1. Appendix

1.1. Accuracy of solution at $D = 10, 30$ and 50

In this section, for each test function, the original algorithm of LFD and 8 other classical algorithms are compared with MLFD with $D = 10$, 30 and 50 respectively, all experimental results and simple statistic analysis are listed in Tables 1, 2, 3.

1.2. Nonparametric Statistical analysis at $D = 10, 30$ and 50

This section mainly analyzes the significant differences between MLFD algorithm and other 9 comparison algorithms. The statistical analysis in this section mainly consists of three parts: Wilcoxon rank test and Friedman-test. It should be noted that since this paper tends to solve higher dimensional problems, so for these three tests, D was taken as 10, 30 and 50.

1.2.1. Wilcoxon sign rank test results

The Wilcoxon test results with significant differences of MLFD and other algorithms at 10, 30 and 50 dimensions are shown in Tables 4, 5, 6, 7, 8, 9 respectively.

1.2.2. Friedman − test

Friedman test is non-parametric bidirectional analysis of variance, which are multi-primitive extensions of sign test. Table 10 show the average ranking of all algorithms using Friedman tests on 17 test functions in 10, 30 and 50 dimensions. It can be observed from Table 10 that the ranking of MLFD algorithm is the first, shown in bold. $\rho - value$ is shown in the last line. According to the Final Rank, it can be proved that MLFD has unbeatable advantages over other algorithms.

1.3. Convergence rate at $D = 10, 30$ and 50

In this section, the convergence performance of the algorithm is compared. It should be noted that, for the sake of clarity, all convergence graphs in this article show logarithmic values of the average results obtained from 30 independent runs. Figures $1 - 3$ shows convergence curves of MLFD and other 9 comparison algorithms based on 17 test functions in $D = 10$, 30 and 50 respectively.

Table 1
Experimental results of MLFD and other comparison algorithms in 10 dimension

Fun	Quality	LFD	SOS	GJO	CS	AEFA	AHO	ASHPSO	OSA	FDB_LFD	MLFD
f_1	Mean	**0.000E+00**	1.099E+02	**0.000E+00**	3.984E+03	**0.000E+00**	9.226E+03	1.583E+03	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Std	**0.000E+00**	4.236E+01	**0.000E+00**	7.639E+02	**0.000E+00**	1.865E+03	3.767E+02	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Best	**0.000E+00**	6.300E+01	**0.000E+00**	2.629E+03	**0.000E+00**	4.305E+03	8.880E+02	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Rank	**3.5**	7	**3.5**	9	**3.5**	10	8	**3.5**	**3.5**	**3.5**
f_2	Mean	1.089E-10	1.513E+02	**6.081E-53**	4.094E+03	1.248E-25	9.898E+03	1.609E+03	3.012E-08	1.787E-10	4.339E-14
	Std	4.637E-11	5.625E+01	**1.145E-52**	6.617E+02	5.079E-26	2.370E+03	4.643E+02	3.366E-08	4.392E-11	9.876E-14
	Best	5.228E-11	4.590E+01	**2.163E-53**	3.091E+03	3.617E-26	4.344E+03	9.087E+02	1.189E-11	5.375E-11	3.834E-17
	Rank	4	7	**1**	9	2	10	8	6	5	3
f_3	Mean	2.221E-10	4.503E+00	**5.939E-54**	2.018E+02	4.526E-25	3.567E+02	7.993E+01	8.230E-08	1.531E-10	1.337E-11
	Std	1.292E-10	1.645E+00	**2.327E-54**	3.716E+01	1.679E-25	1.037E+02	1.515E+01	1.191E-07	1.215E-10	3.027E-11
	Best	5.339E-11	1.619E+00	**9.567E-57**	1.450E+02	2.000E-25	1.875E+02	6.002E+01	4.797E-11	8.646E-11	5.223E-16
	Rank	5	7	**1**	9	2	10	8	6	4	3
f_4	Mean	3.284E-03	1.706E-02	**8.307E-05**	9.146E-01	3.771E-03	2.271E+00	2.454E-01	3.023E-04	5.073E-03	2.642E-04
	Std	3.515E-03	6.544E-03	**9.806E-06**	2.427E-01	1.639E-03	2.264E-01	9.833E-02	2.261E-04	8.065E-04	2.645E-04
	Best	6.572E-05	9.534E-03	**7.756E-05**	4.148E-01	1.181E-03	1.438E+00	1.085E-01	2.930E-05	2.778E-03	4.427E-06
	Rank	4	7	**1**	9	5	10	8	3	6	2
f_5	Mean	5.314E-09	4.390E+02	**2.120E-33**	4.933E+03	9.114E+00	8.181E+03	2.149E+03	4.178E-07	6.375E-09	1.087E-12
	Std	4.592E-09	1.133E+02	**1.761E-33**	8.497E+02	1.789E+01	1.404E+03	5.886E+02	1.199E-06	1.675E-09	1.400E-12
	Best	3.045E-10	2.196E+02	**7.338E-35**	1.770E+03	2.486E-01	4.958E+03	1.017E+03	7.569E-09	4.429E-09	2.898E-16
	Rank	3	7	**1**	9	6	10	8	5	4	2
f_6	Mean	1.327E-05	1.011E+01	**4.309E-20**	3.275E+01	2.437E-13	5.250E+01	2.284E+01	3.167E-05	1.363E-05	7.873E-08
	Std	3.983E-06	1.761E+00	**6.344E-36**	4.775E+00	5.441E-14	4.982E+00	2.465E+00	**1.809E-05**	4.590E-06	7.348E-08
	Best	6.392E-06	6.714E+00	**4.309E-20**	2.598E+01	1.366E-13	4.069E+01	1.835E+01	9.102E-07	9.565E-06	3.572E-09
	Rank	4	7	**1**	9	2	10	8	6	5	3
f_7	Mean	6.667E-01	1.420E+01	6.667E-01	6.165E+03	6.667E-01	2.171E+04	7.351E+02	2.355E-01	6.667E-01	**1.881E-01**
	Std	3.373E-09	6.621E+00	1.779E-08	1.649E+03	0.000E+00	9.170E+03	2.775E+02	2.379E-02	**1.547E-09**	1.931E-02
	Best	6.667E-01	4.502E+00	6.667E-01	1.695E+03	6.667E-01	2.811E+03	2.854E+02	1.557E-01	6.667E-01	**1.428E-01**
	Rank	4	7	5	9	3	10	8	2	6	**1**
f_8	Mean	8.177E+00	3.696E+01	**0.000E+00**	6.726E+01	3.582E+00	9.308E+01	5.906E+01	1.685E-06	2.786E+01	4.437E-10
	Std	1.609E+01	5.819E+00	**0.000E+00**	7.187E+00	1.445E+00	6.845E+00	2.390E+00	3.183E-06	**0.000E+00**	9.265E-10
	Best	1.727E-10	1.897E+01	**0.000E+00**	4.212E+01	9.950E-01	7.840E+01	5.546E+01	5.953E-09	2.786E+01	6.750E-14
	Rank	5	7	**1**	9	4	10	8	3	6	2
f_9	Mean	1.300E+00	2.306E+01	**0.000E+00**	4.101E+01	4.679E+00	6.816E+01	5.054E+01	1.761E-06	2.274E-09	1.874E-10
	Std	6.188E+00	5.809E+00	**0.000E+00**	4.335E+00	1.855E+00	8.417E+00	1.286E+01	3.170E-06	1.611E-09	3.660E-10
	Best	2.528E-10	1.037E+01	**0.000E+00**	3.100E+01	2.000E+00	5.052E+01	2.981E+01	7.763E-09	1.510E-09	0.000E+00
	Rank	5	7	**1**	8	6	10	9	4	3	2
f_{10}	Mean	1.149E-03	2.071E+00	**0.000E+00**	4.567E+01	1.397E-03	1.169E+02	1.656E+01	1.508E-09	4.922E-12	3.797E-15
	Std	4.782E-03	4.751E-01	**0.000E+00**	8.724E+00	3.216E-03	1.645E+01	2.988E+00	1.967E-09	2.073E-12	9.159E-15
	Best	7.427E-13	1.589E+00	**0.000E+00**	2.054E+01	0.000E+00	8.762E+01	1.128E+01	8.890E-12	2.513E-12	0.000E+00
	Rank	5	7	**1**	9	6	10	8	4	3	2
f_{11}	Mean	1.119E-05	6.396E+00	**4.441E-15**	1.469E+01	5.062E-13	1.852E+01	1.213E+01	1.013E-04	8.849E-06	9.226E-07
	Std	3.644E-06	5.554E-01	**0.000E+00**	1.241E+00	5.939E-14	6.384E-01	1.036E+00	1.033E-04	2.980E-07	1.631E-06
	Best	6.705E-06	5.300E+00	**4.441E-15**	1.391E+01	3.597E-13	1.694E+01	1.094E+01	1.356E-05	8.417E-06	4.970E-09
	Rank	5	7	**1**	9	2	10	8	6	4	3
f_{12}	Mean	5.375E+00	3.217E+03	6.297E+00	2.353E+06	6.069E+01	9.749E+06	2.561E+05	2.422E-03	5.434E+00	**3.255E-04**
	Std	2.244E-01	3.048E+03	1.993E-01	1.212E+06	1.732E+02	4.144E+06	1.229E+05	6.761E-03	**9.362E-16**	4.226E-04
	Best	5.026E+00	5.016E+02	6.173E+00	4.924E+05	6.417E+00	2.406E+06	1.384E+05	2.925E-06	5.434E+00	**8.672E-12**
	Rank	3	7	5	9	6	10	8	2	4	**1**
f_{13}	Mean	1.037E-02	6.977E+00	5.552E-02	8.720E+01	**2.755E-27**	1.646E+02	4.355E+01	3.915E-06	2.174E-11	3.487E-07
	Std	5.678E-02	2.288E+00	3.102E-03	1.562E+01	7.827E-28	3.561E+01	3.836E+01	5.370E-06	**0.000E+00**	3.300E-07
	Best	1.576E-11	2.845E+00	5.405E-02	5.311E+01	**1.339E-27**	9.495E+01	1.096E+01	2.532E-08	2.174E-11	5.330E-09
	Rank	5	7	6	9	**1**	10	8	4	2	3

