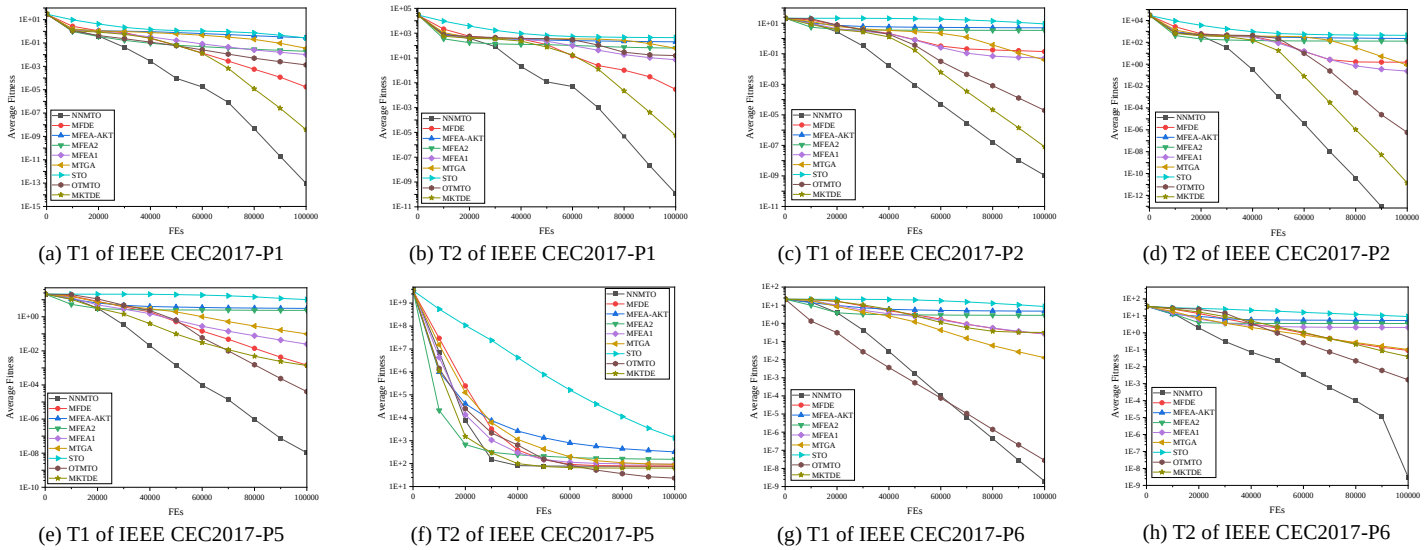
Supplementary Material for "Neural Network-based Knowledge Transfer for Multitask Optimization"

Zhao-Feng Xue, *Student Member, IEEE*, Zi-Jia Wang, *Member, IEEE*, Zhi-Hui Zhan, *Fellow, IEEE*, Sam Kwong, *Fellow, IEEE*, and Jun Zhang, *Fellow, IEEE*

