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## Solving dynamic multi-objective problems using polynomial fitting-based prediction algorithm - Supplementary Material

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### Abstract

Supplementary Material aims to provide the MHV and MSP experimental results for  $n_t, \tau_t = (5, 20)$ ,  $n_t, \tau_t = (10, 10)$  and  $n_t, \tau_t = (10, 20)$ , and Experimental results comparison of different multiobjective optimization algorithms on MHV, MSP

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Table 1. Mean and standard deviation values of MHV obtained by five algorithms for  $(n_t, \tau_t)=(5,20)$

| Fun.                  | $(n_t, \tau_t)$ | MOEA/D-FD                 | TrDMOEA                   | DNSGAA                     | PPS                | PFFA                      |
|-----------------------|-----------------|---------------------------|---------------------------|----------------------------|--------------------|---------------------------|
| DF1                   | (5,20)          | 1.659e+0(7.233e-4)        | 1.637e+0(2.276e-3)        | 1.526e+0(9.569e-3)         | 9.759e-1(7.666e-2) | <b>1.661e+0(2.569e-3)</b> |
|                       | <i>p</i>        | 7.618e-1                  | 6.353e-1                  | 1.518e-3                   | 2.922e-9           | -                         |
|                       | <i>h</i>        | 0                         | 0                         | 1                          | 1                  | -                         |
| DF2                   | (5,20)          | 1.892e+0(8.087e-4)        | <b>1.904e+0(8.154e-5)</b> | 1.822e+0(7.518e-3)         | 1.390e+0(8.652e-2) | 1.765e+0(9.300e-3)        |
|                       | <i>p</i>        | 2.195e-8                  | 1.329e-10                 | 9.049e-2                   | 3.157e-5           | -                         |
|                       | <i>h</i>        | 1                         | 1                         | 0                          | 1                  | -                         |
| DF3                   | (5,20)          | 1.522e+0(2.334e-2)        | 1.537e+0(5.905e-3)        | 1.065e+0(3.369e-2)         | 1.256e+0(2.644e-1) | <b>1.547e+0(1.830e-1)</b> |
|                       | <i>p</i>        | 1.761e-1                  | 5.733e-2                  | 1.492e-6                   | 6.765e-5           | -                         |
|                       | <i>h</i>        | 0                         | 0                         | 1                          | 1                  | -                         |
| DF4                   | (5,20)          | 7.408e+0(7.686e-3)        | 7.183e+0(5.905e-3)        | 7.442e+0(1.607e-2)         | 7.177e+0(6.985e-2) | <b>7.600e+0(1.058e-2)</b> |
|                       | <i>p</i>        | 6.735e-1                  | 5.592e-1                  | 6.952e-1                   | 5.395e-1           | -                         |
|                       | <i>h</i>        | 0                         | 0                         | 0                          | 0                  | -                         |
| DF5                   | (5,20)          | 1.716e+0(5.630e-4)        | <b>1.741e+0(4.824e-3)</b> | 1.596e+0(1.041e-2)         | 1.055e+0(1.321e-1) | 1.729e+0(1.917e-3)        |
|                       | <i>p</i>        | 3.592e-5                  | 6.8658e-7                 | 2.154e-6                   | 1.777e-10          | -                         |
|                       | <i>h</i>        | 1                         | 1                         | 1                          | 1                  | -                         |
| DF6                   | (5,20)          | <b>1.296e+0(5.173e-2)</b> | 9.580e-1(2.451e-1)        | 6.284e-1(2.814e-2)         | 3.437e-2(3.222e-2) | 1.241e+0(1.030e-2)        |
|                       | <i>p</i>        | 9.941e-1                  | 1.496e-1                  | 7.377e-3                   | 9.840e-8           | -                         |
|                       | <i>h</i>        | 0                         | 0                         | 1                          | 1                  | -                         |
| DF7                   | (5,20)          | 3.376e+0(1.475e-2)        | 3.412e+0(9.481e-3)        | 2.807e+0(1.005e-1)         | 3.271e+0(5.757e-2) | <b>3.467e+0(3.265e-3)</b> |