Table 1 continued

Fun	Quality	LFD	SOS	GJO	CS	AEFA	AHO	ASHPSO	OSA	FDB_LFD	MLFD
f_{14}	Mean	6.344E-11	7.390E+00	2.519E-01	1.742E+02	**1.287E-26**	3.930E+02	7.101E+01	5.673E-06	3.719E-11	6.406E-07
	Std	3.068E-11	3.041E+00	6.900E-02	4.767E+01	**4.506E-27**	7.825E+01	2.534E+01	2.069E-05	6.545E-12	6.938E-07
	Best	1.079E-11	2.415E+00	5.554E-02	1.240E+02	**3.987E-27**	2.228E+02	4.262E+01	1.648E-07	3.312E-11	4.409E-09
	Rank	3	7	6	9	**1**	10	8	5	2	4
f_{15}	Mean	6.505E+00	3.755E+00	**0.000E+00**	9.348E+00	3.798E-11	1.310E+01	8.317E+00	5.217E-02	8.116E+00	7.170E-03
	Std	1.202E+00	4.146E-01	**0.000E+00**	7.140E-01	1.016E-11	2.925E-01	7.106E-01	3.192E-02	1.872E-15	4.120E-03
	Best	3.548E+00	2.697E+00	**0.000E+00**	8.819E+00	1.997E-11	1.244E+01	7.118E+00	5.865E-03	8.116E+00	5.886E-04
	Rank	6	5	**1**	9	2	10	8	4	7	3
f_{16}	Mean	-9.052E-01	-7.776E-01	**-1.000E+00**	3.026E-01	**-1.000E+00**	1.048E+00	-2.607E-01	**-1.000E+00**	-9.999E-01	**-1.000E+00**
	Std	1.891E-01	7.534E-02	**0.000E+00**	1.134E-01	**0.000E+00**	2.328E-01	1.198E-01	2.136E-07	1.075E-04	1.469E-10
	Best	-1.000E+00	-8.950E-01	**-1.000E+00**	5.695E-02	**-1.000E+00**	6.847E-01	-3.922E-01	**-1.000E+00**	-1.000E+00	**-1.000E+00**
	Rank	6	7	**2.5**	9	**2.5**	10	8	**2.5**	5	**2.5**
f_{17}	Mean	-7.258E+01	-7.397E+01	-5.291E+01	-5.674E+01	-7.654E+01	-5.456E+01	-6.929E+01	**-7.833E+01**	-7.550E+01	**-7.833E+01**
	Std	9.043E-01	1.639E+00	9.492E-01	1.313E+00	2.163E+00	2.331E+00	3.247E+00	1.251E-04	**1.498E-14**	4.663E-05
	Best	-7.550E+01	-7.671E+01	-5.561E+01	-6.070E+01	-7.833E+01	-5.998E+01	-7.418E+01	**-7.833E+01**	-7.550E+01	**-7.833E+01**
	Rank	6	5	10	8	3	9	7	**1.5**	4	**1.5**
Total Rank		76.5	115	48	151	57	169	136	67.5	73.5	**41.5**
Final Rank		6	7	2	9	3	10	8	4	5	**1**

Table 2
Experimental results of MLFD and other comparison algorithms in 30 dimension

