Supplementary Material for 'A dynamic multi-objective evolutionary algorithm with variable stepsize and dual prediction strategies'

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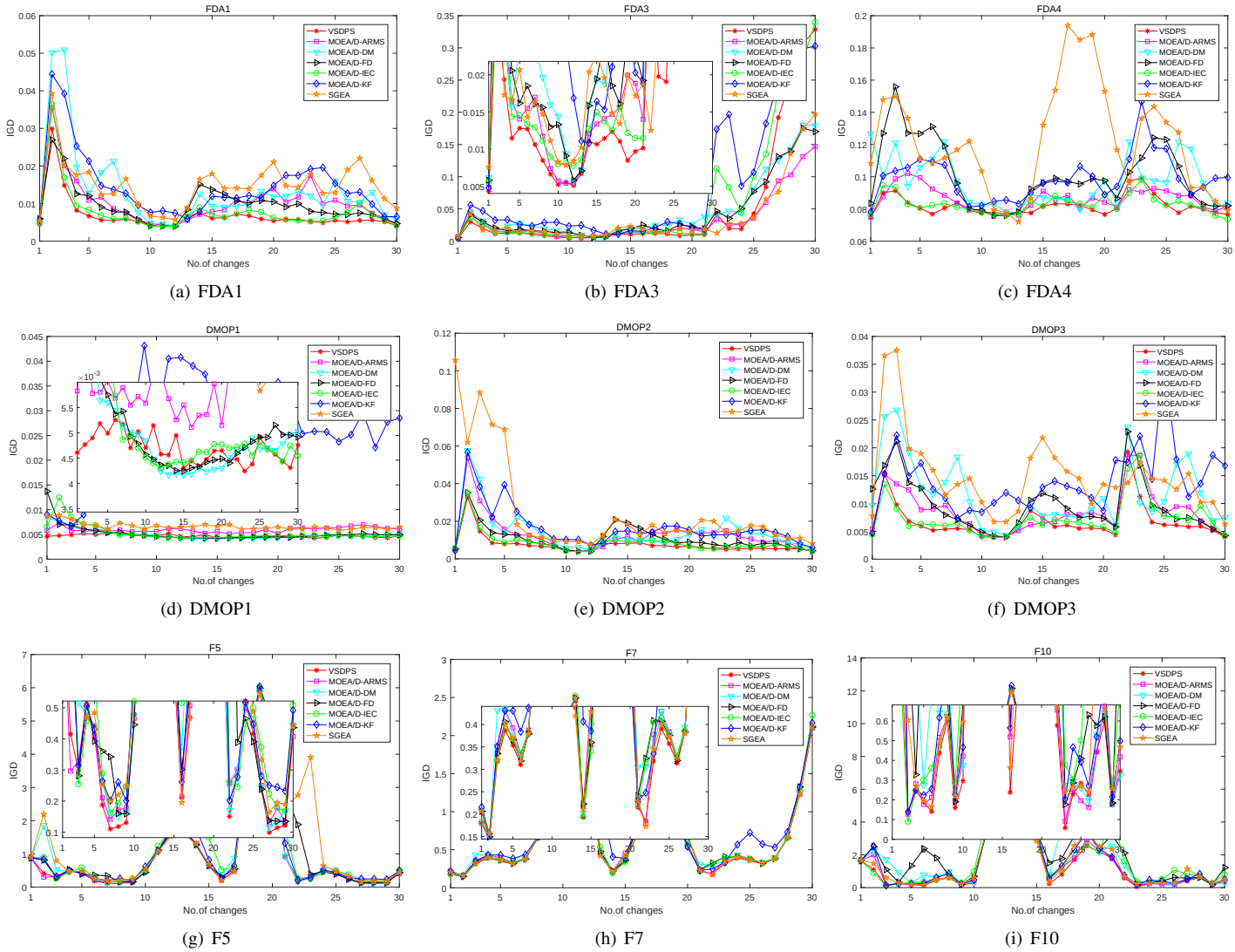
This paper provides supplementary descriptions of the experimental data in the paper 'A dynamic multi-objective evolutionary algorithm with variable stepsize and dual prediction strategies'. Figure S-I illustrates the convergence curves of the IGD values for various test instances of the FDA, dMOP, and F test suites when $n_t = 10$ and $\tau_t = 10$. Figure S-II illustrates the convergence curves of the IGD values for various test instances of the DF test suite when $n_t = 10$ and $\tau_t = 10$. Table S-I and Table S-II describe the statistics of the MIGD values and MHV values obtained by VSDPS and its three variants on FDA, dMOP, F and DF test suites. Table S-III and Table S-IV describe the statistics of the MIGD values and MHV values obtained by VSDPS and its five ratios of dual prediction strategies related variants on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$. Table S-V and Table S-VI present the statistics of the MIGD values and MHV values acquired by VSDPS and its four stepsize related variants on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$. Table S-VII and Table S-VIII present the statistics of the MIGD values and MHV values acquired by VSDPS and different values of control number in static optimization on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

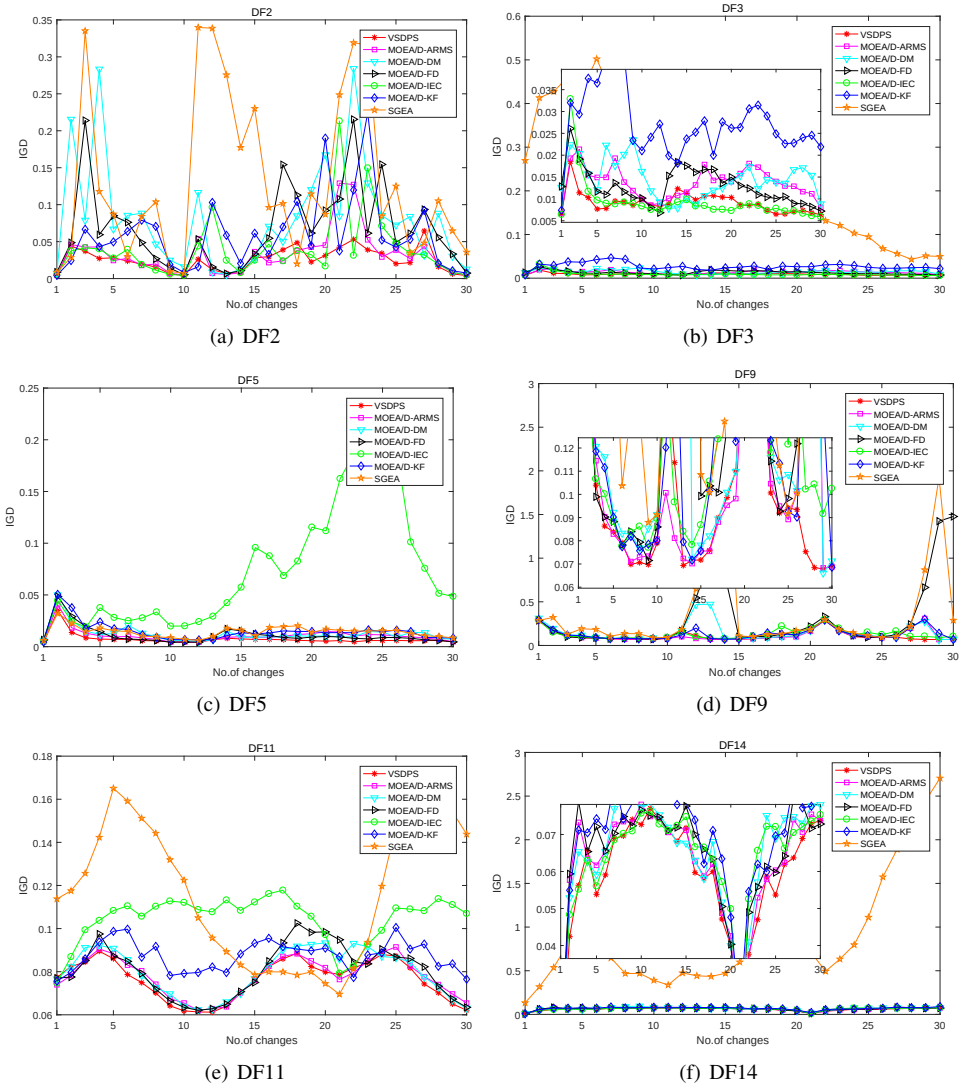


(a) FDA1 (b) FDA3 (c) FDA4

(d) DMOP1 (e) DMOP2 (f) DMOP3

(g) F5 (h) F7 (i) F10

Figure S - I. The convergence curves of the IGD values for several test instances of the FDA, dMOP, and F test suites when $n_t = 10$ and $\tau_t = 10$.