|                       | <i>p</i>        | 2.052e-3                  | 2.009e-1                  | 3.825e-9                   | 2.157e-3           | -                         |
|                       | <i>h</i>        | 1                         | 0                         | 1                          | 1                  | -                         |
| DF8                   | (5,20)          | 1.776e+0(7.908e-4)        | 1.728e+0(5.059e-4)        | 1.784e+0(6.014e-3)         | 1.761e+0(4.778e-3) | <b>1.789e+0(5.550e-4)</b> |
|                       | <i>p</i>        | 1.765e-2                  | 5.522e-4                  | 4.553e-1                   | 3.778e-2           | -                         |
|                       | <i>h</i>        | 1                         | 1                         | 0                          | 1                  | -                         |
| DF9                   | (5,20)          | 1.555e+0(2.818e-2)        | <b>1.626e+0(7.786e-3)</b> | 1.077e+0(3.590e-2)         | 8.214e-1(1.029e-1) | 1.523e+0(1.131e-2)        |
|                       | <i>p</i>        | 1.453e-1                  | 2.660e-4                  | 3.646e-8                   | 2.610e-10          | -                         |
|                       | <i>h</i>        | 0                         | 1                         | 1                          | 1                  | -                         |
| DF10                  | (5,20)          | 1.357e+0(9.566e-3)        | 1.370e+0(2.002e-2)        | <b>1.5134e+0(5.077e-3)</b> | 1.067e+0(3.106e-2) | 1.372e+0(1.266e-2)        |
|                       | <i>p</i>        | 6.204e-1                  | 5.569e-3                  | 6.145e-2                   | 4.686e-8           | -                         |
|                       | <i>h</i>        | 0                         | 1                         | 1                          | 1                  | -                         |
| DF11                  | (5,20)          | 2.960e-1(1.461e-3)        | <b>8.041e-1(5.668e-2)</b> | 3.565e-1(1.151e-3)         | 3.386e-1(4.894e-3) | 3.562e-1(2.538e-3)        |
|                       | <i>p</i>        | 1.488e-1                  | 1.324e-4                  | 6.204e-2                   | 6.100e-1           | -                         |
|                       | <i>h</i>        | 0                         | 1                         | 0                          | 0                  | -                         |
| DF12                  | (5,20)          | 3.262e+0(3.577e-2)        | <b>3.561e+0(1.336e-3)</b> | 3.267e+0(3.615e-2)         | 3.084e+0(3.766e-2) | 3.375e+0(1.062e-2)        |
|                       | <i>p</i>        | 8.534e-1                  | 1.096e-5                  | 4.733e-1                   | 1.041e-4           | -                         |
|                       | <i>h</i>        | 0                         | 1                         | 0                          | 1                  | -                         |
| DF13                  | (5,20)          | 6.736e+0(1.178e-2)        | 7.080e+0(3.604e-2)        | 6.145e+0(1.420e-1)         | 5.536e+0(2.734e-1) | <b>7.176e+0(3.304e-2)</b> |
|                       | <i>p</i>        | 8.564e-4                  | 3.042e-1                  | 3.006e-4                   | 8.352e-8           | -                         |
|                       | <i>h</i>        | 1                         | 0                         | 1                          | 1                  | -                         |
| DF14                  | (5,20)          | 9.132e-1(4.500e-3)        | 1.015e+0(1.136e-2)        | 9.225e-1(7.429e-2)         | 8.826e-1(3.799e-2) | <b>1.073e+0(2.083e-3)</b> |
|                       | <i>p</i>        | 1.087e-1                  | 7.394e-1                  | 1.154e-1                   | 3.032e-2           | -                         |
|                       | <i>h</i>        | 0                         | 0                         | 0                          | 1                  | -                         |
| $\ddagger/\ddagger/t$ |                 | 5/1/8                     | 2/5/7                     | 9/1/4                      | 12/0/2             | -                         |

