \sqrt{\frac{x_2^2}{4} + (\frac{x_1 + x_3}{2})^2}$$

$$J = 2 \left\{ \sqrt{2}x_1x_2 \left[\frac{x_2^2}{12} + (\frac{x_1 + x_3}{2})^2 \right] \right\}, \quad \sigma(\mathbf{X}) = \frac{6PL}{x_4x_3^2}, \delta(x) = \frac{4PL^3}{Ex_3^3x_4},$$

$$P_c(\mathbf{X}) = \frac{4.013E\sqrt{\frac{x_3^2x_4^6}{36}}}{L^2} (1 - \frac{x_3}{2L}\sqrt{\frac{E}{4G}}), P = 6000lb, L = 14in, E = 30 \cdot 10^6 \text{psi},$$

$$G = 12 \cdot 10^6 \text{psi}, \tau_{max} = 13,600 \text{psi}, \sigma_{max} = 30,000 \text{psi}, \delta_{max} = 0.25in$$

Problem (8): Rolling element bearing design problem

Rolling element bearing is a problem of maximization. The goal of this problem is to optimize the dynamic load-carrying capacity of rolling bearings. There are ten decision variables in the model such as pitch diameter (D_m), ball diameter (D_b), number of balls (Z), inner (f_i) and outer (f_o) raceway curvature coefficients, $K_{D_{min}}$, $K_{D_{max}}$, ε , e and ζ . Among them, the latter five appear in constraints and indirectly affect the internal geometric structure. Z is a discrete design variable, and the rest are continuous design variables. Consider $\mathbf{X} = \{x_1, x_2, \dots, x_{10}\} = \{D_m, D_b, Z, f_i, f_o, K_{D_{min}}, K_{D_{max}}, \varepsilon, e, \zeta\}$, the mathematical model is shown as follows.

$$\text{Max } C_d = f_c Z^{2/3} D_b^{1.8} \quad \text{if } D \leq 25.4 \text{mm}, C_d = 3.647 f_c Z^{2/3} D_b^{1.4} \quad \text{if } D > 25.4 \text{mm}$$

subject to :

$$g_1(\mathbf{X}) = \frac{\varphi_0}{2\sin_{-1}(D_b/D_m)} - Z + 1 \geq 0, \quad g_2(\mathbf{X}) = 2D_b - K_{D_{min}}(D - d) \geq 0$$

$$\begin{aligned}
g_3(\mathbf{X}) &= K_{D_{max}}(D - d) - 2D_b \geq 0, \quad g_4(\mathbf{X}) = \zeta B_w - D_b \leq 0 \\
g_5(\mathbf{X}) &= D_m - 0.5(D + d) \geq 0, \quad g_6(\mathbf{X}) = (0.5 + e)(D + d) - D_m \geq 0 \\
g_7(\mathbf{X}) &= 0.5(D - D_m - D_b) - \varepsilon D_b \geq 0, \quad g_8(\mathbf{X}) = f_i \geq 0.515, \quad g_9(\mathbf{X}) = f_o \geq 0.515 \\
x &= \{(D - d)/2 - 3(T/4)\}^2 + \{D/2 - T/4 - D_b\}^2 - \{d/2 + T/4\}^2 \\
y &= 2\{(D - d)/2 - 3(T/4)\}\{D/2 - T/4 - D_b\} \\
f_c &= 37.91 \left[1 + \left\{ 1.04 \left(\frac{1 - \gamma}{1 + \gamma} \right)^{1.72} \left(\frac{f_i(2f_o - 1)}{f_o(2f_i - 1)} \right)^{0.41} \right\}^{10/3} \right]^{-0.3} \\
&\quad * \left[\frac{\gamma^{0.3}(1 - \gamma)^{1.39}}{(1 + \gamma)^{1/3}} \right] \left[\frac{2f_i}{2f_i - 1} \right]^{0.41}, \quad \phi_0 = 2\pi - 2 * \cos^{-1}\left(\frac{x}{y}\right) \\
\gamma &= \frac{D_b}{D_m}, \quad f_i = \frac{r_i}{D_b}, \quad f_o = \frac{r_o}{D_b}, \quad T = D - d - 2D_b \\
D &= 160, d = 90, B_w = 30, r_i = r_o = 11.033 \\
0.5(D + d) &\leq D_m \leq 0.6(D + d), 0.15(D + d) \leq D_b \leq 0.45(D - d) \\
4 \leq Z &\leq 50, 0.515 \leq f_i \text{ and } f_o \leq 0.6, 0.02 \leq e \leq 0.1, 0.6 \leq \zeta \leq 0.85. \\
0.4 \leq K_{D_{min}} &\leq 0.5, 0.6 \leq K_{D_{max}} \leq 0.7, 0.3 \leq \varepsilon \leq 0.4
\end{aligned} \tag{8}$$

Data7: Comparison results for constrained problems and engineering optimization problems.