(a) DF2 (b) DF3

(c) DF5 (d) DF9

(e) DF11 (f) DF14

Figure S - II. The convergence curves of the IGD values for several test instances of the DF test suite when $n_t = 10$ and $\tau_t = 10$.

Table S - I. The statistics of the MIGD values obtained by VSDPS and its three variants were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-S	VSDPS-P	VSDPS-O	VSDPS
FDA1	(10,10)	9.8069e-3 (6.07e-4)-	7.3270e-3 (2.29e-4)-	7.4060e-3 (4.13e-4) -	6.7466e-3 (6.36e-4)
FDA2	(10,10)	7.8205e-3 (2.63e-4)-	5.3950e-3 (4.99e-5) +	5.9032e-3 (7.62e-5)-	5.8454e-3 (8.04e-4)
FDA3	(10,10)	5.2826e-2 (2.10e-3) -	4.4736e-2 (3.01e-3) +	5.5682e-2 (1.81e-3)-	4.8868e-2 (3.00e-3)
FDA4	(10,10)	9.8152e-2 (1.61e-3) -	8.3695e-2 (9.21e-4) =	8.4246e-2 (1.19e-3) =	8.3937e-2 (1.89e-3)
FDA5	(10,10)	2.9791e-1 (4.03e-2) -	1.7818e-1 (5.00e-3) +	2.7176e-1 (2.49e-2)-	2.2040e-1 (1.61e-2)
DMOP1	(10,10)	1.1542e-2 (8.75e-4) -	4.8853e-3 (9.42e-5) -	5.5040e-3 (1.26e-4) -	4.7554e-3 (1.24e-4)
DMOP2	(10,10)	1.2369e-2 (9.41e-4) -	8.7618e-3 (4.09e-4) -	8.8833e-3 (5.72e-4) -	7.9824e-3 (4.23e-4)
DMOP3	(10,10)	1.0374e-2 (9.77e-4) -	7.5255e-3 (4.00e-4) =	7.1657e-3 (2.55e-4) =	7.3219e-3 (4.66e-4)
F5	(10,10)	9.1383e-1 (2.29e-2) +	1.2916e+0 (2.92e-1) -	9.4482e-1 (2.07e-2) -	9.1794e-1 (1.29e-2)
F6	(10,10)	6.1708e-1 (4.23e-3) =	6.9168e-1 (3.72e-2) -	6.2656e-1 (6.27e-3) -	6.1917e-1 (6.93e-3)
F7	(10,10)	7.2865e-1 (4.07e-3) -	7.3666e-1 (5.31e-3) -	7.3213e-1 (6.35e-3) -	7.2383e-1 (7.29e-3)
F8	(10,10)	1.1856e-1 (4.39e-3) -	8.8957e-2 (1.09e-3) +	9.1866e-2 (1.61e-3) =	9.2819e-2 (2.30e-3)
F9	(10,10)	4.8395e-1 (1.28e-1) =	1.4355e+0 (3.48e-1) -	5.5750e-1 (1.61e-1) =	5.4958e-1 (1.55e-1)
F10	(10,10)	1.8998e+0 (5.54e-2) -	2.0314e+0 (7.94e-2) -	1.8879e+0 (4.07e-2) -	1.8220e+0 (2.75e-2)
DF1	(10,10)	1.2120e-2 (1.34e-3) -	9.0115e-3 (4.12e-4) -	8.5278e-3 (5.47e-4) =	8.6641e-3 (4.25e-4)
DF2	(10,10)	3.4937e-2 (4.42e-3) -	4.4156e-2 (4.50e-3) -	4.5032e-2 (5.38e-3) -	2.9877e-2 (5.71e-3)
DF3	(10,10)	1.8176e-2 (8.85e-4) -	1.1288e-2 (4.17e-4) -	9.5954e-3 (3.38e-4) -	9.0387e-3 (3.37e-4)
DF4	(10,10)	8.1510e-2 (1.89e-3) =	8.1795e-2 (8.22e-4) =	8.3306e-2 (8.80e-4) -	8.2237e-2 (5.71e-4)
DF5	(10,10)	1.1117e-2 (4.83e-4) -	7.5300e-3 (2.69e-4) =	8.4010e-3 (3.65e-4) -	7.4775e-3 (3.14e-4)
DF6	(10,10)	2.2599e+0 (1.72e+0) +	4.5427e+0 (9.60e-1) =	1.9749e+0 (1.37e+0) +	4.2883e+0 (6.12e-1)
DF7	(10,10)	3.7361e-2 (3.26e-2) =	7.4027e-2 (4.60e-2) -	3.7477e-2 (3.09e-2) =	3.6343e-2 (2.98e-2)
DF8	(10,10)	1.5695e-1 (6.54e-3) -	1.3124e-1 (1.36e-3) +	1.3048e-1 (2.04e-3) +	1.3623e-1 (9.32e-3)
DF9	(10,10)	2.1002e+0 (8.97e-3) =	2.1164e+0 (1.88e-2) -	2.0919e+0 (4.88e-3) +	2.0982e+0 (8.87e-3)
DF10	(10,10)	2.1742e-1 (1.05e-2) -	1.8564e-1 (1.97e-2) =	1.9140e-1 (1.41e-2) -	1.8876e-1 (2.88e-2)
DF11	(10,10)	8.3012e-2 (8.93e-4) -	7.5338e-2 (5.24e-4) +	7.6617e-2 (3.78e-4) +	7.7054e-2 (1.79e-3)
DF12	(10,10)	2.8315e-1 (2.48e-3) -	2.7981e-1 (1.21e-3) +	2.7847e-1 (1.22e-3) +	2.8193e-1 (4.00e-3)
DF13	(10,10)	3.0499e-1 (6.18e-3) +	3.2511e-1 (2.75e-3) -	3.1946e-1 (3.63e-3) -	3.1168e-1 (3.14e-3)
DF14	(10,10)	6.4171e-2 (9.81e-4) -	5.8366e-2 (4.23e-4) +	5.9129e-2 (5.37e-4) =	5.8892e-2 (8.52e-4)
+/-/=		3/20/5	8/14/6	5/16/7	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - II. The statistics of the MHV values obtained by VSDPS and its three variants were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-S	VSDPS-P	VSDPS-O	VSDPS
FDA1	(10,10)	7.0981e-1 (8.30e-4) -	7.1400e-1 (3.58e-4) -	7.1366e-1 (6.11e-4) -	7.1491e-1 (3.78e-4)
FDA2	(10,10)	5.2552e-1 (4.33e-4) -	5.2873e-1 (1.17e-4) +	5.2790e-1 (1.34e-4) -	5.2828e-1 (1.40e-4)
FDA3	(10,10)	5.4333e-1 (2.12e-3)-	5.5130e-1 (3.71e-3) +	5.4159e-1 (1.59e-3) -	5.4717e-1 (1.65e-3)
FDA4	(10,10)	4.7189e-1 (7.17e-3) -	5.1400e-1 (1.59e-3) =	5.0755e-1 (2.61e-3) -	5.1237e-1 (2.52e-3)
FDA5	(10,10)	4.6653e-1 (1.26e-2) -	5.1806e-1 (1.66e-3) +	4.9038e-1 (5.55e-3) -	5.0642e-1 (3.73e-3)
DMOP1	(10,10)	5.1284e-1 (1.85e-3) -	5.2499e-1 (2.30e-4) -	5.2376e-1 (2.60e-4) -	5.2518e-1 (2.13e-4)
DMOP2	(10,10)	5.1219e-1 (1.84e-3) -	5.1847e-1 (6.38e-4) -	5.1803e-1 (9.08e-4) -	5.1963e-1 (4.96e-4)
DMOP3	(10,10)	7.0969e-1 (1.31e-3) -	7.1371e-1 (4.61e-4) =	7.1404e-1 (3.95e-4) =	7.1397e-1 (7.41e-4)
F5	(10,10)	3.0034e-1 (1.13e-2) =	1.7963e-1 (2.53e-2) -	2.6812e-1 (1.13e-2) -	3.0041e-1 (9.60e-3)
F6	(10,10)	2.5522e-1 (2.86e-3) =	1.9777e-1 (1.10e-2) -	2.4661e-1 (5.71e-3) -	2.5434e-1 (3.65e-3)
F7	(10,10)	2.2515e-1 (2.17e-3) -	2.0653e-1 (5.15e-3) -	2.1963e-1 (1.64e-3) -	2.2710e-1 (1.65e-3)