Table 2. Mean and standard deviation values of MHV obtained by five algorithms for  $(n_t, \tau_t)=(10,10)$

| Fun.                  | $(n_t, \tau_t)$ | MOEA/D-FD                 | TrDMOEA                   | DNSGAA              | PPS                | PFFA                      |
|-----------------------|-----------------|---------------------------|---------------------------|---------------------|--------------------|---------------------------|
| DF1                   | (10,10)         | 1.661e+0(3.713e-4)        | 1.664e+0(1.427e-1)        | 1.530e+0(1.111e-2)  | 9.604e-1(7.314e-2) | <b>1.669e+0(1.209e-3)</b> |
|                       | $p$             | 1.857e-9                  | 4.075e-11                 | 2.879e-6            | 1.174e-9           | -                         |
|                       | $h$             | 1                         | 1                         | 1                   | 1                  | -                         |
| DF2                   | (10,10)         | 1.892e+0(5.494e-4)        | <b>1.900e+0(1.105e-3)</b> | 1.822e+0(8.5958e-3) | 1.423e+0(8.355e-2) | 1.775e+0(1.688e-2)        |
|                       | $p$             | 2.610e-10                 | 6.066e-11                 | 3.0811e-8           | 2.572e-7           | -                         |
|                       | $h$             | 1                         | 1                         | 1                   | 1                  | -                         |
| DF3                   | (10,10)         | 1.559e+0(1.185e-2)        | 1.611e+0(4.851e-2)        | 1.066e+0(2.988e-2)  | 1.321e+0(2.166e-1) | <b>1.621e+0(8.150e-3)</b> |
|                       | $p$             | 8.147e-5                  | 3.368e-5                  | 1.518e-3            | 1.430e-5           | -                         |
|                       | $h$             | 1                         | 1                         | 1                   | 1                  | -                         |
| DF4                   | (10,10)         | 7.400e+0(3.674e-3)        | 7.528e+0(5.462e-1)        | 7.418e+0(1.603e-2)  | 7.230e+0(7.289e-2) | <b>7.588e+0(9.504e-3)</b> |
|                       | $p$             | 9.470e-1                  | 1.858e-1                  | 8.187e-1            | 5.106e-1           | -                         |
|                       | $h$             | 0                         | 0                         | 0                   | 0                  | -                         |
| DF5                   | (10,10)         | 1.720e+0(4.886e-4)        | <b>1.753e+0(1.809e-2)</b> | 1.642e+0(8.940e-3)  | 1.067e+0(1.035e-1) | 1.735e+0(2.456e-3)        |
|                       | $p$             | 5.072e-10                 | 6.466e-11                 | 1.596e-7            | 6.696e-11          | -                         |
|                       | $h$             | 1                         | 1                         | 1                   | 1                  | -                         |
| DF6                   | (10,10)         | <b>1.231e+0(8.906e-3)</b> | 1.115e+0(7.465e-2)        | 5.254e-1(3.128e-2)  | 2.707e-2(2.205e-2) | 1.209e+0(6.852e-3)        |
|                       | $p$             | 1.641e-7                  | 4.969e-9                  | 2.060e-2            | 1.931e-7           | -                         |
|                       | $h$             | 1                         | 1                         | 1                   | 1                  | -                         |
| DF7                   | (10,10)         | 3.374e+0(1.306e-2)        | 3.426e+0(1.283e-2)        | 9.185e-1(1.466e-1)  | 3.283e+0(5.049e-2) | <b>3.466e+0(1.888e-3)</b> |
|                       | $p$             | 6.843e-1                  | 1.120e-1                  | 1.529e-5            | 8.315e-3           | -                         |
|                       | $h$             | 0                         | 0                         | 1                   | 1                  | -                         |
| DF8                   | (10,10)         | 1.774e-2(5.440e-4)        | 1.735e+0(1.954e-2)        | 1.774e+0(1.075e-3)  | 1.750e+0(6.110e-3) | <b>1.783e+0(3.019e-3)</b> |
|                       | $p$             | 8.650e-1                  | 3.207e-7                  | 4.035e-1            | 2.707e-1           | -                         |
|                       | $h$             | 0                         | 1                         | 0                   | 0                  | -                         |
| DF9                   | (10,10)         | 1.548e+0(2.561e-2)        | <b>1.645e+0(4.368e-2)</b> | 1.102e+0(4.769e-2)  | 8.946e-1(1.307e-1) | 1.582e+0(1.071e-2)        |
|                       | $p$             | 8.101e-10                 | 8.516e-11                 | 8.684e-3            | 4.504e-11          | -                         |
|                       | $h$             | 1                         | 1                         | 1                   | 1                  | -                         |
| DF10                  | (10,10)         | 1.358e+0(1.102e-2)        | <b>1.908e+0(1.365e-3)</b> | 1.513e+0(7.707e-1)  | 1.087e+0(2.755e-2) | 1.376e+0(1.223e-2)        |
|                       | $p$             | 5.692e-1                  | 4.075e-11                 | 6.787e-1            | 3.497e-9           | -                         |
|                       | $h$             | 0                         | 1                         | 0                   | 1                  | -                         |
| DF11                  | (10,10)         | 3.097e-1(1.089e-3)        | <b>7.456e-1(4.820e-3)</b> | 3.721e-1(1.347e-3)  | 3.514e-1(5.745e-3) | 3.717e-1(2.936e-3)        |
|                       | $p$             | 2.052e-1                  | 3.020e-11                 | 6.309e-1            | 5.395e-1           | -                         |
|                       | $h$             | 0                         | 1                         | 0                   | 0                  | -                         |
| DF12                  | (10,10)         | 3.414e-1(1.211e-2)        | <b>3.560e+0(1.743e-5)</b> | 3.447e+0(2.034e-2)  | 3.200e+0(4.098e-2) | 3.464e+0(1.167e-2)        |
|                       | $p$             | 8.418e-1                  | 5.072e-10                 | 7.731e-1            | 2.317e-6           | -                         |
|                       | $h$             | 0                         | 1                         | 0                   | 1                  | -                         |
| DF13                  | (10,10)         | 6.674e+0(9.605e-3)        | 7.044e+0(3.101e-2)        | 6.145e+0(1.294e-1)  | 5.573e+0(2.023e-1) | <b>7.113e+0(3.531e-2)</b> |
|                       | $p$             | 1.114e-3                  | 2.116e-1                  | 9.521e-4            | 5.600e-7           | -                         |
|                       | $h$             | 1                         | 0                         | 1                   | 1                  | -                         |
| DF14                  | (10,10)         | 9.175e-1(7.023e-3)        | <b>1.116e+0(1.702e-2)</b> | 9.399e-11(8.314e-2) | 8.552e-1(4.905e-2) | 1.073e+0(2.216e-3)        |
|                       | $p$             | 9.626e-2                  | 4.344e-11                 | 1.624e-1            | 1.564e-2           | -                         |
|                       | $h$             | 0                         | 0                         | 0                   | 1                  | -                         |
| $\ddagger/\ddagger/l$ |                 | 5/2/7                     | 5/7/2                     | 7/1/6               | 11/0/3             | -                         |