Problem	Item	WDO	CPA	PSO	SFO	SOA	SSA	HGS	WCA
problem (1)	AVG	680.752691	681.415016	686.632582	725.933229	698.465360	681.064923	682.393655	680.7779428
	Best	680.641654	680.699731	680.683237	694.055408	681.017570	680.687095	680.735285	680.6440908
	Worst	681.161197	683.563131	714.675030	791.348777	860.642413	681.675671	692.565548	681.0558052
	STD	0.115757	0.629612	7.783646	25.874163	31.960458	0.334516	2.487717	0.109497114
problem (2)	AVG	-0.999643	-0.996449	6.846355E+14	-0.993032	-0.064194	-0.999910	-0.992899	-0.99930028
	Best	-0.999981	-0.998933	-0.033445	-0.999906	-0.995391	-0.999979	-0.999337	-0.999816264
	Worst	-0.998732	-0.991955	2.283912E+15	-0.970977	0.000000	-0.999818	-0.979649	-0.997564454
	STD	0.000269	0.001451	5.404822E+14	0.006296	0.248482	0.000047	0.005183	0.00055072
problem (3)	AVG	263.897266	264.032373	267.266978	264.480529	271.880240	263.899233	263.918571	263.899562
	Best	263.895843	263.896658	264.241236	263.898928	263.909822	263.895845	263.895853	263.8958454
	Worst	263.904357	264.635129	272.747973	266.536862	282.842712	263.932769	264.092723	263.9349649
	STD	0.002034	0.181652	2.221231	0.559284	9.470407	0.007945	0.046291	0.007325538
problem (4)	AVG	2994.471066	3506.739005	3176.949295	1.336953E+11	3016.391930	5.655078E+12	2995.661443	2997.532353
	Best	2994.471066	3166.297315	3106.090801	3182.681685	3001.820328	4082.463272	2994.471066	2994.471066
	Worst	2994.471066	4063.683078	3265.723360	7.084974E+11	3038.558972	4.499232E+13	3002.849175	3016.770389
	STD	0.000000	231.046223	41.896245	1.939802E+11	9.021691	8.612796E+12	2.586899	5.711258205
problem (5)	AVG	6686.245938	18122.243259	555456.108474	104728.048751	6162.893182	7767.520913	6418.656981	6404.480065

problem (6)	Best	5900.810241	6229.110025	42001.158126	7086.796849	5893.566902	6287.506015	5949.627060	5885.332774
	Worst	7238.341206	113025.627799	1540896.344000	533542.017437	7326.915077	11706.641539	7318.061588	7319.000702
	STD	430.977359	26564.364763	427797.462344	110401.334873	428.980550	1420.708486	399.765430	500.7152729
	AVG	0.014301	0.018293	0.028332	0.013593	0.012756	0.019747	0.014617	0.013050533
	Best	0.012665	0.013911	0.016853	0.012872	0.012694	0.017788	0.012666	0.012665433
problem (7)	Worst	0.017773	0.025218	0.047427	0.014570	0.012844	0.023051	0.017766	0.013981015
	STD	0.002114	0.002752	0.008259	0.000460	0.000031	0.001423	0.001743	0.000329574
	AVG	1.724852	2.394012	2.929719	2.748107	1.740463	3.297567E+14	2.283138	1.776400705
	Best	1.724852	1.931113	2.076405	1.861846	1.727203	3.465846	1.727164	1.724852381
	Worst	1.760997	3.178293	4.111937	3.959375	1.787941	3.718326E+15	3.297963	2.003087895
problem (8)	STD	0.007131	0.274680	0.505797	0.580582	0.015453	8.004044E+14	0.456279	0.088391649
	AVG	85203.040899	70875.356209	-3.47E+11	-1.17E+13	85126.784836	N/A	78643.319114	85240.228445
	Best	85539.192933	81184.351608	5.96E+04	8.27E+04	85413.792626	N/A	83025.649583	85539.192933
	Worst	83501.984871	60318.117522	-6.12E+12	-3.64E+14	84809.096947	N/A	73012.989131	83078.630886
	STD	480.752927	6036.515908	1.205595E+12	6.537581E+13	145.368840	N/A	2784.338156	525.8873408