F8	(10,10)	4.3203e-1 (6.21e-3) -	4.9423e-1 (2.22e-3) +	4.8635e-1 (3.30e-3) -	4.8724e-1 (2.46e-3)
F9	(10,10)	3.3572e-1 (2.32e-2) =	1.6402e-1 (3.17e-2) -	3.1910e-1 (1.64e-2) -	3.3623e-1 (1.82e-2)
F10	(10,10)	2.4203e-1 (9.57e-3) =	1.7950e-1 (1.48e-2) -	2.1326e-1 (1.63e-2) -	2.4701e-1 (1.15e-2)
DF1	(10,10)	5.1225e-1 (1.83e-3) -	5.1835e-1 (6.81e-4) -	5.1864e-1 (8.84e-4) =	5.1904e-1 (7.97e-4)
DF2	(10,10)	6.7642e-1 (5.62e-3) -	6.7148e-1 (6.54e-3) -	6.6739e-1 (3.86e-3) -	6.8351e-1 (3.51e-3)
DF3	(10,10)	4.7101e-1 (1.42e-3) -	4.7981e-1 (2.49e-3) -	4.8389e-1 (5.88e-4) -	4.8465e-1 (4.36e-4)
DF4	(10,10)	2.8345e-1 (1.15e-4) -	2.8434e-1 (4.95e-5) -	2.8393e-1 (7.99e-5) -	2.8442e-1 (6.12e-5)
DF5	(10,10)	1.2632e-1 (4.41e-4) -	1.2725e-1 (2.28e-4) =	1.2697e-1 (3.24e-4) -	1.2720e-1 (2.65e-4)
DF6	(10,10)	4.3347e-1 (1.60e-1) +	1.0120e-1 (5.28e-2) -	4.0810e-1 (1.57e-1) +	2.2196e-1 (7.12e-2)
DF7	(10,10)	1.4914e-1 (4.32e-3) =	1.4592e-1 (4.55e-3) -	1.5017e-1 (3.41e-3) =	1.5005e-1 (3.70e-3)
DF8	(10,10)	7.9356e-2 (3.74e-4) -	8.0848e-2 (1.07e-4) +	8.0874e-2 (8.95e-5) +	8.0692e-2 (1.38e-4)
DF9	(10,10)	3.9743e-2 (2.50e-2) =	4.1644e-2 (2.26e-2) =	3.1960e-2 (1.51e-3) =	4.0221e-2 (2.18e-2)
DF10	(10,10)	4.6679e-1 (1.09e-2) -	5.9859e-1 (2.48e-2) +	5.3418e-1 (1.55e-2) -	5.6423e-1 (3.33e-2)
DF11	(10,10)	2.8091e-1 (1.03e-3) -	2.8894e-1 (4.09e-4) =	2.8768e-1 (5.24e-4) -	2.8880e-1 (5.41e-4)
DF12	(10,10)	8.9467e-1 (1.81e-3) -	9.0481e-1 (9.87e-4) +	9.0391e-1 (4.60e-4) =	9.0370e-1 (1.05e-3)
DF13	(10,10)	4.5307e-1 (1.80e-2) -	5.6563e-1 (6.12e-3) +	5.2753e-1 (7.95e-3) -	5.5899e-1 (4.60e-3)
DF14	(10,10)	5.6538e-1 (2.10e-3) -	5.8168e-1 (7.91e-4) -	5.7808e-1 (1.06e-3) -	5.8230e-1 (1.15e-3)
+/-/=		1/21/6	8/15/5	2/21/5	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - III. The statistics of the MIGD values obtained by VSDPS and its five ratios of dual prediction strategies related variants were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-P1	VSDPS-P2	VSDPS-P3	VSDPS-P4	VSDPS-P5	VSDPS
FDA1	(10,10)	7.5599e-3 (1.25e-3) -	6.9612e-3 (4.27e-4) -	6.8171e-3 (4.07e-4) =	6.7917e-3 (4.64e-4) =	6.7173e-3 (2.76e-4) =	6.7257e-3 (3.34e-4)
FDA2	(10,10)	5.9296e-3 (9.43e-4) -	5.7089e-3 (5.81e-4) =	5.5445e-3 (3.21e-4) +	5.3869e-3 (9.09e-5) +	5.3737e-3 (6.88e-5) +	5.6014e-3 (1.40e-4)
FDA3	(10,10)	5.3480e-2 (2.88e-3) -	5.3475e-2 (2.36e-3) -	5.3727e-2 (2.41e-3) -	5.3888e-2 (2.49e-3) -	5.3572e-2 (3.58e-3) -	5.1836e-2 (2.27e-3)
FDA4	(10,10)	8.5351e-2 (2.97e-3) =	8.4186e-2 (1.31e-3) =	8.4278e-2 (1.24e-3) =	8.3836e-2 (1.10e-3) =	8.4169e-2 (1.52e-3) =	8.3918e-2 (1.16e-3)
FDA5	(10,10)	2.3134e-1 (2.28e-2) =	2.3203e-1 (2.55e-2) =	2.2079e-1 (1.49e-2) =	2.2228e-1 (1.52e-2) =	2.1878e-1 (1.44e-2) =	2.2695e-1 (2.12e-2)
DMOP1	(10,10)	5.0144e-3 (1.06e-3) =	4.6410e-3 (4.72e-4) =	4.5236e-3 (2.80e-4) =	4.3646e-3 (7.83e-5) +	4.3468e-3 (4.47e-5) +	4.6079e-3 (1.69e-4)
DMOP2	(10,10)	9.0302e-3 (1.61e-3) -	8.2605e-3 (6.31e-4) -	8.0609e-3 (4.79e-4) =	7.8924e-3 (4.59e-4) =	8.1608e-3 (5.63e-4) =	7.8973e-3 (4.27e-4)
DMOP3	(10,10)	8.3378e-3 (9.86e-4) -	7.8019e-3 (5.92e-4) -	7.4452e-3 (4.17e-4) =	7.6905e-3 (5.75e-4) =	7.6809e-3 (6.02e-4) =	7.4214e-3 (4.85e-4)
F5	(10,10)	1.1203e+0 (2.34e-1) -	1.0701e+0 (1.49e-1) -	1.0658e+0 (1.59e-1) -	1.0811e+0 (1.77e-1) -	1.1430e+0 (1.73e-1) -	9.6233e-1 (1.03e-1)
F6	(10,10)	6.3446e-1 (1.98e-2) -	6.4064e-1 (3.60e-2) -	6.3510e-1 (1.71e-2) -	6.3393e-1 (2.13e-2) -	6.4870e-1 (1.82e-2) -	6.2297e-1 (1.80e-2)
F7	(10,10)	7.2640e-1 (7.20e-3) -	7.2548e-1 (6.27e-3) -	7.2540e-1 (8.02e-3) =	7.2619e-1 (5.78e-3) -	7.2811e-1 (5.21e-3) -	7.2271e-1 (8.73e-3)
F8	(10,10)	9.1818e-2 (8.56e-3) =	9.0822e-2 (6.79e-3) =	9.0314e-2 (6.84e-3) =	8.6626e-2 (1.83e-3) +	8.6090e-2 (1.20e-3) +	9.0036e-2 (2.64e-3)
F9	(10,10)	8.4155e-1 (3.33e-1) -	7.9601e-1 (2.16e-1) -	8.1103e-1 (2.61e-1) -	8.9625e-1 (2.74e-1) -	8.4651e-1 (2.25e-1) -	6.6372e-1 (2.42e-1)
F10	(10,10)	1.9704e+0 (1.20e-1) -	2.0045e+0 (1.41e-1) -	2.0051e+0 (1.54e-1) -	1.9762e+0 (1.13e-1) -	2.0524e+0 (6.73e-2) -	1.8849e+0 (1.20e-1)
DF1	(10,10)	8.8066e-3 (4.28e-4) =	9.1366e-3 (4.97e-4) -	8.6219e-3 (5.61e-4) =	8.5390e-3 (5.00e-4) =	1.1096e-2 (6.38e-4) -	8.6283e-3 (5.17e-4)
DF2	(10,10)	2.9131e-2 (4.53e-3) =	2.8883e-2 (4.23e-3) =	2.8438e-2 (4.73e-3) =	2.7187e-2 (2.85e-3) =	2.9845e-2 (4.96e-3) =	2.8284e-2 (4.80e-3)
DF3	(10,10)	8.4546e-3 (3.03e-4) -	1.0725e-2 (3.08e-4) -	9.8366e-3 (3.79e-4) -	8.5578e-3 (2.63e-4) -	1.3421e-2 (5.41e-4) -	8.1299e-3 (2.08e-4)