Fun	Quality	LFD	SOS	GJO	CS	AEFA	AHO	ASHPSO	OSA	FDB_LFD	MLFD
f_1	Mean	**0.000E+00**	1.694E+03	**0.000E+00**	2.917E+04	3.000E-01	5.550E+04	3.784E+04	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Std	**0.000E+00**	3.235E+02	**0.000E+00**	2.544E+03	1.643E+00	3.545E+03	7.547E+03	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Best	**0.000E+00**	1.137E+03	**0.000E+00**	2.536E+04	0.000E+00	4.421E+04	2.272E+04	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Rank	**3**	7	**3**	8	6	10	9	**3**	**3**	**3**
f_2	Mean	7.629E-10	1.523E+03	2.981E-04	3.314E+04	**1.136E-24**	5.420E+04	3.588E+04	1.273E-08	6.679E-10	2.172E-14
	Std	2.025E-10	3.576E+02	6.523E-05	2.167E+03	**3.514E-25**	4.555E+03	6.767E+03	1.470E-08	1.181E-10	3.278E-14
	Best	4.605E-10	9.876E+02	2.576E-04	3.137E+04	**5.748E-25**	4.440E+04	2.968E+04	1.107E-10	5.665E-10	1.222E-16
	Rank	4	7	6	8	**1**	10	9	5	3	2
f_3	Mean	6.977E-07	1.971E+02	2.905E-05	4.951E+03	**1.102E-23**	8.266E+03	5.209E+03	1.838E-07	8.142E-08	4.809E-11
	Std	6.056E-07	4.521E+01	3.396E-05	2.000E+02	**3.157E-24**	2.382E+02	7.819E+02	3.455E-07	1.257E-07	8.090E-11
	Best	8.576E-08	1.249E+02	1.294E-05	4.662E+03	**5.670E-24**	7.258E+03	3.615E+03	2.576E-09	4.167E-08	6.723E-14
	Rank	5	7	6	8	**1**	10	9	4	3	2
f_4	Mean	4.369E-03	2.138E-01	2.049E-03	3.277E+01	5.535E-02	1.114E+02	3.376E+01	3.478E-04	8.043E-03	**2.608E-04**
	Std	3.548E-03	6.863E-02	9.557E-04	1.893E+00	8.628E-02	5.131E-01	6.162E+00	**2.074E-04**	1.677E-03	2.420E-04
	Best	1.554E-03	9.029E-02	1.142E-03	3.130E+01	8.297E-03	1.105E+02	2.491E+01	2.668E-05	5.612E-03	**7.113E-06**
	Rank	4	7	3	8	6	10	9	2	5	**1**
f_5	Mean	1.253E-05	4.421E+03	2.686E+02	4.323E+04	1.235E+03	7.330E+04	5.090E+04	2.562E-06	1.309E-05	**6.662E-12**
	Std	9.675E-06	1.121E+03	2.170E+02	5.316E+03	2.902E+02	1.280E+04	7.470E+03	2.945E-06	4.609E-06	**1.062E-11**
	Best	4.480E-07	2.347E+03	1.511E+01	4.061E+04	8.102E+02	5.248E+04	3.669E+04	6.743E-08	7.737E-06	**3.168E-15**
	Rank	3	7	5	8	6	10	9	2	4	**1**
f_6	Mean	1.218E-03	2.218E+01	2.517E+01	6.230E+01	9.395E-03	7.982E+01	7.175E+01	1.873E-05	2.062E-03	**5.237E-08**
	Std	6.919E-04	2.391E+00	1.252E+01	1.794E+00	2.702E-02	3.067E+00	6.994E+00	1.318E-05	8.800E-04	**4.475E-08**
	Best	2.724E-04	1.756E+01	1.078E+00	6.091E+01	5.651E-13	6.916E+01	5.871E+01	2.663E-06	4.253E-04	**8.207E-11**
	Rank	3	6	7	8	5	10	9	2	4	**1**
f_7	Mean	6.667E-01	1.730E+03	6.722E-01	3.620E+05	1.220E+00	1.406E+06	5.397E+05	2.477E-01	6.667E-01	**2.394E-01**
	Std	4.693E-05	8.808E+02	1.119E-03	1.270E+04	1.075E+00	1.244E+05	1.791E+05	9.003E-03	**1.170E-16**	1.267E-02
	Best	6.667E-01	8.524E+02	6.690E-01	3.531E+05	6.667E-01	8.657E+05	2.772E+05	2.001E-01	6.667E-01	**2.093E-01**
	Rank	4	7	5	8	6	10	9	2	3	**1**
f_8	Mean	1.990E-01	1.977E+02	1.263E-03	3.278E+02	1.827E+01	3.712E+02	3.546E+02	3.229E-06	8.074E-08	**9.984E-10**
	Std	4.048E-01	2.166E+01	0.000E+00	3.528E+00	4.988E+00	6.376E-01	3.965E+01	5.051E-06	4.694E-08	**1.247E-09**
	Best	2.801E-08	1.667E+02	1.263E-03	3.267E+02	8.955E+00	3.696E+02	2.827E+02	8.282E-09	1.272E-08	**5.329E-14**
	Rank	5	7	4	8	6	10	9	3	2	**1**
f_9	Mean	1.000E-01	1.732E+02	8.179E+00	2.633E+02	2.557E+01	3.540E+02	3.326E+02	2.492E-06	1.184E-07	**5.661E-10**
	Std	3.051E-01	1.665E+01	7.201E+00	3.950E+01	7.035E+00	1.345E+01	3.350E+01	4.766E-06	2.505E-08	**1.125E-09**
	Best	4.887E-08	1.404E+02	2.998E+00	2.267E+02	1.300E+01	3.224E+02	2.583E+02	8.818E-09	9.466E-08	**1.599E-14**
	Rank	4	7	5	8	6	10	9	3	2	**1**
f_{10}	Mean	7.396E-04	1.576E+01	2.264E-02	2.855E+02	1.029E-01	5.044E+02	3.269E+02	7.435E-10	1.070E-08	**2.628E-16**
	Std	2.257E-03	2.892E+00	1.892E-02	1.339E+01	2.716E-01	2.840E+01	7.275E+01	1.445E-09	2.222E-08	**4.742E-16**
	Best	1.454E-10	1.010E+01	3.548E-04	2.772E+02	0.000E+00	4.231E+02	2.019E+02	1.878E-13	1.574E-10	**0.000E+00**
	Rank	4	7	5	8	6	10	9	2	3	**1**
f_{11}	Mean	4.737E-05	1.006E+01	2.083E-03	1.879E+01	**7.981E-13**	2.045E+01	1.933E+01	8.500E-05	4.846E-05	2.033E-07
	Std	7.177E-06	7.762E-01	0.000E+00	3.781E-01	**8.297E-14**	1.245E-01	7.195E-01	7.738E-05	4.665E-06	2.870E-07
	Best	3.281E-05	8.102E+00	2.083E-03	1.808E+01	**6.475E-13**	2.024E+01	1.837E+01	1.169E-05	4.624E-05	1.667E-08
	Rank	3	7	6	8	**1**	10	9	5	4	2
f_{12}	Mean	2.696E+01	2.205E+05	2.891E+01	6.687E+07	1.348E+02	1.777E+08	7.587E+07	3.484E-03	2.685E+01	**8.386E-04**
	Std	1.520E-01	9.697E+04	0.000E+00	1.486E+07	2.229E+02	6.133E+06	1.686E+07	4.163E-03	1.054E-01	**9.648E-04**
	Best	2.651E+01	7.817E+04	2.891E+01	4.960E+07	2.641E+01	1.527E+08	5.388E+07	1.445E-04	2.680E+01	**3.820E-05**
	Rank	4	7	5	8	6	10	9	2	3	**1**
f_{13}	Mean	**5.231E-08**	2.830E+01	4.957E-01	3.424E+02	1.177E+00	4.983E+02	3.812E+02	3.835E-06	1.123E-07	1.064E-07
	Std	7.400E-08	8.333E+00	1.029E-01	9.250E+00	1.886E+00	5.964E+01	8.697E+01	5.463E-06	**4.293E-08**	9.282E-08
	Best	**4.374E-09**	1.346E+01	4.289E-01	3.248E+02	3.754E-27	3.726E+02	2.592E+02	1.476E-08	5.007E-08	5.137E-09
	Rank	**1**	7	5	8	6	10	9	4	3	2

Table 2 continued

Fun	Quality	LFD	SOS	GJO	CS	AEFA	AHO	ASHPSO	OSA	FDB_LFD	MLFD
f_{14}	Mean	4.616E-01	8.879E+01	2.689E+00	1.272E+03	3.880E+00	2.477E+03	1.969E+03	4.499E-05	**6.163E-08**	1.268E-06
	Std	1.048E+00	1.803E+01	6.086E-03	2.045E+02	1.445E+01	2.367E+02	2.105E+02	8.275E-05	**2.325E-08**	1.804E-06
	Best	3.958E-08	5.616E+01	2.672E+00	7.427E+02	7.095E-26	1.870E+03	1.758E+03	2.857E-08	3.957E-08	**1.145E-08**
	Rank	4	7	5	8	6	10	9	3	**1**	2
f_{15}	Mean	8.667E+00	1.912E+01	**1.622E-02**	4.173E+01	1.188E-01	4.954E+01	4.240E+01	9.424E-02	1.833E+01	2.358E-02
	Std	1.107E+01	1.815E+00	**7.832E-03**	7.490E-15	3.745E-01	4.337E-01	3.835E+00	5.152E-02	9.179E+00	1.372E-02
	Best	1.574E-01	1.539E+01	9.801E-03	4.173E+01	**2.236E-10**	4.851E+01	3.585E+01	2.740E-02	9.145E-01	4.608E-03
	Rank	5	7	**1**	8	4	10	9	3	6	2
f_{16}	Mean	**-3.000E+00**	-1.216E+00	**-3.000E+00**	3.798E+00	-2.970E+00	6.461E+00	3.418E+00	**-3.000E+00**	**-3.000E+00**	**-3.000E+00**
	Std	6.530E-11	1.515E-01	2.242E-06	1.830E-01	6.012E-02	3.891E-02	8.780E-01	2.335E-07	**1.552E-11**	4.488E-11
	Best	**-3.000E+00**	-1.462E+00	**-3.000E+00**	3.656E+00	-3.000E+00	6.362E+00	1.716E+00	**-3.000E+00**	**-3.000E+00**	**-3.000E+00**
	Rank	**3**	7	**3**	9	6	10	8	**3**	**3**	**3**
f_{17}	Mean	-6.839E+01	-5.814E+01	-3.294E+01	-4.430E+01	-7.433E+01	-3.290E+01	-4.481E+01	**-7.833E+01**	-6.511E+01	**-7.833E+01**
	Std	1.520E+00	3.034E+00	7.490E-15	1.993E+00	1.671E+00	1.033E+00	4.951E+00	9.485E-05	**1.498E-14**	4.233E-05
	Best	-6.985E+01	-6.200E+01	-3.294E+01	-4.719E+01	-7.739E+01	-3.827E+01	-5.218E+01	**-7.833E+01**	-6.511E+01	**-7.833E+01**
	Rank	4	6	9	8	3	10	7	**1.5**	5	**1.5**
Total Rank		63	117	83	137	81	170	150	49.5	57	**27.5**
Final Rank		4	7	6	8	5	10	9	2	3	**1**