TABLE S.I
PROPERTIES OF THE IEEE CEC2017 BENCHMARK PROBLEMS

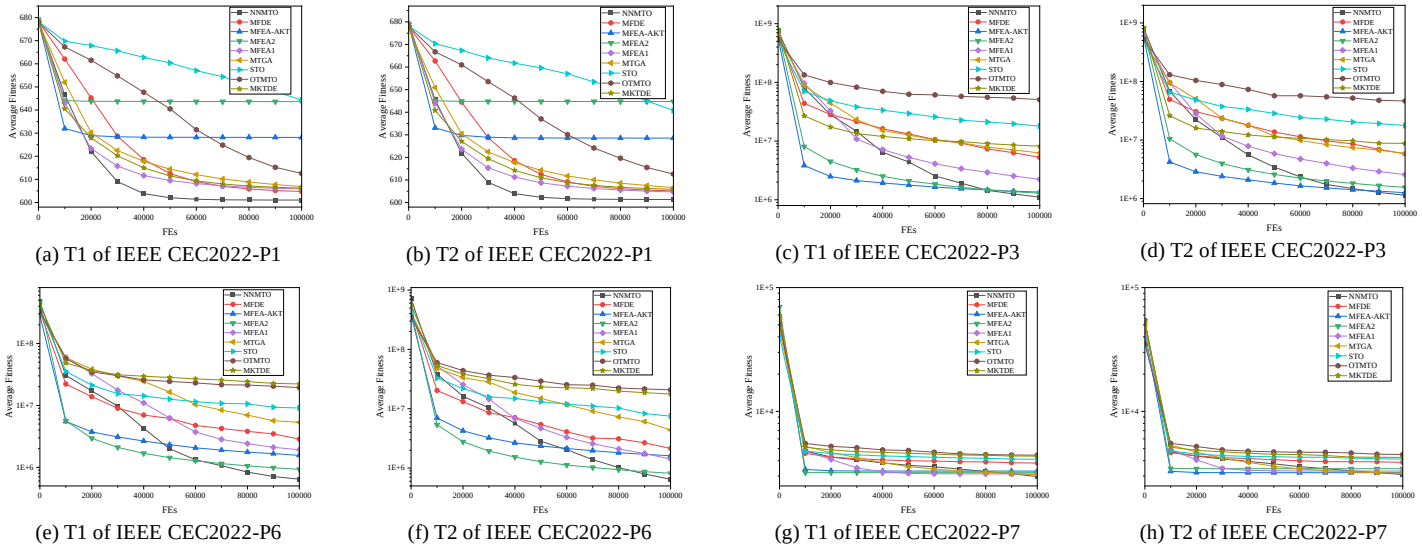
Problem	Task	Dimensionality	Degree of Intersection	Inter-task similarity
CI+HS	Griewank (T_1)	50	Complete Intersection	1.0000
	Rastrigin (T_2)	50		
CI+MS	Ackley (T_1)	50	Complete Intersection	0.2261
	Rastrigin (T_2)	50		
CI+LS	Ackley (T_1)	50	Complete Intersection	0.0002
	Schwefel (T_2)	50		
PI+HS	Rastrigin (T_1)	50	Partial Intersection	0.8670
	Sphere (T_2)	50		
PI+MS	Ackley (T_1)	50	Partial Intersection	0.2152
	Rosenbrock (T_2)	50		
PI+LS	Ackley (T_1)	50	Partial Intersection	0.0725
	Weierstrass (T_2)	25		
NI+HS	Rosenbrock (T_1)	50	No Intersection	0.9434
	Rastrigin (T_2)	50		
NI+MS	Griewank (T_1)	50	No Intersection	0.3669
	Weierstrass (T_2)	50		
NI+LS	Rastrigin (T_1)	50	No Intersection	0.0016
	Schwefel (T_2)	50		



(a) T1 of IEEE CEC2017-P1 (b) T2 of IEEE CEC2017-P1 (c) T1 of IEEE CEC2017-P2 (d) T2 of IEEE CEC2017-P2

(e) T1 of IEEE CEC2017-P5 (f) T2 of IEEE CEC2017-P5 (g) T1 of IEEE CEC2017-P6 (h) T2 of IEEE CEC2017-P6

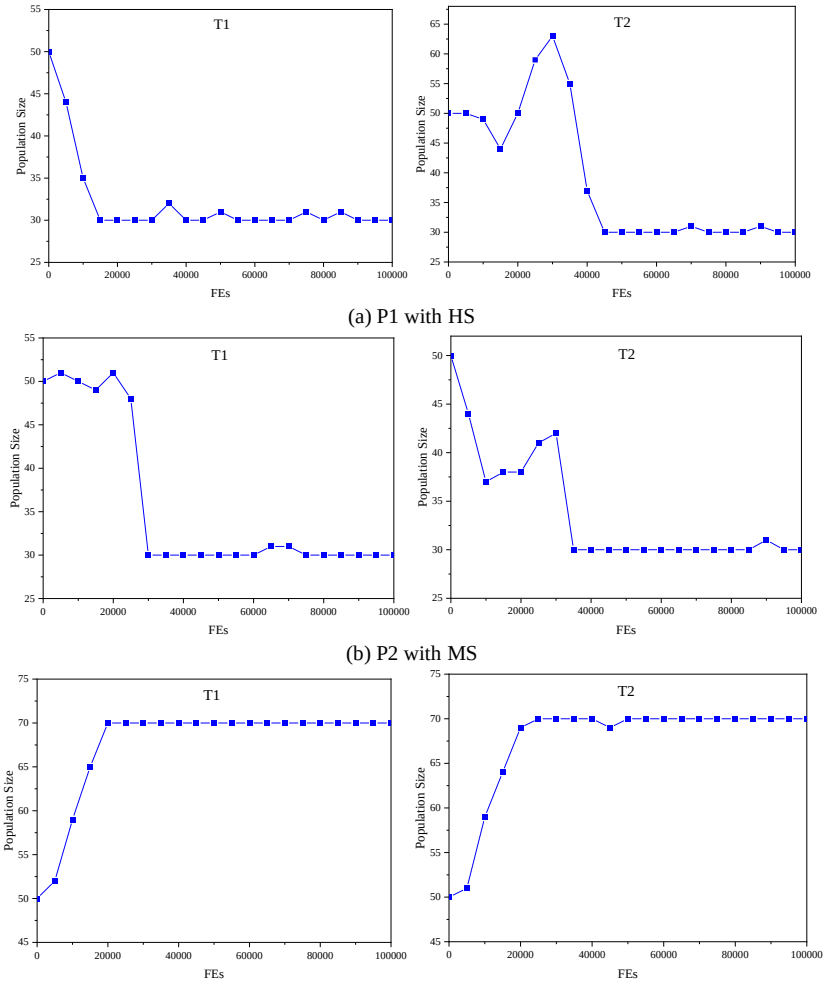
Fig. S1. Convergence curves of the average fitness on (a) T1 of IEEE CEC2017-P1; (b) T2 of IEEE CEC2017-P1; (c) T1 of IEEE CEC2017-P2; (d) T2 of IEEE CEC2017-P2; (e) T1 of IEEE CEC2017-P5; (f) T2 of IEEE CEC2017-P5; (g) T1 of IEEE CEC2017-P6; (h) T2 of IEEE CEC2017-P6.