DF4	(10,10)	8.1826e-2 (6.76e-4) =	8.2521e-2 (7.54e-4) =	8.2221e-2 (5.58e-4) =	8.2099e-2 (7.36e-4) =	8.2885e-2 (6.42e-4) -	8.2087e-2 (6.82e-4)
DF5	(10,10)	7.4129e-3 (3.45e-4) =	8.3170e-3 (3.79e-4) -	7.8334e-3 (3.27e-4) -	7.1666e-3 (4.05e-4) +	1.1452e-2 (6.18e-4) -	7.3923e-3 (4.16e-4)
DF6	(10,10)	4.6688e+0 (8.28e-1) -	3.6995e+0 (1.31e+0) =	3.6242e+0 (1.51e+0) =	3.8882e+0 (1.32e+0) =	3.4582e+0 (8.82e-1) =	3.7917e+0 (1.36e+0)
DF7	(10,10)	3.3358e-2 (2.87e-2) =	3.0096e-2 (2.61e-2) =	3.7304e-2 (3.09e-2) =	3.1988e-2 (2.85e-2) =	5.7105e-2 (3.71e-2) -	3.7529e-2 (2.91e-2)
DF7	(10,10)	1.4110e-1 (9.85e-4) -	1.4019e-1 (2.25e-3) -	1.3847e-1 (2.47e-3) -	1.3738e-1 (2.28e-3) -	1.4205e-1 (3.02e-3) -	1.3531e-1 (2.49e-3)
DF9	(10,10)	2.1018e+0 (1.45e-2) =	2.0978e+0 (8.30e-3) =	2.0979e+0 (8.89e-3) =	2.1010e+0 (1.40e-2) =	2.1061e+0 (1.91e-2) =	2.1001e+0 (1.45e-2)
DF10	(10,10)	1.9896e-1 (2.99e-2) =	1.8223e-1 (1.77e-2) =	1.8612e-1 (1.94e-2) =	1.8232e-1 (1.60e-2) =	1.9041e-1 (1.65e-2) =	1.8859e-1 (1.94e-2)
DF11	(10,10)	7.5377e-2 (4.72e-4) +	7.7997e-2 (4.59e-4) -	7.7393e-2 (5.33e-4) -	7.6450e-2 (3.72e-4) +	7.9072e-2 (4.35e-4) -	7.6954e-2 (4.07e-4)
DF12	(10,10)	2.8794e-1 (8.94e-4) -	2.8331e-1 (1.64e-3) -	2.8410e-1 (1.90e-3) -	2.8396e-1 (1.10e-3) -	2.8269e-1 (1.70e-3) -	2.8184e-1 (1.24e-3)
DF13	(10,10)	3.1153e-1 (3.63e-3) =	3.0784e-1 (3.36e-3) +	3.1234e-1 (3.26e-3) =	3.1138e-1 (2.79e-3) =	3.0448e-1 (4.39e-3) +	3.1186e-1 (3.34e-3)
DF14	(10,10)	5.8922e-2 (4.52e-4) -	6.0202e-2 (4.76e-4) -	5.9387e-2 (5.62e-4) -	5.9283e-2 (4.82e-4) -	6.1629e-2 (6.86e-4) -	5.8623e-2 (3.85e-4)
+/-/=		1/15/12	1/16/11	1/11/16	5/10/13	4/15/9	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - IV. The statistics of the MHV values obtained by VSDPS and its ratio of dual prediction strategies five variants were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-P1	VSDPS-P2	VSDPS-P3	VSDPS-P4	VSDPS-P5	VSDPS
FDA1	(10,10)	7.1350e-1 (1.95e-3) -	7.1449e-1 (5.85e-4) -	7.1471e-1 (5.85e-4) =	7.1475e-1 (7.08e-4) =	7.1482e-1 (4.19e-4) =	7.1489e-1 (4.81e-4)
FDA2	(10,10)	5.2800e-1 (1.29e-3) -	5.2831e-1 (8.20e-4) -	5.2851e-1 (5.06e-4) +	5.2877e-1 (1.49e-4) +	5.2877e-1 (1.17e-4) +	5.2841e-1 (2.23e-4)
FDA3	(10,10)	5.4373e-1 (2.96e-3) -	5.4418e-1 (2.53e-3) -	5.4394e-1 (2.77e-3) -	5.4364e-1 (2.81e-3) -	5.4382e-1 (3.60e-3) -	5.4624e-1 (2.41e-3)
FDA4	(10,10)	5.0880e-1 (6.71e-3) -	5.1095e-1 (2.22e-3) -	5.1200e-1 (2.46e-3) -	5.1200e-1 (2.67e-3) -	5.1084e-1 (3.13e-3) -	5.1386e-1 (2.93e-3)
FDA5	(10,10)	5.0246e-1 (8.64e-3) -	5.0419e-1 (8.33e-3) =	5.0790e-1 (3.78e-3) =	5.0708e-1 (4.15e-3) =	5.0859e-1 (3.90e-3) =	5.0703e-1 (5.17e-3)
DMOP1	(10,10)	5.2483e-1 (1.94e-3) =	5.2552e-1 (8.79e-4) =	5.2570e-1 (5.30e-4) =	5.2604e-1 (1.70e-4) +	5.2605e-1 (1.25e-4) +	5.2559e-1 (3.31e-4)
DMOP2	(10,10)	5.1783e-1 (2.68e-3) -	5.1911e-1 (9.40e-4) -	5.1944e-1 (7.39e-4) =	5.1970e-1 (7.21e-4) =	5.1925e-1 (8.86e-4) -	5.1976e-1 (7.18e-4)
DMOP3	(10,10)	7.1232e-1 (1.58e-3) -	7.1325e-1 (8.82e-4) -	7.1375e-1 (6.19e-4) =	7.1341e-1 (8.67e-4) =	7.1337e-1 (8.47e-4) -	7.1383e-1 (7.34e-4)
F5	(10,10)	2.4644e-1 (4.44e-2) -	2.4718e-1 (4.14e-2) -	2.5476e-1 (3.79e-2) -	2.5014e-1 (4.02e-2) -	2.2813e-1 (2.70e-2) -	2.8401e-1 (3.05e-2)
F6	(10,10)	2.3907e-1 (1.53e-2) -	2.3602e-1 (1.75e-2) -	2.3738e-1 (1.50e-2) -	2.3830e-1 (1.49e-2) -	2.2736e-1 (1.14e-2) -	2.4881e-1 (1.28e-2)
F7	(10,10)	2.2042e-1 (7.39e-3) =	2.2038e-1 (7.00e-3) =	2.2027e-1 (7.64e-3) =	2.1884e-1 (5.92e-3) -	2.1709e-1 (2.52e-3) -	2.2421e-1 (7.34e-3)
F8	(10,10)	4.8702e-1 (1.70e-2) =	4.9029e-1 (1.13e-2) =	4.9105e-1 (1.20e-2) =	4.9803e-1 (3.07e-3) +	4.9790e-1 (2.87e-3) +	4.9364e-1 (4.02e-3)
F9	(10,10)	2.7054e-1 (5.18e-2) -	2.7620e-1 (4.23e-2) -	2.7191e-1 (4.43e-2) -	2.6571e-1 (4.73e-2) -	2.4797e-1 (3.26e-2) -	3.1157e-1 (4.43e-2)
F10	(10,10)	2.1410e-1 (3.26e-2) -	2.1122e-1 (3.22e-2) -	2.1589e-1 (2.92e-2) -	2.1173e-1 (3.17e-2) -	1.9252e-1 (2.11e-2) -	2.3621e-1 (2.60e-2)
DF1	(10,10)	5.1825e-1 (6.61e-4) -	5.1780e-1 (7.91e-4) -	5.1865e-1 (8.71e-4) =	5.1875e-1 (7.78e-4) =	5.1443e-1 (1.05e-3) -	5.1861e-1 (8.20e-4)
DF2	(10,10)	6.8463e-1 (3.48e-3) =	6.8424e-1 (4.27e-3) =	6.8494e-1 (4.31e-3) =	6.8638e-1 (4.00e-3) =	6.8333e-1 (5.20e-3) =	6.8549e-1 (4.45e-3)
DF3	(10,10)	4.8410e-1 (5.26e-4) -	4.8252e-1 (5.33e-4) -	4.8365e-1 (6.63e-4) -	4.8455e-1 (4.96e-4) -	4.7791e-1 (8.78e-4) -	4.8669e-1 (4.20e-4)
DF4	(10,10)	2.8448e-1 (5.57e-5) =	2.8436e-1 (7.32e-5) -	2.8444e-1 (5.46e-5) =	2.8446e-1 (5.28e-5) =	2.8427e-1 (6.91e-5) -	2.8446e-1 (5.50e-5)