Table 3
Experimental results of MLFD and other comparison algorithms in 50 dimension

Fun	Quality	LFD	SOS	GJO	CS	AEFA	AHO	ASHPSO	OSA	FDB_LFD	MLFD
f_1	Mean	**0.000E+00**	4.017E+03	3.680E+01	6.424E+04	1.547E+01	1.155E+05	9.895E+04	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Std	**0.000E+00**	9.391E+02	6.812E+00	4.326E+03	1.733E+01	5.009E+03	9.300E+03	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Best	**0.000E+00**	2.728E+03	2.600E+01	5.595E+04	**0.000E+00**	1.058E+05	8.606E+04	**0.000E+00**	**0.000E+00**	**0.000E+00**
	Rank	**2.5**	7	6	8	5	10	9	**2.5**	**2.5**	**2.5**
f_2	Mean	2.075E-09	3.805E+03	7.506E+01	6.872E+04	9.663E-02	1.161E+05	8.671E+04	6.241E-08	2.299E-09	**3.190E-15**
	Std	5.318E-10	5.887E+02	1.442E+01	3.515E+03	4.437E-01	6.742E+03	2.422E+04	9.070E-08	2.182E-10	**4.888E-15**
	Best	1.321E-09	2.755E+03	6.469E+01	5.942E+04	2.489E-24	9.022E+04	4.790E+04	4.175E-11	2.196E-09	**1.039E-18**
	Rank	2	7	6	8	5	10	9	4	3	**1**
f_3	Mean	1.530E-05	7.956E+02	2.328E+01	1.489E+04	7.419E+00	2.944E+04	1.863E+04	3.518E-07	7.790E-06	**1.377E-12**
	Std	1.752E-05	1.171E+02	5.107E+00	8.737E+02	1.041E+01	1.391E+03	4.723E+03	5.164E-07	4.584E-06	**3.396E-12**
	Best	3.173E-07	6.082E+02	8.749E+00	1.435E+04	1.387E-02	2.619E+04	1.190E+04	1.999E-09	5.442E-06	**4.486E-16**
	Rank	4	7	6	8	5	10	9	2	3	**1**
f_4	Mean	3.795E-03	7.640E-01	3.263E-01	1.199E+02	2.444E-01	3.793E+02	2.673E+02	4.251E-04	1.628E-03	**2.095E-04**
	Std	2.371E-03	1.426E-01	3.640E-01	1.233E+01	2.656E-01	1.070E+00	2.391E+01	2.419E-04	5.667E-04	**1.840E-04**
	Best	4.804E-05	4.855E-01	1.361E-02	9.954E+01	6.049E-02	3.759E+02	2.219E+02	1.155E-04	1.359E-03	**1.515E-05**
	Rank	4	7	6	8	5	10	9	2	3	**1**
f_5	Mean	5.709E-06	9.422E+03	3.855E+04	1.365E+05	2.548E+03	1.881E+05	1.381E+05	8.088E-06	5.570E-06	**2.081E-12**
	Std	3.166E-06	2.224E+03	1.019E+04	1.327E+04	5.574E+02	3.173E+04	1.018E+04	1.262E-05	4.395E-07	**2.457E-12**
	Best	1.669E-06	5.972E+03	2.237E+04	1.268E+05	1.543E+03	1.212E+05	1.199E+05	3.132E-09	4.736E-06	**4.954E-16**
	Rank	3	6	7	8	5	10	9	4	2	**1**
f_6	Mean	4.007E-04	2.640E+01	9.189E+01	7.580E+01	2.854E+00	8.951E+01	8.597E+01	2.148E-05	4.233E-04	**1.376E-08**
	Std	1.327E-04	2.778E+00	**0.000E+00**	3.413E+00	9.578E-01	1.725E+00	3.127E+00	1.250E-05	8.204E-05	1.368E-08
	Best	2.099E-04	2.165E+01	9.189E+01	7.315E+01	1.139E+00	8.571E+01	7.897E+01	2.727E-06	3.844E-04	**7.141E-10**
	Rank	3	6	10	7	5	9	8	2	4	**1**
f_7	Mean	6.667E-01	1.016E+04	1.761E+02	2.438E+06	2.186E+01	5.906E+06	2.347E+06	2.504E-01	6.668E-01	**2.485E-01**
	Std	7.561E-05	3.957E+03	1.492E+02	4.909E-10	2.304E+01	2.470E+05	2.013E+06	1.231E-03	**3.133E-05**	4.609E-03
	Best	6.667E-01	4.463E+03	1.289E+02	2.438E+06	1.314E+00	4.879E+06	5.035E+05	2.498E-01	6.668E-01	**2.316E-01**
	Rank	3	7	6	9	5	10	8	2	4	**1**
f_8	Mean	3.786E+00	3.786E+02	7.501E+01	5.907E+02	4.146E+01	7.490E+02	6.850E+02	3.671E-06	6.443E-07	**2.485E-11**
	Std	9.767E+00	2.666E+01	1.525E+01	2.399E+01	8.464E+00	1.346E+01	1.595E+01	5.127E-06	2.644E-07	**4.157E-11**
	Best	3.728E-07	3.075E+02	5.696E+01	5.721E+02	2.686E+01	6.845E+02	6.604E+02	1.751E-09	5.321E-07	**5.507E-14**
	Rank	4	7	6	8	5	10	9	3	2	**1**
f_9	Mean	6.667E-02	3.494E+02	1.032E+02	5.540E+02	5.667E+01	6.932E+02	6.308E+02	4.066E-06	7.108E-07	**3.833E-11**
	Std	3.651E-01	2.847E+01	6.764E+00	2.580E+01	1.399E+01	2.524E+01	4.273E+00	1.027E-05	1.163E-07	**1.260E-10**
	Best	3.378E-07	2.816E+02	9.903E+01	5.312E+02	3.500E+01	6.322E+02	6.186E+02	1.846E-09	6.556E-07	**8.882E-15**
	Rank	4	7	6	8	5	10	9	3	2	**1**
f_{10}	Mean	2.519E-09	3.500E+01	1.792E+00	6.080E+02	2.589E+00	1.028E+03	8.530E+02	2.638E-09	1.957E-09	**2.665E-16**
	Std	1.952E-09	5.810E+00	2.968E-01	0.000E+00	6.693E-01	5.555E+01	2.682E+02	3.712E-09	7.658E-10	**7.865E-16**
	Best	1.085E-09	2.344E+01	1.264E+00	6.080E+02	1.574E+00	8.384E+02	4.762E+02	7.751E-12	1.715E-09	**0.000E+00**
	Rank	3	7	5	8	6	10	9	4	2	**1**
f_{11}	Mean	8.009E-05	1.065E+01	3.492E+00	1.957E+01	4.391E-01	2.068E+01	1.989E+01	4.757E-05	8.053E-05	**3.196E-08**
	Std	1.281E-05	5.581E-01	7.223E-01	1.192E-02	5.777E-01	6.124E-02	9.842E-01	3.418E-05	1.767E-05	**3.669E-08**
	Best	5.794E-05	9.679E+00	2.341E+00	1.954E+01	8.251E-13	2.054E+01	1.804E+01	2.572E-06	5.493E-05	**8.970E-10**
	Rank	3	7	6	8	5	10	9	2	4	**1**
f_{12}	Mean	4.721E+01	7.860E+05	6.166E+04	1.325E+08	5.668E+02	4.557E+08	3.864E+08	1.746E-02	4.727E+01	**3.804E-04**
	Std	1.309E-01	3.399E+05	8.421E+03	1.159E+07	5.625E+02	3.886E+07	7.337E+07	4.846E-02	1.674E-01	**4.228E-04**
	Best	4.693E+01	2.479E+05	5.639E+04	1.191E+08	8.853E+01	3.154E+08	2.854E+08	1.285E-05	4.682E+01	**1.885E-06**
	Rank	3	7	6	8	5	10	9	2	4	**1**
f_{13}	Mean	2.203E-03	3.675E+01	1.745E+00	3.636E+02	2.505E+00	6.346E+02	5.678E+02	6.825E-06	6.200E-04	**5.751E-08**
	Std	1.646E-03	9.810E+00	1.977E-01	1.160E+01	1.910E+00	4.577E+01	4.132E+01	1.516E-05	4.821E-04	**8.594E-08**
	Best	2.872E-04	2.469E+01	1.583E+00	3.306E+02	9.420E-02	5.413E+02	4.748E+02	4.768E-11	3.352E-04	**1.388E-10**
	Rank	4	7	5	8	6	10	9	2	3	**1**