(a) T1 of IEEE CEC2022-P1 (b) T2 of IEEE CEC2022-P1 (c) T1 of IEEE CEC2022-P3 (d) T2 of IEEE CEC2022-P3

(e) T1 of IEEE CEC2022-P6 (f) T2 of IEEE CEC2022-P6 (g) T1 of IEEE CEC2022-P7 (h) T2 of IEEE CEC2022-P7

Fig. S2. Convergence curves of the average fitness on (a) T1 of IEEE CEC2022-P1; (b) T2 of IEEE CEC2022-P1; (c) T1 of IEEE CEC2022-P3; (d) T2 of IEEE CEC2022-P3; (e) T1 of IEEE CEC2022-P6; (f) T2 of IEEE CEC2022-P6; (g) T1 of IEEE CEC2022-P7; (h) T2 of IEEE CEC2022-P7.



(a) P1 with HS

(b) P2 with MS

(c) P3 with LS

Fig. S3. Population size fluctuation of NNMTO on the IEEE CEC2017 problems.

TABLE S.II

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF STO AND NNMTO VARIANTS WITH OR WITHOUT NNKT OR FAMP

Problem		NNMTO	NNMTO-w/o-NNKT	NNMTO-w/o-FAMP	STO
P1	T1	**9.41E-14**	3.20E-04(≈)	*4.57E-06(+)*	2.68E-01(+)
	T2	**1.18E-10**	*4.97E-02(≈)*	1.53E+02(+)	4.40E+02(+)
P2	T1	*1.08E-09*	**3.43E-10(-)**	3.59E-05(+)	9.04E+00(+)
	T2	**0.00E+00**	**0.00E+00(≈)**	3.06E+02(+)	4.36E+02(+)
P3	T1	**2.12E+01**	*2.12E+01(≈)*	*2.12E+01(≈)*	2.12E+01(≈)
	T2	*1.05E+04*	1.13E+04(+)	**8.51E+03(-)**	1.40E+04(+)
P4	T1	**2.57E+02**	3.90E+02(+)	*2.94E+02(≈)*	4.53E+02(+)
	T2	**2.40E-11**	3.62E+00(+)	*5.29E-09(+)*	4.32E+00(+)
P5	T1	**1.06E-08**	6.53E-02(≈)	*5.30E-05(+)*	1.01E+01(+)
	T2	7.62E+01	8.24E+01(+)	**7.41E+01(≈)**	1.34E+03(+)
P6	T1	**1.99E-09**	2.11E+00(+)	*3.18E-05(+)*	8.48E+00(+)
	T2	**3.11E-09**	2.04E-01(+)	*3.21E-01(+)*	9.10E+00(+)
P7	T1	**6.16E+01**	9.26E+01(+)	*6.17E+01(≈)*	1.23E+03(+)
	T2	**1.42E+02**	*2.29E+02(+)*	2.77E+02(+)	4.39E+02(+)
P8	T1	**2.81E-08**	3.93E-03(+)	*3.83E-06(+)*	2.84E-01(+)
	T2	1.02E+00	**2.71E-01(-)**	*9.14E-01(≈)*	4.23E+01(+)
P9	T1	*3.28E+02*	3.98E+02(+)	**9.89E+01(-)**	4.44E+02(+)
	T2	*9.12E+03*	1.12E+04(+)	**8.42E+03(≈)**	1.38E+04(+)
Number of +/≈/−			11/5/2	10/6/2	17/1/0