DF5	(10,10)	1.2722e-1 (3.06e-4) =	1.2712e-1 (3.06e-4) =	1.2719e-1 (2.70e-4) =	1.2731e-1 (3.18e-4) =	1.2670e-1 (3.22e-4) -	1.2727e-1 (3.51e-4)
DF6	(10,10)	9.4925e-2 (4.43e-2) -	2.7387e-1 (1.15e-1) =	2.6983e-1 (1.24e-1) =	2.3520e-1 (1.07e-1) =	2.5113e-1 (8.57e-2) =	2.4350e-1 (1.21e-1)
DF7	(10,10)	1.5060e-1 (3.33e-3) =	1.5100e-1 (3.03e-3) =	1.5023e-1 (3.48e-3) =	1.5084e-1 (3.22e-3) =	1.4800e-1 (4.15e-3) -	1.5016e-1 (3.30e-3)
DF8	(10,10)	8.0496e-2 (1.40e-4) -	8.0349e-2 (1.03e-4) -	8.0398e-2 (1.57e-4) -	8.0454e-2 (1.38e-4) -	8.0277e-2 (2.31e-4) -	8.0623e-2 (1.51e-4)
DF9	(10,10)	3.1161e-2 (3.69e-3) =	3.1359e-2 (2.22e-3) =	3.0816e-2 (3.47e-3) =	3.1780e-2 (2.01e-3) =	3.1502e-2 (1.74e-3) =	3.1234e-2 (3.73e-3)
DF10	(10,10)	5.5665e-1 (3.11e-2) =	5.5657e-1 (3.41e-2) =	5.5681e-1 (3.73e-2) =	5.7108e-1 (2.86e-2) =	5.3811e-1 (3.52e-2) -	5.5702e-1 (3.22e-2)
DF11	(10,10)	2.8921e-1 (5.48e-4) +	2.8807e-1 (5.04e-4) -	2.8838e-1 (7.85e-4) -	2.8912e-1 (3.52e-4) =	2.8650e-1 (5.19e-4) -	2.8894e-1 (5.17e-4)
DF12	(10,10)	9.0329e-1 (4.08e-4) -	9.0193e-1 (6.48e-4) -	9.0144e-1 (6.77e-4) -	9.0210e-1 (4.12e-4) -	9.0052e-1 (6.26e-4) -	9.0503e-1 (3.95e-4)
DF13	(10,10)	5.5985e-1 (5.48e-3) =	5.5449e-1 (5.64e-3) -	5.5661e-1 (5.13e-3) -	5.5890e-1 (4.51e-3) =	5.2856e-1 (6.79e-3) -	5.6096e-1 (6.00e-3)
DF14	(10,10)	5.8247e-1 (8.37e-4) =	5.8072e-1 (1.34e-3) -	5.8183e-1 (1.12e-3) =	5.8234e-1 (7.88e-4) =	5.7575e-1 (1.26e-3) -	5.8238e-1 (8.96e-4)
+/-/=		1/16/11	0/18/10	1/11/16	3/10/15	3/20/5	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - V. The statistics of the MIGD values obtained by VSDPS and its four stepsize related variants were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-S1	VSDPS-S2	VSDPS-S3	VSDPS-S4	VSDPS
FDA1	(10,10)	6.6957e-3 (1.37e-3) =	6.7199e-3 (4.47e-4) =	6.8433e-3 (4.42e-4) =	6.8900e-3 (3.04e-4) =	6.6058e-3 (2.61e-4)
FDA2	(10,10)	5.7391e-3 (5.52e-4) =	5.8991e-3 (1.37e-4) -	5.5615e-3 (1.99e-4) +	6.2062e-3 (9.31e-5) -	5.7197e-3 (8.28e-5)
FDA3	(10,10)	4.9037e-2 (6.10e-3) =	5.3855e-2 (2.57e-3) -	5.0182e-2 (2.86e-3) =	5.1411e-2 (2.28e-3) =	5.1048e-2 (1.73e-3)
FDA4	(10,10)	9.0203e-2 (5.12e-3) -	8.5984e-2 (1.59e-3) -	8.4119e-2 (1.60e-3) =	8.5572e-2 (1.37e-3) -	8.4406e-2 (1.10e-3)
FDA5	(10,10)	2.0121e-1 (1.50e-2) +	3.1079e-1 (4.02e-2) -	2.1445e-1 (1.39e-2) =	2.1110e-1 (6.98e-3) +	2.1907e-1 (8.37e-3)
DMOP1	(10,10)	4.3795e-3 (2.78e-4) +	4.6935e-3 (6.26e-5) +	4.7351e-3 (1.97e-4) =	5.5968e-3 (1.29e-4) -	4.7985e-3 (6.84e-5)
DMOP2	(10,10)	8.2655e-3 (1.83e-3) =	8.1160e-3 (6.22e-4) =	8.0948e-3 (7.72e-4) =	8.9581e-3 (4.60e-4) -	7.8956e-3 (4.13e-4)
DMOP3	(10,10)	1.6787e-2 (5.39e-3) -	7.4676e-3 (4.97e-4) =	7.3956e-3 (5.37e-4) =	7.6295e-3 (3.75e-4) -	7.1466e-3 (4.85e-4)
F5	(10,10)	9.1840e+0 (6.82e-2) =	9.1445e-1 (2.22e-2) =	9.5541e-1 (3.99e-2) -	9.1964e-1 (1.23e-2) =	9.1687e-1 (1.61e-2)
F6	(10,10)	6.1917e-1 (9.35e-3) =	6.1522e-1 (4.89e-3) =	6.2374e-1 (4.13e-3) -	6.1676e-1 (5.69e-3) =	6.1708e-1 (4.76e-3)
F7	(10,10)	7.2309e-1 (3.67e-2) =	7.2324e-1 (4.65e-3) =	7.2327e-1 (5.50e-3) =	7.3052e-1 (4.63e-3) -	7.2183e-1 (5.16e-3)
F8	(10,10)	1.0382e-1 (7.97e-3) -	9.4765e-2 (1.56e-3) =	9.2196e-2 (1.93e-3) +	9.9069e-2 (1.06e-3) -	9.3893e-2 (1.60e-3)
F9	(10,10)	1.3066e+0 (3.53e-1) -	4.9039e-1 (1.47e-1) =	7.9241e-1 (3.06e-1) -	4.8499e-1 (1.07e-1) =	4.8475e-1 (1.54e-1)
F10	(10,10)	2.1070e+0 (1.73e-1) -	1.8539e+0 (4.55e-2) -	1.8831e+0 (7.28e-2) -	1.8154e+0 (2.25e-2) =	1.8240e+0 (2.69e-2)
DF1	(10,10)	8.7743e-3 (6.08e-3) =	8.9170e-3 (7.01e-4) =	8.8799e-3 (7.20e-4) =	8.8944e-3 (4.14e-4) =	8.6271e-3 (5.66e-4)
DF2	(10,10)	9.1786e-2 (2.96e-2) -	3.5506e-2 (5.82e-3) -	4.4210e-2 (7.01e-3) -	2.4954e-2 (2.95e-3) +	2.9793e-2 (4.79e-3)
DF3	(10,10)	1.1409e-2 (2.20e-3) -	8.5231e-3 (3.45e-4) +	8.9701e-3 (6.00e-4) +	1.2014e-2 (3.63e-4) -	9.2705e-3 (3.35e-4)
DF4	(10,10)	8.0989e-2 (6.31e-4) +	8.2850e-2 (7.01e-4) -	8.2051e-2 (6.14e-4) =	8.3470e-2 (6.87e-4) -	8.2230e-2 (7.25e-4)
DF5	(10,10)	8.5721e-3 (1.72e-3) =	7.5615e-3 (4.22e-4) =	7.3793e-3 (7.27e-4) =	8.5245e-3 (4.01e-4) -	7.4444e-3 (4.33e-4)
DF6	(10,10)	3.7048e+0 (1.19e+0) =	2.5506e+0 (2.17e+0) =	3.5740e+0 (1.59e+0) =	4.2930e+0 (1.13e+0) =	3.9780e+0 (8.26e-1)
DF7	(10,10)	9.1911e-2 (4.40e-2) -	1.8189e-2 (8.70e-3) +	6.2268e-2 (3.32e-2) -	3.9278e-2 (2.86e-2) -	2.4659e-2 (1.59e-2)
DF8	(10,10)	1.4928e-1 (2.29e-3) -	1.3409e-1 (2.69e-3) +	1.3606e-1 (2.48e-3) =	1.3794e-1 (2.74e-3) -	1.3554e-1 (2.02e-3)
DF9	(10,10)	2.3162e+0 (1.17e-1) -	2.0964e+0 (7.45e-3) =	2.1057e+0 (9.31e-3) -	2.0952e+0 (6.42e-3) =	2.1009e+0 (1.81e-2)