Table 3 continued

Fun	Quality	LFD	SOS	GJO	CS	AEFA	AHO	ASHPSO	OSA	FDB_LFD	MLFD
f_{14}	Mean	2.989E+00	1.981E+02	7.937E+00	2.336E+03	3.096E+01	4.667E+03	4.308E+03	4.340E-05	1.653E+00	**8.204E-07**
	Std	2.140E+00	4.460E+01	8.616E-01	1.820E+02	2.389E+01	2.934E+02	2.170E+02	1.064E-04	1.054E+00	**1.268E-06**
	Best	7.018E-02	1.366E+02	7.119E+00	2.195E+03	1.225E+00	3.857E+03	3.818E+03	3.188E-07	1.261E-01	**4.402E-09**
	Rank	4	7	5	8	6	10	9	2	3	**1**
f_{15}	Mean	1.274E+00	3.567E+01	2.333E+00	7.251E+01	1.809E+00	8.820E+01	7.886E+01	1.548E-01	1.563E+00	**1.190E-02**
	Std	7.682E-01	2.373E+00	1.140E-01	2.096E+00	1.431E+00	3.963E-01	5.919E+00	9.892E-02	8.390E-01	**7.995E-03**
	Best	1.273E-01	3.065E+01	2.297E+00	6.883E+01	3.778E-02	8.743E+01	7.133E+01	2.820E-02	1.643E-01	**7.586E-04**
	Rank	3	7	6	8	5	10	9	2	4	**1**
f_{16}	Mean	**-5.000E+00**	-1.396E+00	-4.983E+00	6.371E+00	-4.929E+00	1.200E+01	1.065E+01	**-5.000E+00**	**-5.000E+00**	**-5.000E+00**
	Std	4.718E-10	3.619E-01	9.362E-16	0.000E+00	9.043E-02	2.163E-02	1.335E+00	1.441E-07	2.387E-10	**2.620E-11**
	Best	**-5.000E+00**	-2.024E+00	-4.983E+00	6.371E+00	-5.000E+00	1.196E+01	8.608E+00	**-5.000E+00**	**-5.000E+00**	**-5.000E+00**
	Rank	**2.5**	7	5	8	6	10	9	**2.5**	**2.5**	**2.5**
f_{17}	Mean	-6.681E+01	-5.128E+01	-2.697E+01	-3.589E+01	-7.226E+01	-2.728E+01	-2.966E+01	**-7.833E+01**	-6.507E+01	**-7.833E+01**
	Std	8.426E-01	2.612E+00	1.270E+00	5.795E-01	1.944E+00	3.709E-01	3.406E+00	9.214E-05	2.746E-01	**4.516E-05**
	Best	-6.808E+01	-5.554E+01	-2.795E+01	-3.634E+01	-7.544E+01	-2.923E+01	-3.545E+01	**-7.833E+01**	-6.524E+01	**-7.833E+01**
	Rank	4	6	10	7	3	9	8	**1.5**	5	**1.5**
Total Rank		56	116	107	135	87	168	150	42.5	53	**20.5**
Final Rank		4	7	6	8	5	10	9	2	3	**1**

Table 4
Statistical comparisons of WSRT for MLFD vs. LFD, SOS, GJO, CS and AEFA in 10 dimension

Fun	MLFD vs. LFD				MLFD vs. SOS				MLFD vs. GJO				MLFD vs. CS				MLFD vs. AEFA			
	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner
f_1	1.00E+00	12	43	=	1.69E-06	25	30	+	1.00E+00	15	40	=	1.95E-03	33	22	+	1.00E+00	36	19	=
f_2	1.71E-06	18	37	+	1.71E-06	26	29	+	1.95E-03	21	34	-	1.95E-03	43	12	+	1.95E-03	55	0	-
f_3	1.71E-06	26	29	+	1.72E-06	24	31	+	1.95E-03	30	25	-	1.95E-03	35	20	+	1.95E-03	55	0	-
f_4	4.70E-06	18	37	+	1.73E-06	13	42	+	1.95E-03	38	17	-	1.95E-03	15	40	+	1.95E-03	0	55	+
f_5	1.73E-06	18	37	+	1.72E-06	27	28	+	1.95E-03	41	14	-	1.95E-03	45	10	+	1.95E-03	0	55	+
f_6	1.73E-06	5	50	+	1.73E-06	7	48	+	1.95E-03	48	7	-	1.95E-03	5	50	+	1.95E-03	55	0	-
f_7	1.70E-06	0	25	+	1.72E-06	0	31	+	1.95E-03	25	30	+	1.95E-03	15	40	+	1.95E-03	30	25	+
f_8	1.12E-05	0	31	+	1.72E-06	24	31	+	1.95E-03	25	30	-	1.95E-03	12	43	+	1.95E-03	15	40	+
f_9	4.72E-06	10	45	+	1.71E-06	34	21	+	1.95E-03	30	25	-	1.95E-03	30	25	+	1.95E-03	13	42	+
f_{10}	1.72E-06	28	27	+	1.69E-06	20	35	+	3.91E-03	19	36	-	1.95E-03	10	45	+	1.05E-01	18	37	=
f_{11}	1.73E-06	15	40	+	1.72E-06	33	22	+	1.95E-03	33	22	-	1.95E-03	26	29	+	1.95E-03	55	0	-
f_{12}	1.73E-06	11	44	+	1.73E-06	20	35	+	1.95E-03	17	38	+	1.95E-03	29	26	+	1.95E-03	0	55	+
f_{13}	3.58E-04	30	25	-	1.72E-06	12	43	+	1.95E-03	9	46	+	1.95E-03	19	36	+	1.95E-03	21	34	-
f_{14}	1.70E-06	20	35	-	1.70E-06	20	35	+	1.95E-03	22	33	+	1.95E-03	18	37	+	1.95E-03	20	35	-
f_{15}	1.72E-06	24	31	+	1.73E-06	10	45	+	1.95E-03	15	40	-	1.95E-03	22	33	+	1.95E-03	55	0	-
f_{16}	1.73E-06	9	46	+	1.70E-06	25	30	+	1.95E-03	35	20	-	1.95E-03	15	40	+	1.95E-03	35	20	-
f_{17}	1.70E-06	25	30	+	1.71E-06	22	33	+	1.95E-03	35	20	+	1.95E-03	18	37	+	9.92E-01	30	25	=
/+/-/=			14/2/1				17/0/0				5/11/1				17/0/0				6/8/3	

Table 5
Statistical comparisons of WSRT for MLFD vs. AHO, ASHPSO, OSA and FDB_LFD in 10 dimension