TABLE S.III

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT G VALUES

Problem		NNMTO(G = 50)	G = 25	G = 100	G = 200
P1	T1	*9.41E-14*	**2.85E-15(≈)**	3.50E-13(+)	6.16E-04(+)
	T2	*1.18E-10*	**3.66E-12(≈)**	3.18E-10(+)	1.54E+01(+)
P2	T1	**1.08E-09**	*1.09E-09(≈)*	1.80E-09(≈)	1.03E-01(+)
	T2	**0.00E+00**	**0.00E+00(≈)**	**0.00E+00(≈)**	*2.98E-01(≈)*
P3	T1	**2.12E+01**	*2.12E+01(≈)*	2.12E+01(≈)	2.12E+01(≈)
	T2	*1.05E+04*	**1.02E+04(≈)**	1.08E+04(≈)	1.12E+04(+)
P4	T1	*2.57E+02*	**1.25E+02(-)**	3.75E+02(+)	3.68E+02(+)
	T2	**2.40E-11**	6.65E-02(-)	*1.55E-10(+)*	3.75E-09(+)
P5	T1	*1.06E-08*	1.46E-07(≈)	**2.06E-09(≈)**	4.40E-02(+)
	T2	7.62E+01	**6.97E+01(≈)**	8.02E+01(≈)	*7.23E+01(≈)*
P6	T1	**1.99E-09**	1.76E-01(≈)	*4.40E-02(+)*	1.74E-01(+)
	T2	**3.11E-09**	4.40E-02(≈)	1.75E-02(≈)	*7.65E-04(≈)*
P7	T1	**6.16E+01**	8.39E+01(+)	7.48E+01(≈)	*6.16E+01(≈)*
	T2	*1.42E+02*	**6.98E+01(≈)**	2.59E+02(+)	1.45E+02(≈)
P8	T1	**2.81E-08**	1.14E-03(+)	*3.70E-04(≈)*	3.70E-04(+)
	T2	1.02E+00	2.00E+00(+)	**5.69E-01(-)**	*7.55E-01(≈)*
P9	T1	3.28E+02	**2.49E+02(≈)**	*3.24E+02(≈)*	3.67E+02(≈)
	T2	*9.12E+03*	**8.87E+03(≈)**	9.74E+03(≈)	9.77E+03(+)
Number of +/≈/−		~	3/13/2	6/11/1	10/8/0

TABLE S.IV

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT g VALUES

Problem		NNMTO(g = 5)	g = 1	g = 10	g = 15	g = 20
P1	T1	*9.41E-14*	5.02E-05(≈)	**1.37E-15(≈)**	2.19E-13(≈)	9.29E-04(≈)
	T2	1.18E-10	**3.03E-14(≈)**	*1.62E-12(≈)*	1.69E-10(≈)	1.77E+01(≈)
P2	T1	1.08E-09	**2.238E-10(-)**	5.50E-10(≈)	3.30E-10(-)	*2.60E-10(-)*
	T2	**0.00E+00**	**0.00E+00(≈)**	**0.00E+00(≈)**	**0.00E+00(≈)**	**0.00E+00(≈)**
P3	T1	**2.12E+01**	2.12E+01(≈)	*2.12E+01(≈)*	2.12E+01(≈)	2.12E+01(≈)
	T2	**1.05E+04**	1.11E+04(+)	*1.09E+04(≈)*	1.09E+04(+)	1.12E+04(+)
P4	T1	**2.57E+02**	3.90E+02(+)	*3.21E+02(+)*	3.43E+02(+)	3.79E+02(+)
	T2	*2.40E-11*	1.05E+00(+)	**1.82E-11(≈)**	4.73E-05(≈)	6.86E-11(≈)
P5	T1	**1.06E-08**	4.54E-02(+)	*4.09E-08(≈)*	2.97E-07(-)	6.87E-02(-)
	T2	**7.62E+01**	8.53E+01(+)	*8.15E+01(+)*	8.28E+01(+)	7.85E+01(+)
P6	T1	**1.99E-09**	1.95E+00(+)	1.92E-01(≈)	*5.78E-02(≈)*	1.72E-01(+)
	T2	**3.11E-09**	1.54E-01(+)	1.04E-02(≈)	*1.83E-03(≈)*	2.96E-02(≈)
P7	T1	**6.16E+01**	1.62E+02(+)	*7.00E+01(+)*	1.01E+02(≈)	8.79E+01(+)
	T2	*1.42E+02*	2.31E+02(+)	**1.01E+02(≈)**	2.09E+02(≈)	2.43E+02(+)
P8	T1	**2.81E-08**	1.64E-03(+)	*3.11E-08(≈)*	2.10E-03(+)(≈)	1.79E-05(+)
	T2	1.02E+00	*7.82E-01(≈)*	1.70E+00(+)	**7.49E-01(≈)**	1.13E+00(≈)
P9	T1	**3.28E+02**	3.95E+02(+)	*3.50E+02(≈)*	3.74E+02(+)	3.78E+02(+)
	T2	**9.12E+03**	1.11E+04(+)	*9.98E+03(+)*	1.04E+04(+)	1.08E+04(+)
Number of +/≈/−		~	12/5/1	5/13/0	6/10/2	9/7/2