DF10	(10,10)	1.9512e-1 (5.43e-2) =	2.0176e-1 (2.66e-2) -	1.7938e-1 (1.24e-2) =	1.8953e-1 (1.37e-2) =	1.8746e-1 (2.50e-2)
DF11	(10,10)	8.0760e-2 (2.63e-3) -	7.7717e-2 (8.29e-4) -	7.6875e-2 (6.52e-4) =	7.7975e-2 (3.79e-4) -	7.7088e-2 (4.50e-4)
DF12	(10,10)	3.2210e-1 (1.45e-2) -	2.8119e-1 (1.69e-3) +	2.8209e-1 (1.16e-3) =	2.8407e-1 (1.37e-3) -	2.8239e-1 (1.67e-3)
DF13	(10,10)	3.2419e-1 (8.62e-3) -	3.2090e-1 (3.42e-3) -	3.1750e-1 (5.65e-3) -	3.1929e-1 (4.14e-3) -	3.1314e-1 (3.31e-3)
DF14	(10,10)	6.1017e-2 (2.17e-3) -	5.9141e-2 (6.77e-4) =	5.8827e-2 (8.03e-4) =	5.9695e-2 (4.51e-4) -	5.8742e-2 (3.29e-4)
+/-/=		3/14/11	5/10/13	3/8/17	2/16/10	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - VI. The statistics of the MHV values obtained by VSDPS and its four stepsize related variants were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-S1	VSDPS-S2	VSDPS-S3	VSDPS-S4	VSDPS
FDA1	(10,10)	7.1436e-1 (2.06e-3) =	7.1488e-1 (6.64e-4) =	7.1467e-1 (7.10e-4) =	7.1371e-1 (4.69e-4) -	7.1506e-1 (3.88e-4)
FDA2	(10,10)	5.2824e-1 (8.96e-4) =	5.2800e-1 (1.72e-4) -	5.2849e-1 (3.21e-4) +	5.2746e-1 (1.47e-4) -	5.2821e-1 (1.32e-4)
FDA3	(10,10)	5.4791e-1 (6.48e-3) =	5.4417e-1 (2.62e-3) -	5.4712e-1 (2.58e-3) =	5.4609e-1 (2.19e-3) =	5.4669e-1 (1.69e-3)
FDA4	(10,10)	5.0446e-1 (1.01e-2) -	5.0414e-1 (3.08e-3) -	5.1240e-1 (3.80e-3) =	5.1159e-1 (2.16e-3) =	5.1260e-1 (2.35e-3)
FDA5	(10,10)	5.0348e-1 (8.80e-3) =	4.7792e-1 (1.14e-2) -	5.0761e-1 (5.97e-3) =	5.0994e-1 (2.26e-3) +	5.0800e-1 (3.13e-3)
DMOP1	(10,10)	5.2636e-1 (5.43e-4) +	5.2536e-1 (1.54e-4) +	5.2536e-1 (3.70e-4) =	5.2370e-1 (2.51e-4) -	5.2522e-1 (1.40e-4)
DMOP2	(10,10)	5.1912e-1 (2.89e-3) =	5.1939e-1 (9.79e-4) =	5.1940e-1 (1.31e-3) =	5.1799e-1 (7.40e-4) -	5.1977e-1 (6.56e-4)
DMOP3	(10,10)	7.0057e-1 (7.54e-3) -	7.1369e-1 (7.23e-4) -	7.1385e-1 (7.96e-4) =	7.1354e-1 (5.03e-4) -	7.1426e-1 (7.30e-4)
F5	(10,10)	2.9520e-1 (3.01e-2) =	3.0336e-1 (9.43e-3) +	2.7222e-1 (2.07e-2) -	2.9180e-1 (1.20e-2) =	2.9738e-1 (8.33e-3)
F6	(10,10)	2.5467e-1 (9.07e-3) =	2.5718e-1 (1.82e-3) +	2.5117e-1 (2.86e-3) -	2.5197e-1 (2.29e-3) -	2.5569e-1 (1.92e-3)
F7	(10,10)	2.1455e-1 (1.34e-2) -	2.2729e-1 (2.36e-3) =	2.2607e-1 (3.05e-3) =	2.1962e-1 (1.25e-3) -	2.2738e-1 (1.79e-3)
F8	(10,10)	4.7792e-1 (1.23e-2) -	4.8092e-1 (3.93e-3) -	4.8946e-1 (3.86e-3) +	4.7766e-1 (1.92e-3) -	4.8559e-1 (3.56e-3)
F9	(10,10)	2.3477e-1 (2.88e-2) -	3.4657e-1 (1.84e-2) =	3.0477e-1 (2.63e-2) -	3.3711e-1 (1.14e-2) =	3.4384e-1 (1.81e-2)
F10	(10,10)	1.8260e-1 (3.61e-2) -	2.4313e-1 (1.99e-2) =	2.1983e-1 (2.07e-2) -	2.4461e-1 (1.29e-2) =	2.4850e-1 (1.01e-2)
DF1	(10,10)	5.1545e-1 (8.65e-3) =	5.1806e-1 (1.10e-3) =	5.1813e-1 (1.14e-3) =	5.1720e-1 (5.99e-4) -	5.1862e-1 (9.33e-4)
DF2	(10,10)	6.2362e-1 (2.95e-2) -	6.7518e-1 (5.46e-3) -	6.6975e-1 (8.50e-3) -	6.8859e-1 (2.40e-3) +	6.8444e-1 (4.47e-3)
DF3	(10,10)	4.8087e-1 (3.72e-3) -	4.8561e-1 (6.28e-4) +	4.8491e-1 (9.63e-4) +	4.8011e-1 (6.11e-4) -	4.8444e-1 (5.77e-4)
DF4	(10,10)	2.8476e-1 (1.51e-4) +	2.8434e-1 (6.71e-5) -	2.8448e-1 (1.13e-4) =	2.8401e-1 (5.22e-5) -	2.8444e-1 (5.53e-5)
DF5	(10,10)	1.2642e-1 (8.58e-4) -	1.2701e-1 (3.35e-4) -	1.2730e-1 (4.25e-4) =	1.2690e-1 (3.19e-4) -	1.2728e-1 (3.21e-4)
DF6	(10,10)	2.8214e-1 (8.09e-2) =	3.9328e-1 (2.20e-1) +	2.8186e-1 (1.52e-1) =	2.0281e-1 (9.14e-2) =	2.3099e-1 (8.83e-2)
DF7	(10,10)	1.4508e-1 (3.60e-3) -	1.5228e-1 (1.23e-3) +	1.4743e-1 (3.69e-3) -	1.4962e-1 (3.53e-3) -	1.5155e-1 (1.93e-3)
DF8	(10,10)	7.9997e-2 (1.24e-4) -	8.0654e-2 (1.58e-4) =	8.0677e-2 (1.58e-4) =	8.0599e-2 (1.34e-4) =	8.0585e-2 (1.61e-4)
DF9	(10,10)	2.8355e-2 (4.71e-3) -	3.0046e-2 (2.59e-3) -	3.1532e-2 (2.00e-3) =	3.1843e-2 (1.12e-3) =	3.1593e-2 (1.95e-3)
DF10	(10,10)	6.0449e-1 (2.85e-2) +	5.1350e-1 (1.79e-2) -	5.7985e-1 (3.17e-2) =	5.7622e-1 (2.39e-2) =	5.6241e-1 (3.42e-2)
DF11	(10,10)	2.8655e-1 (2.11e-3) -	2.8696e-1 (1.18e-3) -	2.8862e-1 (6.74e-4) =	2.8828e-1 (3.24e-4) -	2.8880e-1 (4.69e-4)
DF12	(10,10)	8.9854e-1 (2.23e-3) -	9.0282e-1 (7.52e-4) -	9.0420e-1 (5.78e-4) +	9.0307e-1 (4.91e-4) -	9.0367e-1 (3.64e-4)
	(10,10)	5.6690e-1 (6.83e-3) +	5.3105e-1 (9.50e-3) -	5.5496e-1 (5.53e-3) -	5.5512e-1 (4.54e-3) -	5.5824e-1 (3.78e-3)
DF14	(10,10)	5.8389e-1 (1.21e-3) +	5.7929e-1 (1.32e-3) -	5.8165e-1 (1.64e-3) =	5.8108e-1 (1.05e-3) -	5.8225e-1 (7.88e-4)
+/-/=		5/14/9	6/15/7	4/7/17	2/17/9	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - VII. The statistics of the MIGD values obtained by VSDPS and different values of control number in static optimization were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-O1	VSDPS-O2	VSDPS-O3	VSDPS-O4	VSDPS-O5	VSDPS