Fun	MLFD vs. AHO				MLFD vs. ASHPSO				MLFD vs. OSA				MLFD vs. FDB_LFD			
	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner
f_1	1.95E-03	24	31	+	1.95E-03	0	55	+	1.00E+00	27	28	=	1.00E+00	21	34	=
f_2	1.95E-03	30	25	+	1.95E-03	0	55	+	0.0019531	26	29	+	1.95E-03	12	43	+
f_3	1.95E-03	13	42	+	1.95E-03	0	55	+	1.95E-03	14	41	+	1.95E-03	18	37	+
f_4	1.95E-03	15	40	+	1.95E-03	0	55	+	1.25E-01	39	16	=	1.95E-03	12	43	+
f_5	1.95E-03	5	50	+	1.95E-03	0	55	+	1.95E-03	18	37	+	1.95E-03	23	32	+
f_6	1.95E-03	3	52	+	1.95E-03	0	55	+	1.95E-03	4	51	+	1.95E-03	4	51	+
f_7	1.95E-03	27	28	+	1.95E-03	0	55	+	1.95E-03	30	25	+	1.95E-03	22	33	+
f_8	1.95E-03	24	31	+	1.95E-03	0	55	+	1.95E-03	18	37	+	1.95E-03	18	37	+
f_9	1.95E-03	20	35	+	1.95E-03	0	55	+	1.95E-03	23	32	+	1.95E-03	28	27	+
f_{10}	1.95E-03	30	25	+	1.95E-03	12	43	+	1.95E-03	20	35	+	1.95E-03	24	31	+
f_{11}	1.95E-03	10	45	+	1.95E-03	10	45	+	0.0019531	17	38	+	1.95E-03	29	26	+
f_{12}	1.95E-03	19	36	+	1.95E-03	3	52	+	3.13E-02	15	40	+	1.95E-03	24	31	+
f_{13}	1.95E-03	9	46	+	1.95E-03	9	46	+	1.95E-03	9	46	+	1.95E-03	45	10	-
f_{14}	1.95E-03	20	35	+	0.0019531	5	50	+	1.95E-03	20	35	+	1.95E-03	27	28	-
f_{15}	1.95E-03	26	29	+	1.95E-03	0	55	+	2.73E-02	6	49	+	1.95E-03	20	35	+
f_{16}	1.95E-03	18	37	+	1.95E-03	0	55	+	3.91E-03	28	27	+	1.95E-03	26	29	+
f_{17}	1.95E-03	20	35	+	1.95E-03	0	55	+	1.37E-02	14	41	+	1.95E-03	29	26	+
/+/-/=				17/0/0				17/0/0				15/0/2				14/2/1

Table 6
Statistical comparisons of WSRT for MLFD vs. LFD, SOS, GJO, CS and AEFA in 30 dimension

Fun	MLFD vs. LFD				MLFD vs. SOS				MLFD vs. GJO				MLFD vs. CS				MLFD vs. AEFA			
	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner
f_1	1.00E+00	27	28	=	1.72E-06	17	38	+	1.00E+00	21	34	=	1.95E-03	7	48	+	1.00E+00	21	34	=
f_2	1.73E-06	17	38	+	1.72E-06	24	31	+	1.95E-03	18	37	+	1.95E-03	16	39	+	1.95E-03	55	0	-
f_3	1.73E-06	9	46	+	1.72E-06	27	28	+	1.95E-03	11	44	+	1.95E-03	20	35	+	1.95E-03	55	0	-
f_4	1.73E-06	11	44	+	1.73E-06	26	29	+	1.95E-03	25	30	+	1.95E-03	17	38	+	1.95E-03	0	55	+
f_5	1.73E-06	26	29	+	1.72E-06	9	46	+	1.95E-03	22	33	+	1.95E-03	20	35	+	1.95E-03	0	55	+
f_6	1.73E-06	11	44	+	1.73E-06	2	53	+	1.95E-03	13	42	+	1.95E-03	5	50	+	4.32E-01	36	19	=
f_7	1.73E-06	16	39	+	1.72E-06	18	37	+	1.95E-03	17	38	+	1.95E-03	23	32	+	1.95E-03	4	51	+
f_8	1.72E-06	24	31	+	1.70E-06	20	35	+	1.95E-03	20	35	+	1.95E-03	14	41	+	1.95E-03	0	55	+
f_9	1.73E-06	0	55	+	1.73E-06	14	41	+	1.95E-03	11	44	+	1.95E-03	5	50	+	1.95E-03	0	55	+
f_{10}	1.73E-06	0	55	+	1.71E-06	26	29	+	1.95E-03	27	28	+	1.95E-03	9	46	+	2.19E-01	15	40	=
f_{11}	1.73E-06	4	51	+	1.73E-06	11	44	+	1.95E-03	17	38	+	1.95E-03	31	24	+	1.95E-03	55	0	-
f_{12}	1.73E-06	8	47	+	1.73E-06	0	55	+	1.95E-03	20	35	+	1.95E-03	24	31	+	1.95E-03	0	55	+
f_{13}	1.83E-03	46	9	-	1.73E-06	5	50	+	1.95E-03	4	51	+	1.95E-03	12	43	+	9.77E-03	3	52	+
f_{14}	4.49E-02	19	36	+	1.73E-06	24	31	+	1.95E-03	20	35	+	1.95E-03	3	52	+	9.92E-01	36	19	=
f_{15}	1.73E-06	0	55	+	1.73E-06	0	55	+	3.59E-01	45	10	=	1.95E-03	5	50	+	8.40E-02	45	10	=
f_{16}	4.63E-06	20	35	+	1.71E-06	26	29	+	1.95E-03	20	35	+	1.95E-03	22	33	+	5.49E-01	45	10	=
f_{17}	1.73E-06	11	44	+	1.72E-06	17	38	+	1.95E-03	17	38	+	1.95E-03	14	41	+	1.95E-03	8	47	+
/+/-/=				15/1/1				17/0/0				15/0/2				17/0/0				8/3/6

Table 7
Statistical comparisons of WSRT for MLFD vs. AHO, ASHPSO, OSA and FDB_LFD in 30 dimension

Fun	MLFD vs. AHO				MLFD vs. ASHPSO				MLFD vs. OSA				MLFD vs. FDB_LFD			
	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner
f_1	1.95E-03	19	36	+	1.95E-03	0	55	+	1.00E+00	45	10	=	1.00E+00	27	28	=
f_2	1.95E-03	26	29	+	1.95E-03	0	55	+	0.001953	27	28	+	1.95E-03	12	43	+
f_3	1.95E-03	9	46	+	1.95E-03	0	55	+	1.95E-03	27	28	+	1.95E-03	11	44	+
f_4	1.95E-03	8	47	+	1.95E-03	0	55	+	4.96E-01	36	19	=	1.95E-03	16	39	+
f_5	1.95E-03	14	41	+	1.95E-03	0	55	+	1.95E-03	45	10	+	1.95E-03	26	29	+
f_6	1.95E-03	13	42	+	1.95E-03	0	55	+	1.95E-03	15	40	+	1.95E-03	0	55	+
f_7	1.95E-03	20	35	+	1.95E-03	0	55	+	1.95E-03	15	40	+	1.95E-03	12	43	+
f_8	1.95E-03	18	37	+	1.95E-03	0	55	+	1.95E-03	26	29	+	1.95E-03	16	39	+
f_9	1.95E-03	7	48	+	1.95E-03	0	55	+	1.95E-03	27	28	+	1.95E-03	19	36	+
f_{10}	1.95E-03	22	33	+	1.95E-03	0	55	+	1.95E-03	18	37	+	1.95E-03	22	33	+
f_{11}	1.95E-03	26	29	+	1.95E-03	0	55	+	0.001953	20	35	+	1.95E-03	24	31	+
f_{12}	1.95E-03	12	43	+	1.95E-03	0	55	+	9.57E-01	36	19	=	1.95E-03	15	40	+
f_{13}	1.95E-03	0	55	+	1.95E-03	0	55	+	3.71E-02	7	48	+	4.71E-01	26	29	=
f_{14}	1.95E-03	15	40	+	0.001953	0	55	+	3.52E-02	23	32	+	1.95E-03	52	3	-
f_{15}	1.95E-03	5	50	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	9	46	+
f_{16}	1.95E-03	26	29	+	1.95E-03	0	55	+	1.95E-03	25	30	+	1.95E-03	20	35	+
f_{17}	1.95E-03	25	30	+	1.95E-03	0	55	+	2.15E-01	45	10	=	1.95E-03	17	38	+
/+/-/=				17/0/0				17/0/0				13/0/4				14/1/2

Table 8
Statistical comparisons of WSRT for MLFD vs. LFD, SOS, GJO and CS in 50 dimension