TABLE S.V

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT S VALUES

Problem		NNMTO(S = 10)	S = 1	S = 5	S = 15	S = 20
P1	T1	9.41E-14	**0.00E+00(-)**	*1.25E-15(≈)*	3.70E-04(+)	1.36E-03(+)
	T2	1.18E-10	**9.06E-15(-)**	*1.52E-12(≈)*	3.98E+00(+)	4.53E+00(+)
P2	T1	1.08E-09	**2.24E-10(-)**	*4.89E-10(-)*	4.45E-09(+)	8.23E-02(+)
	T2	**0.00E+00**	**0.00E+00(≈)**	**0.00E+00(≈)**	*1.15E-14(≈)*	2.79E+00(≈)
P3	T1	**2.12E+01**	2.12E+01(≈)	*2.12E+01(≈)*	2.12E+01(≈)	2.12E+01(≈)
	T2	1.05E+04	1.11E+04(+)	1.11E+04(+)	*1.03E+04(≈)*	**9.75E+03(-)**
P4	T1	2.57E+02	3.73E+02(+)	3.18E+02(+)	*2.38E+02(≈)*	**1.59E+02(-)**
	T2	*2.40E-11*	4.12E-11(≈)	**4.68E-12(≈)**	1.28E-10(≈)	3.06E+00(≈)
P5	T1	*1.06E-08*	2.54E-06(≈)	**9.81E-10(-)**	4.40E-02(+)	1.13E-01(+)
	T2	*7.62E+01*	8.13E+01(+)	8.08E+01(+)	**7.40E+01(≈)**	8.27E+01(+)
P6	T1	**1.99E-09**	5.78E-02(+)	1.18E-01(≈)	*6.46E-09(+)*	1.51E-01(+)
	T2	**3.11E-09**	2.11E-03(≈)	7.25E-04(≈)	*5.70E-07(+)*	1.80E-03(≈)
P7	T1	**6.16E+01**	8.94E+01(+)	7.88E+01(≈)	*6.65E+01(≈)*	7.66E+01(+)
	T2	1.42E+02	2.51E+02(+)	2.82E+02(+)	**8.23E+01(≈)**	*1.11E+02(≈)*
P8	T1	*2.81E-08*	5.30E-04(+)	6.46E-08(≈)	**5.60E-09(≈)**	3.70E-04(+)
	T2	*1.02E+00*	**8.27E-01(≈)**	1.15E+00(≈)	1.32E+00(≈)	1.22E+00(≈)
P9	T1	3.28E+02	3.97E+02(+)	3.73E+02(+)	*1.69E+02(-)*	**1.61E+02(-)**
	T2	9.12E+03	1.07E+04(+)	1.01E+04(+)	*8.51E+03(≈)*	**7.98E+03(-)**
Number of +/≈/−		~	9/6/3	6/10/2	6/11/1	8/6/4

TABLE S.VI

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT *lr* VALUES

Problem		NNMTO(*lr*= 0.01)	*lr* = 0.0001	*lr* = 0.001	*lr* =0.1
P1	T1	**9.41E-14**	3.20E-03(≈)	9.86E-04(≈)	*7.40E-04(≈)*
	T2	**1.18E-10**	*1.54E+01(≈)*	3.38E+01(≈)	1.77E+01(+)
P2	T1	**1.08E-09**	*3.34E-08(≈)*	5.78E-02(≈)	4.40E-02(≈)
	T2	**0.00E+00**	*9.53E-12(≈)*	2.49E-01(≈)	1.49E-01(≈)
P3	T1	**2.12E+01**	*2.12E+01(≈)*	2.12E+01(≈)	2.12E+01(≈)
	T2	**1.05E+04**	1.06E+04(≈)	1.09E+04(≈)	*1.05E+04(≈)*
P4	T1	*2.57E+02*	2.83E+02(≈)	**2.50E+02(≈)**	2.81E+02(≈)
	T2	*2.40E-11*	5.34E-11(≈)	**1.74E-11(≈)**	2.57E-11(≈)
P5	T1	*1.06E-08*	**3.41E-09(≈)**	5.14E-02(≈)	1.20E-01(≈)
	T2	*7.62E+01*	**7.21E+01(≈)**	7.77E+01(≈)	8.26E+01(≈)
P6	T1	**1.99E-09**	*4.40E-02(≈)*	1.15E-01(+)	5.18E-02(≈)
	T2	**3.11E-09**	*5.69E-05(≈)*	2.73E-04(≈)	7.30E-04(≈)
P7	T1	*6.16E+01*	6.26E+01(≈)	**6.12E+01(≈)**	7.43E+01(≈)
	T2	1.42E+02	**7.20E+01(≈)**	*1.02E+02(≈)*	1.31E+02(≈)
P8	T1	*2.81E-08*	7.40E-04(≈)	6.16E-04(+)	**2.61E-09(≈)**
	T2	**1.02E+00**	*1.64E+00(+)*	1.82E+00(+)	1.71E+00(+)
P9	T1	3.28E+02	3.29E+02(≈)	**3.05E+02(≈)**	*3.20E+02(≈)*
	T2	**9.12E+03**	*9.22E+03(≈)*	9.65E+03(+)	9.32E+03(≈)
Number of +/≈/-			1/17/0	4/14/0	2/16/0