FDA1	(10,10)	7.4060e-3 (4.13e-4) -	6.7243e-3 (2.55e-4) =	6.5386e-3 (2.63e-4) =	6.4322e-3 (3.26e-4) =	6.5973e-3 (3.92e-4) =	6.5922e-3 (3.63e-4)
FDA2	(10,10)	5.9032e-3 (7.62e-5) -	5.7452e-3 (1.10e-4) =	5.8717e-3(9.27e-5) -	5.7028e-3 (9.38e-5) =	5.7460e-3 (1.24e-4) =	5.6651e-3 (1.29e-4)
FDA3	(10,10)	5.5682e-2 (1.81e-3) -	5.0812e-2 (3.15e-3) =	4.8914e-2 (2.48e-3) +	4.8114e-2 (2.37e-3) +	4.7013e-2 (3.34e-3) +	5.0620e-2 (2.16e-3)
FDA4	(10,10)	8.4246e-2 (1.19e-3) =	8.3745e-2 (1.04e-3) =	8.3761e-2 (1.16e-3) =	8.4585e-2 (1.43e-3) =	8.4815e-2 (1.16e-3) -	8.3709e-2 (9.80e-4)
FDA5	(10,10)	2.7176e-1 (2.49e-2) -	2.2925e-1 (1.95e-2) =	2.1279e-1 (9.75e-3) +	2.1466e-1 (1.05e-2) +	2.1858e-1 (3.46e-2) +	2.2425e-1 (1.11e-2)
DMOP1	(10,10)	5.5040e-3 (1.26e-4) -	4.9582e-3 (2.14e-4) -	4.6357e-3 (1.08e-4) +	4.4739e-3 (6.89e-5) +	4.4370e-3 (1.99e-4) +	4.8205e-3 (6.76e-5)
DMOP2	(10,10)	8.8833e-3 (5.72e-4) -	8.1140e-3 (5.77e-4) =	7.6295e-3 (3.44e-4) +	7.7911e-3 (6.03e-4) =	8.0755e-3 (9.49e-4) =	7.9433e-3 (3.76e-4)
DMOP3	(10,10)	7.1657e-3 (2.55e-4) +	7.2444e-3 (3.06e-4) =	8.0186e-3 (4.49e-4) -	8.3517e-3 (6.55e-4) -	9.3956e-3 (1.74e-3) -	7.3717e-3 (4.65e-4)
F5	(10,10)	9.4482e-1 (2.07e-2) -	9.1849e-1 (1.34e-2) =	9.1179e-1 (9.81e-3) =	9.1268e-1 (1.68e-2) =	9.2068e-1 (1.91e-2) =	9.2556e-1 (2.54e-2)
F6	(10,10)	6.2656e-1 (6.27e-3) -	6.1951e-1 (4.80e-3) =	6.2749e-1 (5.53e-3) -	6.1545e-1 (4.11e-3) =	6.1799e-1 (4.24e-3) =	6.1780e-1 (4.27e-3)
F7	(10,10)	7.3213e-1 (6.35e-3) -	7.2476e-1 (5.10e-3) -	7.1889e-1 (3.52e-3) =	7.1813e-1 (4.94e-3) =	7.2022e-1 (3.97e-3) =	7.1942e-1 (3.68e-3)
F8	(10,10)	9.1866e-2 (1.61e-3) =	9.2736e-2 (1.63e-3) =	9.3603e-2 (2.05e-3) =	9.6068e-2 (2.75e-3) -	9.8949e-2 (4.03e-3) -	9.3173e-2 (1.18e-3)
F9	(10,10)	5.5750e-1 (1.61e-1) =	5.8437e-1 (2.40e-1) =	5.3344e-1 (1.66e-1) =	5.9435e-1 (1.63e-1) =	6.0110e-1 (2.25e-1) =	5.8956e-1 (2.42e-1)
F10	(10,10)	1.8879e+0 (4.07e-2) -	1.8370e+0 (4.15e-2) =	1.8155e+0 (3.35e-2) =	1.8205e+0 (3.33e-2) =	1.8418e+0 (6.38e-2) =	1.8381e+0 (3.46e-2)
DF1	(10,10)	8.5278e-3 (5.47e-4) =	8.6648e-3 (4.21e-4) =	8.9984e-3 (7.83e-4) =	9.9277e-3 (1.13e-3) -	1.1058e-2 (2.01e-3) -	8.5648e-3 (5.87e-4)
DF2	(10,10)	4.5032e-2 (5.38e-3) -	3.2806e-2 (6.64e-3) -	2.7238e-2 (4.23e-3) =	2.3516e-2 (3.17e-3) +	2.3774e-2 (4.36e-3) +	2.8000e-2 (4.24e-3)
DF3	(10,10)	9.5954e-3 (3.38e-4) -	9.2048e-3 (2.98e-4) =	9.4282e-3 (2.72e-4) -	9.8269e-3 (3.55e-4) -	1.0803e-2 (8.13e-4) -	9.1315e-3 (2.26e-4)
DF4	(10,10)	8.3306e-2 (8.80e-4) -	8.2677e-2 (7.17e-4) =	8.1711e-2 (4.75e-4) +	8.1121e-2 (5.20e-4) +	8.1238e-2 (5.43e-4) +	8.2233e-2 (6.42e-4)
DF5	(10,10)	8.4010e-3 (3.65e-4) -	7.5481e-3 (3.48e-4) =	7.3054e-3 (3.17e-4) =	7.4377e-3 (4.86e-4) =	7.5753e-3 (4.89e-4) =	7.3832e-3 (3.69e-4)
DF6	(10,10)	1.9749e+0 (1.37e+0) +	3.8439e+0 (1.23e+0) =	4.4457e+0 (9.91e-1) =	4.5675e+0 (9.37e-1) =	4.7318e+0 (1.15e+0) =	4.3751e+0 (1.29e+0)
DF7	(10,10)	3.7477e-2 (3.09e-2) =	3.6671e-2 (3.10e-2) =	4.6648e-2 (3.02e-2) =	4.0143e-2 (3.10e-2) =	3.7316e-2 (2.68e-2) -	3.2462e-2 (2.52e-2)
DF8	(10,10)	1.3048e-1 (2.04e-3) +	1.3466e-1 (3.38e-3) =	1.3961e-1 (2.64e-3) -	1.4136e-1 (2.07e-3) -	1.4434e-1 (4.18e-3) -	1.3489e-1 (1.96e-3)
DF9	(10,10)	2.0919e+0 (4.88e-3) +	2.0971e+0 (8.39e-3) =	2.1044e+0 (1.68e-2) -	2.1162e+0 (2.64e-2) -	2.1162e+0 (2.10e-2) -	2.1035e+0 (1.39e-2)
DF10	(10,10)	1.9140e-1 (1.41e-2) -	1.9114e-1 (1.21e-2) -	1.7966e-1 (2.60e-2) =	1.7211e-1 (2.17e-2) =	2.0778e-1 (5.11e-2) =	1.7818e-1 (1.31e-2)
DF11	(10,10)	7.6617e-2 (3.78e-4) =	7.6764e-2 (5.84e-4) =	7.7097e-2 (7.04e-4) =	7.7805e-2 (6.76e-4) -	7.8228e-2 (1.05e-3) -	7.6530e-2 (4.59e-4)
DF12	(10,10)	2.7847e-1 (1.22e-3) =	2.8098e-1 (1.85e-3) =	2.8404e-1 (1.87e-3) -	2.8985e-1 (3.23e-3) -	3.0397e-1 (1.49e-2) -	2.8165e-1 (1.06e-3)
DF13	(10,10)	3.1946e-1 (3.63e-3) -	3.1384e-1 (4.81e-3) =	3.1326e-1 (3.73e-3) =	3.1326e-1 (3.43e-3) =	3.1453e-1 (4.76e-3) -	3.1187e-1 (3.65e-3)
DF14	(10,10)	5.9129e-2 (5.37e-4) =	5.8974e-2 (8.20e-4) =	5.8861e-2 (4.51e-4) =	5.8780e-2 (4.35e-4) =	5.9249e-2 (8.18e-4) -	5.8681e-2 (4.19e-4)
+/-/=		4/16/8	0/4/24	5/7/16	5/8/15	5/12/11	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.

Table S - VIII. The statistics of the MHV values obtained by VSDPS and different values of control number in static optimization were run 30 times independently on FDA, dMOP, F, and DF test suites when $n_t = 10$, $\tau_t = 10$.