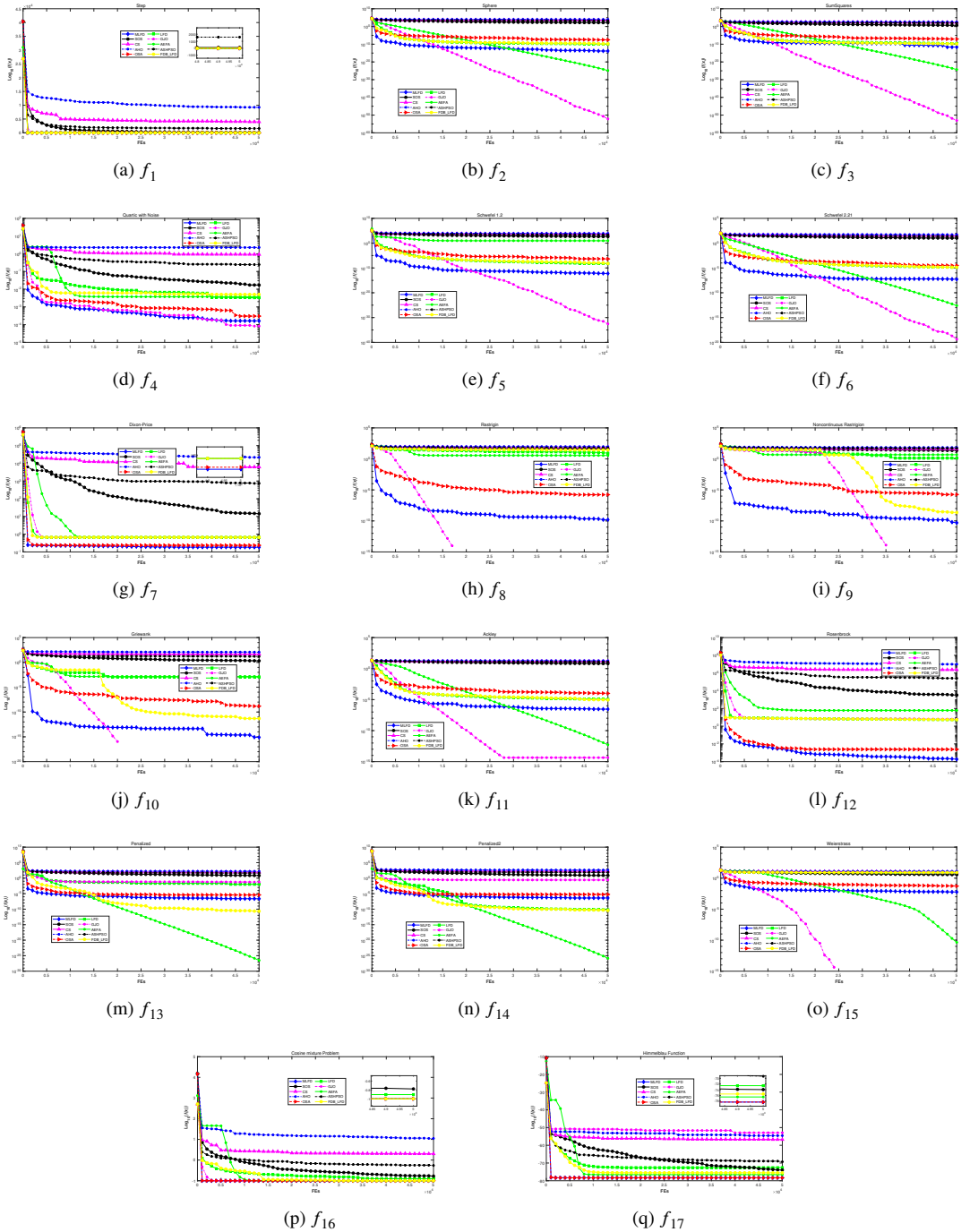
Fun	MLFD vs. LFD				MLFD vs. SOS				MLFD vs. GJO				MLFD vs. CS			
	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner
f_1	1.00E+00	21	34	=	1.72E-06	24	31	+	1.95E-03	8	47	+	1.95E-03	22	33	+
f_2	1.73E-06	0	55	+	1.71E-06	12	43	+	1.95E-03	20	35	+	1.95E-03	6	49	+
f_3	1.73E-06	0	55	+	1.73E-06	3	52	+	1.95E-03	0	55	+	1.95E-03	20	35	+
f_4	1.92E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_5	1.73E-06	0	55	+	1.73E-06	8	47	+	1.95E-03	24	31	+	1.95E-03	16	39	+
f_6	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_7	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_8	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_9	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{10}	1.73E-06	8	47	+	1.70E-06	22	33	+	1.95E-03	13	42	+	1.95E-03	1	54	+
f_{11}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{12}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{13}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{14}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{15}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{16}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{17}	1.73E-06	0	55	+	1.73E-06	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
/+/-/=				16/0/1				17/0/0				17/0/0				17/0/0

Table 9
Statistical comparisons of WSRT for MLFD vs. AEFA, AHO, ASHPSO, OSA and FDB_LFD in 50 dimension

Fun	MLFD vs. AEFA				MLFD vs. AHO				MLFD vs. ASHPSO				MLFD vs. OSA				MLFD vs. FDB_LFD			
	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner	p_Value	R+	R-	Winner
f_1	1.95E-03	5	50	+	1.95E-03	24	31	+	1.95E-03	0	55	+	1.00E+00	45	10	=	1.00E+00	45	10	=
f_2	2.32E-01	15	40	=	1.95E-03	19	36	+	1.95E-03	0	55	+	0.001953	0	55	+	1.95E-03	0	55	+
f_3	1.95E-03	0	55	+	1.95E-03	5	50	+	1.95E-03	3	52	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_4	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.31E-01	12	43	=	1.95E-03	0	55	+
f_5	1.95E-03	0	55	+	1.95E-03	23	32	+	1.95E-03	9	46	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_6	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_7	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	6.45E-02	9	46	=	1.95E-03	0	55	+
f_8	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_9	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{10}	1.95E-03	0	55	+	1.95E-03	18	37	+	1.95E-03	16	39	+	1.95E-03	20	35	+	1.95E-03	13	42	+
f_{11}	4.32E-01	36	19	=	1.95E-03	0	55	+	1.95E-03	0	55	+	0.001953	0	55	+	1.95E-03	0	55	+
f_{12}	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	3.91E-03	1	54	+	1.95E-03	0	55	+
f_{13}	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-02	5	50	+	1.95E-03	0	55	+
f_{14}	1.95E-03	0	55	+	1.95E-03	0	55	+	0.001953	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
$_{15}$	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{16}	5.57E-01	21	34	=	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+
f_{17}	1.95E-03	0	55	+	1.95E-03	0	55	+	1.95E-03	0	55	+	4.32E-01	26	29	=	1.95E-03	0	55	+
/+/-/=	13/0/4				17/0/0				17/0/0				13/0/4				16/0/1			

Table 10
Average Rankings of the algorithms (Friedman −Test)

Algorithm	D=10		D=30		D=50		Total Rank	Final Rank
	Ranking	final rank	Ranking	final rank	Ranking	final rank		
LFD	4.5000	6	3.7059	4	3.3235	4	14	5.5
SOS	6.7647	7	6.8824	7	6.8235	7	21	7
GJO	2.7647	2	5.0000	6	6.2941	6	14	5.5
CS	8.8824	9	8.0588	8	7.9412	8	25	8
AEFA	3.2941	3	4.7647	5	5.1176	5	13	4
AHO	9.9412	10	10.0000	10	9.8824	10	30	10
ASHPSO	8.0000	8	8.8235	9	8.8235	9	26	9
OSA	4.0882	4	3.0000	2	2.6176	2	8	2
FDB_LFD	4.3235	5	3.2941	3	3.0882	3	11	3
MLFD	**2.4412**	**1**	**1.4706**	**1**	**1.0882**	**1**	**3**	**1**
p_Value	4.5347E-22		3.0957E-24		2.0182E-26			