TABLE S.VII

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT *epochs* VALUES

Problem		NNMTO(*epochs* = 30)	*epochs* = 10	*epochs* = 50
P1	T1	**9.41E-14**	2.10E-03(≈)	*9.86E-04(+)*
	T2	**1.18E-10**	4.08E+01(≈)	*6.03E+00(+)*
P2	T1	**1.08E-09**	*1.48E-09(≈)*	5.14E-02(≈)
	T2	**0.00E+00**	**0.00E+00(≈)**	*1.99E-01(≈)*
P3	T1	**2.12E+01**	*2.12E+01(≈)*	2.12E+01(≈)
	T2	**1.05E+04**	1.13E+04(+)	*1.06E+04(≈)*
P4	T1	**2.57E+02**	2.86E+02(≈)	*2.80E+02(≈)*
	T2	*2.40E-11*	4.97E-11(≈)	**2.02E-11(≈)**
P5	T1	1.06E-08	*5.71E-09(≈)*	**2.21E-09(≈)**
	T2	*7.62E+01*	**7.51E+01(≈)**	8.04E+01(≈)
P6	T1	**1.99E-09**	*1.32E-01(+)*	2.47E-01(+)
	T2	**3.11E-09**	*3.76E-03(≈)*	1.21E-02(≈)
P7	T1	**6.16E+01**	*6.72E+01(≈)*	6.95E+01(≈)
	T2	**1.42E+02**	*1.44E+02(≈)*	1.55E+02(≈)
P8	T1	*2.81E-08*	**8.23E-09(≈)**	1.26E-07(+)
	T2	**1.02E+00**	1.69E+00(+)	*1.35E+00(≈)*
P9	T1	*3.28E+02*	3.73E+02(+)	**3.03E+02(≈)**
	T2	**9.12E+03**	1.05E+04(+)	*9.56E+03(≈)*
Number of +/≈/-			5/13/0	4/14/0

TABLE S.VIII

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT *lr* VALUES

Problem		NNMTO(*goal*= 1E-5)	*goal* = 0	*goal* = 0.0001	*goal* =0.001	*goal* =0.01
P1	T1	**9.41E-14**	*3.70E-04(≈)*	8.63E-04(≈)	1.73E-03(≈)	3.70E-04(≈)
	T2	**1.18E-10**	1.65E+01(≈)	2.39E+00(≈)	3.67E+01(≈)	*2.07E+00(≈)*
P2	T1	*1.08E-09*	5.14E-02(≈)	4.40E-02(≈)	**9.91E-10(≈)**	4.40E-02(≈)
	T2	**0.00E+00**	3.48E-01(≈)	*9.95E-02(≈)*	**0.00E+00(≈)**	9.95E-02(≈)
P3	T1	**2.12E+01**	*2.12E+01(≈)*	2.12E+01(≈)	2.12E+01(≈)	2.12E+01(≈)
	T2	1.05E+04	1.06E+04(≈)	*1.04E+04(≈)*	**1.01E+04(≈)**	1.05E+04(≈)
P4	T1	**2.57E+02**	*2.62E+02(≈)*	3.56E+02(+)	3.98E+02(+)	3.87E+02(+)
	T2	*2.40E-11*	**5.42E-12(≈)**	3.09E-11(+)	1.12E-03(+)	3.48E-11(+)
P5	T1	1.06E-08	1.74E-04(≈)	4.40E-02(+)	*4.59E-09(≈)*	**3.55E-09**(+)
	T2	7.62E+01	7.42E+01(≈)	8.24E+01(+)	**7.20E+01(≈)**	7.55E+01(≈)
P6	T1	**1.99E-09**	*4.43E-02(≈)*	2.13E-01(≈)	1.09E-01(≈)	1.95E-01(+)
	T2	**3.11E-09**	5.97E-02(≈)	2.22E-02(≈)	*1.61E-02(≈)*	1.96E-03(≈)
P7	T1	**6.16E+01**	*6.91E+01(≈)*	6.70E+01(≈)	8.49E+01(+)	8.82E+01(+)
	T2	1.42E+02	**8.66E+01(≈)**	1.59E+02(≈)	9.51E+01(≈)	*1.38E+02(≈)*
P8	T1	*2.81E-08*	3.70E-04(≈)	**2.61E-09(≈)**	9.86E-04(≈)	3.70E-04(+)
	T2	**1.02E+00**	1.45E+00(≈)	*1.27E+00(≈)*	1.98E+00(+)	1.68E+00(+)
P9	T1	*3.28E+02*	**2.71E+02(≈)**	3.76E+02(+)	3.95E+02(+)	4.06E+02(+)
	T2	**9.12E+03**	9.55E+03(≈)	*9.27E+03(≈)*	9.96E+03(+)	9.52E+03(≈)
Number of +/≈/-			0/18/0	5/13/0	6/12/0	8/10/0