Problem	(n_t, τ_t)	VSDPS-O1	VSDPS-O2	VSDPS-O3	VSDPS-O4	VSDPS-O5	VSDPS
FDA1	(10,10)	7.1366e-1 (6.11e-4) -	7.1481e-1 (3.71e-4) -	7.1422e-1 (3.83e-4) -	7.1446e-1 (4.57e-4) -	7.1425e-1 (6.07e-4) -	7.1507e-1 (5.57e-4)
FDA2	(10,10)	5.2790e-1 (1.34e-4) -	5.2820e-1 (1.44e-4) =	5.2831e-1 (1.62e-4) =	5.2829e-1 (1.50e-4) =	5.2720e-1 (2.15e-4) -	5.2831e-1 (2.07e-4)
FDA3	(10,10)	5.4159e-1 (1.59e-3) -	5.4669e-1 (3.16e-3) =	5.4268e-1 (2.50e-3) -	5.4313e-1 (2.26e-3) -	5.5112e-1 (3.32e-3) +	5.4713e-1 (2.10e-3)
FDA4	(10,10)	5.0755e-1 (2.61e-3) -	5.1139e-1 (3.39e-3) =	5.1417e-1 (2.80e-3) =	5.1494e-1 (2.96e-3) +	5.0486e-1 (3.12e-3) -	5.1290e-1 (2.60e-3)
FDA5	(10,10)	4.9038e-1 (5.55e-3) -	5.0265e-1 (5.20e-3) =	5.0903e-1 (2.56e-3) +	5.0969e-1 (2.95e-3) +	5.0680e-1 (1.05e-2) +	5.0534e-1 (2.98e-3)
DMOP1	(10,10)	5.2376e-1 (2.60e-4) -	5.2486e-1 (4.65e-4) -	5.2455e-1 (2.31e-4) -	5.2593e-1 (1.72e-4) +	5.2607e-1 (4.86e-4) +	5.2515e-1 (1.68e-4)
DMOP2	(10,10)	5.1803e-1 (9.08e-4) -	5.1940e-1 (9.65e-4) =	5.2021e-1 (5.46e-4) +	5.1002e-1 (9.53e-4) -	5.1967e-1 (1.38e-3) =	5.1965e-1 (6.09e-4)
DMOP3	(10,10)	7.1404e-1 (3.95e-4) +	7.1406e-1 (4.29e-4) =	7.1358e-1 (6.58e-4) =	7.1255e-1 (9.74e-4) -	7.1098e-1 (2.56e-3) -	7.1392e-1 (6.75e-4)
F5	(10,10)	2.6812e-1 (1.13e-2) -	2.9226e-1 (1.16e-2) =	2.9165e-1 (6.36e-3) -	3.0520e-1 (8.33e-3) +	3.0326e-1 (7.80e-3) +	2.9671e-1 (7.66e-3)
F6	(10,10)	2.4661e-1 (5.71e-3) -	2.5277e-1 (3.93e-3) -	2.5697e-1 (2.16e-3) +	2.5657e-1 (2.64e-3) =	2.5669e-1 (2.93e-3) +	2.5565e-1 (2.17e-3)
F7	(10,10)	2.1963e-1 (1.64e-3) -	4.5659e-1 (1.17e-1) -	4.5826e-1 (1.18e-1) =	4.5950e-1 (1.18e-1) =	4.5699e-1 (1.17e-1) -	5.1605e-1 (1.38e-3)
F8	(10,10)	4.8635e-1 (3.30e-3) -	4.8647e-1 (2.62e-3) =	4.8682e-1 (3.41e-3) =	4.8453e-1 (4.56e-3) =	4.7980e-1 (5.44e-3) -	4.8681e-1 (2.17e-3)
F9	(10,10)	3.1910e-1 (1.64e-2) -	3.3038e-1 (2.83e-2) =	3.4024e-1 (1.51e-2) =	3.3603e-1 (1.80e-2) =	3.4079e-1 (2.15e-2) =	3.3153e-1 (2.50e-2)
F10	(10,10)	2.1326e-1 (1.63e-2) -	2.4035e-1 (1.37e-2) -	2.5608e-1 (1.22e-2) +	2.5496e-1 (6.73e-3) =	2.4407e-1 (1.15e-2) -	2.4870e-1 (1.03e-2)
DF1	(10,10)	5.1864e-1 (8.84e-4) =	5.1848e-1 (6.70e-4) =	5.1804e-1 (1.19e-3) =	5.1677e-1 (1.65e-3) -	5.1512e-1 (2.95e-3) -	5.1868e-1 (9.74e-4)
DF2	(10,10)	6.6739e-1 (3.86e-3) -	6.7984e-1 (7.24e-3) -	6.8691e-1 (4.07e-3) =	6.9118e-1 (3.25e-3) +	6.9090e-1 (4.48e-3) +	6.8578e-1 (4.36e-3)
DF3	(10,10)	4.8389e-1 (5.88e-4) -	4.8458e-1 (5.93e-4) =	4.8339e-1 (5.01e-4) -	4.8355e-1 (6.65e-4) -	4.8198e-1 (1.36e-3) -	4.8466e-1 (4.34e-4)
DF4	(10,10)	2.8393e-1 (7.99e-5) -	2.8430e-1 (1.38e-4) -	2.8455e-1 (6.61e-5) +	2.8470e-1 (5.29e-5) +	2.8471e-1 (1.38e-4) +	2.8441e-1 (6.55e-5)
DF5	(10,10)	1.2697e-1 (3.24e-4) -	1.2728e-1 (2.64e-4) =	1.2719e-1 (2.95e-4) =	1.2696e-1 (4.36e-4) -	1.2679e-1 (4.54e-4) -	1.2728e-1 (3.16e-4)
DF6	(10,10)	4.0810e-1 (1.57e-1) +	2.3565e-1 (1.19e-1) =	1.7811e-1 (6.48e-2) -	2.4047e-1 (8.55e-2) =	2.2632e-1 (8.70e-2) =	2.1134e-1 (1.07e-1)
DF7	(10,10)	1.5017e-1 (3.41e-3) =	1.5028e-1 (3.47e-3) =	1.4907e-1 (3.47e-3) =	1.4973e-1 (3.63e-3) =	1.4994e-1 (3.14e-3) =	1.5069e-1 (2.90e-3)
DF8	(10,10)	8.0874e-2 (8.95e-5) +	8.0682e-2 (2.01e-4) =	8.0439e-2 (1.54e-4) -	8.0294e-2 (1.16e-4) -	8.0167e-2 (2.19e-4) -	8.0653e-2 (1.22e-4)
DF9	(10,10)	3.1960e-2 (1.51e-3) =	3.1355e-2 (2.13e-3) =	2.9453e-2 (5.20e-3) -	2.8134e-2 (5.78e-3) -	2.8849e-2 (5.47e-3) -	3.1362e-2 (4.08e-3)
DF10	(10,10)	5.3418e-1 (1.55e-2) -	5.4242e-1 (3.11e-2) -	5.9050e-1 (3.21e-2) +	6.0323e-1 (2.87e-2) +	5.9402e-1 (2.46e-2) =	5.7489e-1 (2.67e-2)
DF11	(10,10)	2.8768e-1 (5.24e-4) -	2.8842e-1 (5.81e-4) =	2.8885e-1 (7.26e-4) =	2.8884e-1 (6.93e-4) =	2.8870e-1 (8.25e-4) =	2.8874e-1 (4.52e-4)
DF12	(10,10)	9.0391e-1 (4.60e-4) -	9.0393e-1 (4.06e-4) =	9.0395e-1 (5.22e-4) =	9.0243e-1 (7.90e-4) -	8.9959e-1 (2.68e-3) -	9.0414e-1 (4.86e-4)
DF13	(10,10)	5.2753e-1 (7.95e-3) -	5.5070e-1 (9.35e-3) -	5.4397e-1 (5.24e-3) -	5.5172e-1 (5.96e-3) -	5.7452e-1 (8.10e-3) +	5.5998e-1 (3.94e-3)
DF14	(10,10)	5.7808e-1 (1.06e-3) -	5.8055e-1 (1.87e-3) -	5.8283e-1 (1.36e-3) =	5.8440e-1 (8.32e-4) +	5.8486e-1 (2.11e-3) +	5.8193e-1 (1.02e-3)
+/-/=		3/22/3	0/10/18	6/9/13	8/11/9	9/13/6	

The statistics following (+), (-), and (=) indicate that the algorithm performed better, worse, and similarly compared to VSDPS according to the Wilcoxon rank sum test at a significance level of 0.05.