(a) f_1 (b) f_2 (c) f_3

(d) f_4 (e) f_5 (f) f_6

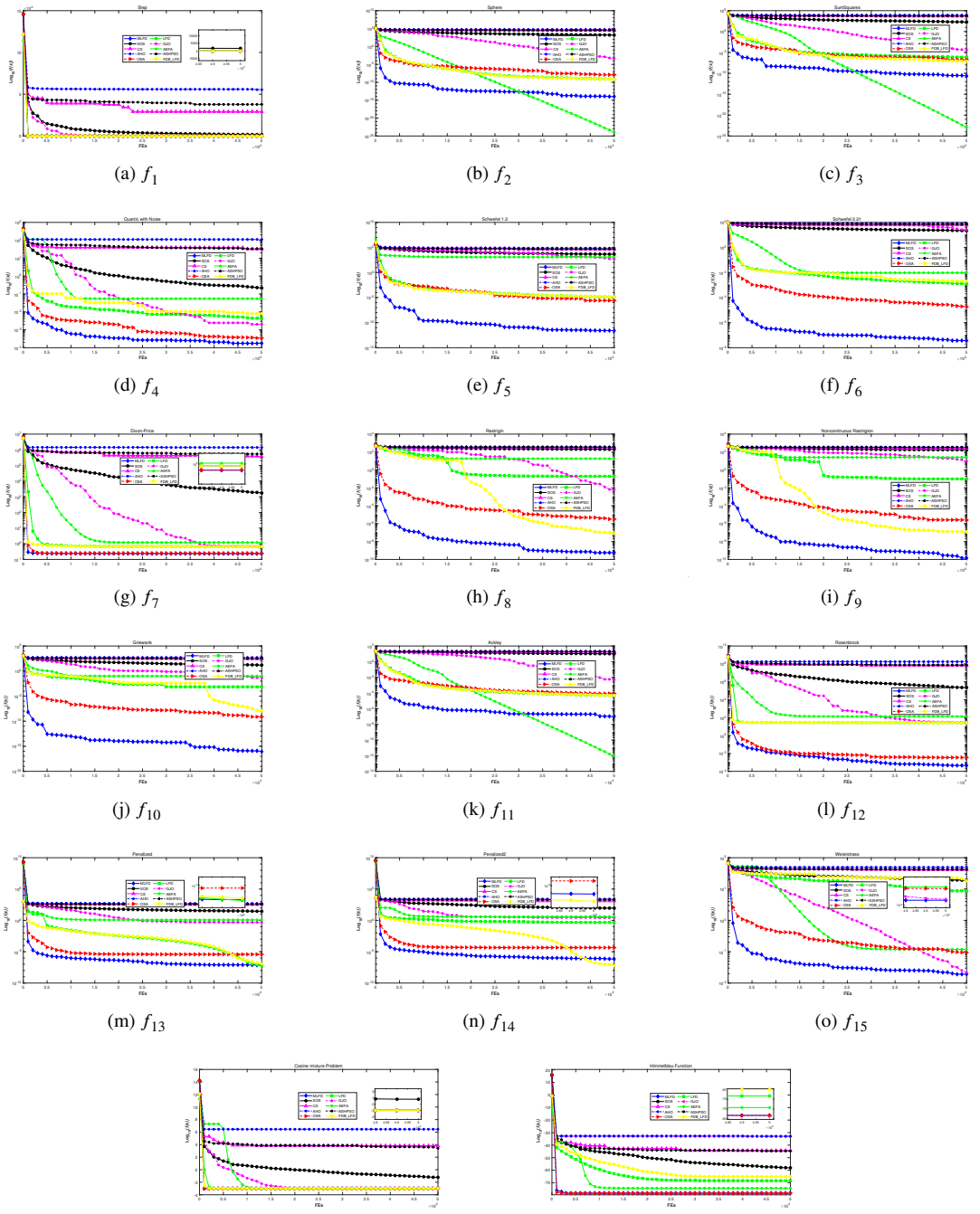
(g) f_7 (h) f_8 (i) f_9

(j) f_{10} (k) f_{11} (l) f_{12}

(m) f_{13} (n) f_{14} (o) f_{15}

(p) f_{16} (q) f_{17}

Figure 1: Convergence profiles of different algorithms obtained on the test function with 10 dimensions. Note that the logarithmic values of the average results obtained by 10 independent runs are shown in the above figures for clarity.



(a) f_1 (b) f_2 (c) f_3

(d) f_4 (e) f_5 (f) f_6

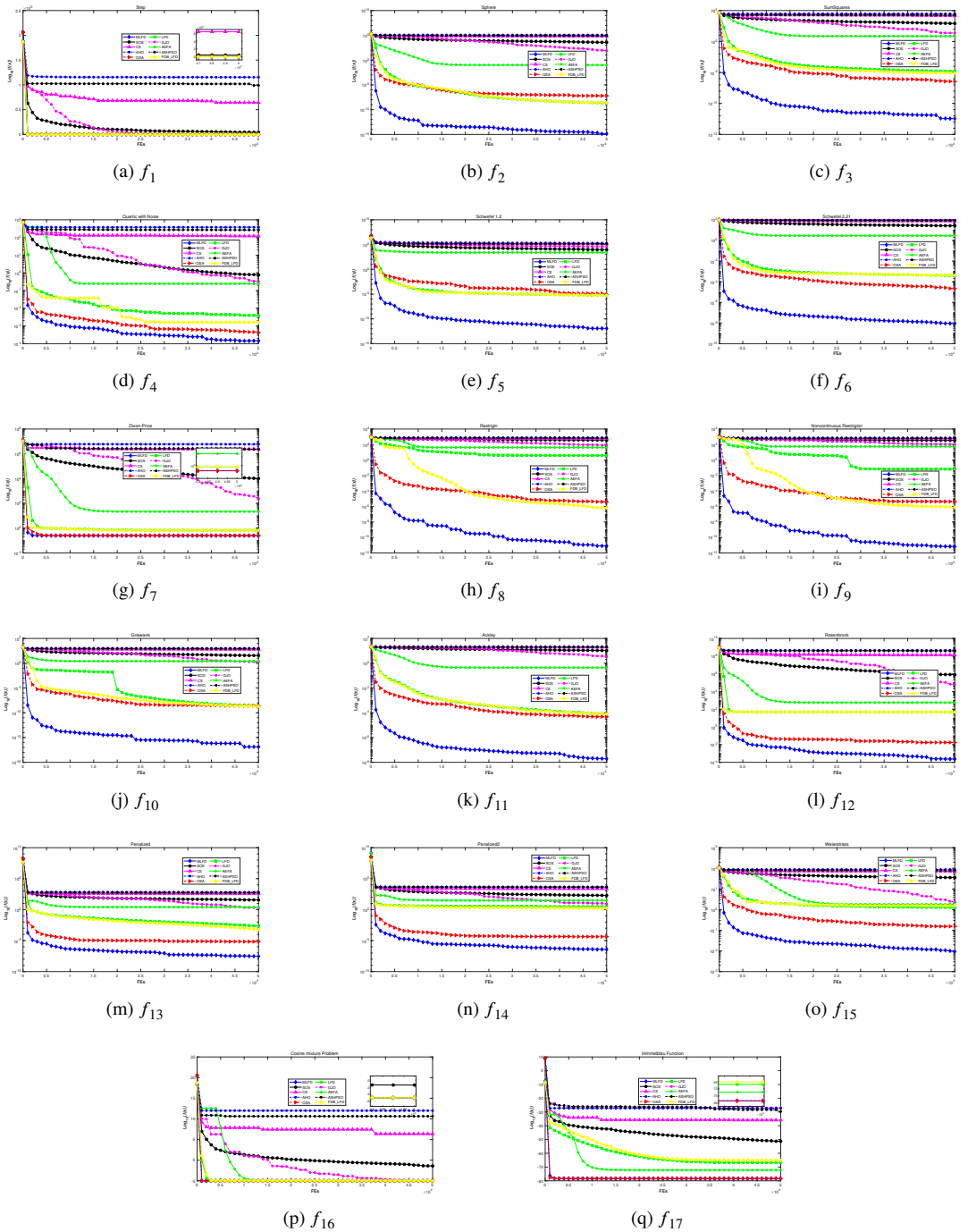
(g) f_7 (h) f_8 (i) f_9

(j) f_{10} (k) f_{11} (l) f_{12}

(m) f_{13} (n) f_{14} (o) f_{15}

(p) f_{16} (q) f_{17}

Figure 2: Convergence profiles of different algorithms obtained on the test function with 30 dimensions. Note that the logarithmic values of the average results obtained by 10 independent runs are shown in the above figures for clarity.



(a) f_1 (b) f_2 (c) f_3

(d) f_4 (e) f_5 (f) f_6

(g) f_7 (h) f_8 (i) f_9

(j) f_{10} (k) f_{11} (l) f_{12}

(m) f_{13} (n) f_{14} (o) f_{15}

(p) f_{16} (q) f_{17}

Figure 3: Convergence profiles of different algorithms obtained on the test function with 50 dimensions. Note that the logarithmic values of the average results obtained by 10 independent runs are shown in the above figures for clarity.