TABLE S.IX

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT $MaxG_{stag}$ VALUES

Problem		NNMTO ($MaxG_{stag}$ = 5)	$MaxG_{stag}$ = 1	$MaxG_{stag}$ = 3	$MaxG_{stag}$ = 10
P1	T1	**9.41E-14**	2.13E-04(+)	*3.73E-05(+)*	2.46E-03(+)
	T2	**1.18E-10**	1.10E+00(+)	*2.37E-01(+)*	4.31E+01(+)
P2	T1	**1.08E-09**	2.16E-03(+)	8.72E-07(+)	*1.92E-09(≈)*
	T2	**0.00E+00**	1.22E-02(+)	*4.15E-09(+)*	**0.00E+00(≈)**
P3	T1	*2.12E+01*	2.12E+01(≈)	2.12E+01(≈)	**2.12E+01(≈)**
	T2	*1.05E+04*	1.14E+04(+)	1.08E+04(≈)	**9.86E+03(-)**
P4	T1	**2.57E+02**	3.10E+02(≈)	2.63E+02(≈)	*2.76E+02(≈)*
	T2	*2.40E-11*	8.87E-06(+)	5.51E-09(+)	**1.44E-12(-)**
P5	T1	*1.06E-08*	2.59E-03(+)	2.17E-06(+)	**1.54E-09(≈)**
	T2	7.62E+01	**6.47E+01(≈)**	*6.97E+01(≈)*	7.64E+01(≈)
P6	T1	**1.99E-09**	*5.24E-03(+)*	4.91E-02(+)	4.40E-02(≈)
	T2	**3.11E-09**	*2.64E-03(+)*	1.06E-02(+)	7.90E-02(+)
P7	T1	6.16E+01	*4.94E+01(≈)*	**4.63E+01(≈)**	7.71E+01(≈)
	T2	1.42E+02	*5.32E+01(≈)*	**1.75E+01(-)**	1.39E+02(≈)
P8	T1	**2.81E-08**	9.55E-04(+)	*2.02E-05(+)*	1.23E-03(≈)
	T2	1.02E+00	**4.58E-01(-)**	*5.44E-01(-)*	2.35E+00(+)
P9	T1	3.28E+02	*3.14E+02(-)*	3.50E+02(≈)	**1.51E+02(-)**
	T2	*9.12E+03*	1.02E+04(+)	9.83E+03(+)	**8.22E+03(≈)**
Number of +/≈/-			11/5/2	10/6/2	4/11/3

TABLE S.X

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT *es* VALUES

Problem		NNMTO(*es*= 10)	*es* = 5	*es* = 20	*es* = 30
P1	T1	*9.41E-14*	**4.27E-16(≈)**	8.63E-04(≈)	1.11E-03(≈)
	T2	*1.18E-10*	**4.77E-13(≈)**	6.04E+00(≈)	2.28E+01(≈)
P2	T1	*1.08E-09*	**6.02E-10(-)**	5.78E-02(≈)	1.02E-01(≈)
	T2	**0.00E+00**	**0.00E+00(≈)**	*9.95E-02(≈)*	2.98E-01(≈)
P3	T1	**2.12E+01**	*2.12E+01(≈)*	2.12E+01(≈)	2.12E+01(≈)
	T2	**1.05E+04**	1.10E+04(≈)	*1.05E+04(≈)*	1.06E+04(≈)
P4	T1	2.57E+02	2.70E+02(≈)	*2.54E+02(≈)*	**2.18E+02(≈)**
	T2	*2.40E-11*	**1.41E-11(≈)**	2.13E-01(≈)	2.68E-11(≈)
P5	T1	**1.06E-08**	*4.40E-02(≈)*	5.78E-02(≈)	9.38E-02(≈)
	T2	7.62E+01	7.87E+01(≈)	**7.18E+01(≈)**	*7.60E+01(≈)*
P6	T1	**1.99E-09**	4.40E-02(≈)	7.81E-02(+)	*3.61E-02(+)*
	T2	**3.11E-09**	1.74E-03(≈)	*2.19E-08(≈)*	3.10E-03(≈)
P7	T1	**6.16E+01**	6.72E+01(≈)	6.80E+01(≈)	*6.16E+01(≈)*
	T2	1.42E+02	1.35E+02(≈)	**1.02E+02(≈)**	*1.07E+02(≈)*
P8	T1	*2.81E-08*	7.39E-04(≈)	1.48E-03(≈)	**2.56E-09(≈)**
	T2	**1.02E+00**	1.65E+00(+)	*1.27E+00(≈)*	1.71E+00(≈)
P9	T1	3.28E+02	**3.02E+02(≈)**	3.32E+02(≈)	*3.13E+02(≈)*
	T2	**9.12E+03**	*9.26E+03(≈)*	9.26E+03(≈)	9.45E+03(≈)
Number of +/≈/-			1/16/1	1/17/0	1/17/0

TABLE S.XI

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT *F* VALUES

Problem		NNMTO (*F* = 0.5)	*F* = 0.1	*F* = 0.9
P1	T1	**9.41E-14**	1.16E+00(+)	*3.01E-01(+)*
	T2	**1.18E-10**	4.43E+02(+)	*3.92E+02(+)*
P2	T1	**1.08E-09**	6.19E+00(+)	*1.55E+00(+)*
	T2	**0.00E+00**	3.50E+02(+)	*3.11E+02(+)*
P3	T1	**2.12E+01**	*2.12E+01(≈)*	2.12E+01(+)
	T2	*1.05E+04*	**2.87E+03(-)**	1.08E+04(≈)
P4	T1	**2.57E+02**	8.21E+02(+)	*4.26E+02(+)*
	T2	**2.40E-11**	1.77E+03(+)	*1.08E+01(+)*
P5	T1	**1.06E-08**	8.54E+00(+)	*2.58E+00(+)*
	T2	**7.62E+01**	9.84E+05(+)	*6.67E+02(+)*
P6	T1	**1.99E-09**	1.05E+01(+)	*3.63E+00(+)*
	T2	**3.11E-09**	9.19E+00(+)	*1.54E+00(+)*
P7	T1	**6.16E+01**	1.22E+06(+)	*6.20E+02(+)*
	T2	**1.42E+02**	5.26E+02(+)	*4.18E+02(+)*
P8	T1	**2.81E-08**	1.34E+00(+)	*3.81E-01(+)*
	T2	**1.02E+00**	2.49E+01(+)	*9.06E+00(+)*
P9	T1	**3.28E+02**	6.53E+02(+)	*4.30E+02(+)*
	T2	*9.12E+03*	**3.13E+03(-)**	1.05E+04(+)
Number of +/≈/-			15/1/2	17/1/0

TABLE S.XII

THE IEEE CEC2017 EXPERIMENTAL RESULTS OF NNMTO VARIANTS WITH DIFFERENT *CR* VALUES

Problem		NNMTO (*CR* = 0.6)	*CR* = 0.1	*CR* = 0.9
P1	T1	**9.41E-14**	1.27E+00(+)	*4.01E-03(+)*
	T2	**1.18E-10**	5.95E+02(+)	*8.34E+01(+)*
P2	T1	**1.08E-09**	9.80E+00(+)	*2.27E+00(+)*
	T2	**0.00E+00**	7.56E+02(+)	*1.01E+02(+)*
P3	T1	*2.12E+01*	**2.11E+01(-)**	2.12E+01(≈)
	T2	*1.05E+04*	**6.58E+03(-)**	1.10E+04(+)
P4	T1	**2.57E+02**	1.16E+03(+)	*3.23E+02(+)*
	T2	**2.40E-11**	1.94E+03(+)	*1.02E-04(+)*
P5	T1	**1.06E-08**	1.03E+01(+)	*2.23E+00(+)*
	T2	**7.62E+01**	2.49E+06(+)	*1.43E+02(+)*
P6	T1	**1.99E-09**	1.58E+01(+)	*2.56E+00(+)*
	T2	**3.11E-09**	1.48E+01(+)	*1.09E+00(+)*
P7	T1	**6.16E+01**	2.22E+06(+)	*2.07E+02(+)*
	T2	**1.42E+02**	8.18E+02(+)	*2.88E+02(+)*
P8	T1	**2.81E-08**	1.91E+00(+)	*6.27E-03(+)*
	T2	**1.02E+00**	3.49E+01(+)	*9.58E+00(+)*
P9	T1	**3.28E+02**	2.53E+03(+)	*3.92E+02(+)*
	T2	9.12E+03	**7.23E+03(-)**	*8.59E+03(≈)*
Number of +/≈/-			15/0/3	16/2/0