Table 3. Mean and standard deviation values of MHV obtained by five algorithms for  $(n_f, \tau_f)=(10,20)$

| Fun.                 | $(n_f, \tau_f)$ | MOEA/D-FD          | TrDMOEA                   | DNSGAA                    | PPS                | PFFA                      |
|----------------------|-----------------|--------------------|---------------------------|---------------------------|--------------------|---------------------------|
| DF1                  | (10,20)         | 1.585e+0(5.552e-4) | 1.534e+0(2.841e-3)        | 1.541e+0(2.554e-3)        | 1.498e+0(1.010e-1) | <b>1.592e+0(1.625e-3)</b> |
|                      | <i>p</i>        | 9.883e-3           | 9.517e-7                  | 2.377e-7                  | 3.081e-8           | -                         |
|                      | <i>h</i>        | 1                  | 1                         | 1                         | 1                  | -                         |
| DF2                  | (10,20)         | 1.896e+0(3.873e-4) | <b>1.901e+0(4.106e-4)</b> | 1.873e+0(4.244e-3)        | 1.582e+0(8.767e-2) | 1.794e+0(6.612e-3)        |
|                      | <i>p</i>        | 1.302e-3           | 3.081e-8                  | 5.942e-2                  | 4.943e-5           | -                         |
|                      | <i>h</i>        | 1                  | 1                         | 0                         | 1                  | -                         |
| DF3                  | (10,20)         | 1.461e+0(1.215e-2) | <b>1.520e+0(1.832e-2)</b> | 8.248e-1(4.199e-2)        | 1.312e+0(2.375e-1) | 1.455e+0(2.134e-1)        |
|                      | <i>p</i>        | 3.871e-1           | 1.665e-8                  | 3.020e-11                 | 1.010e-8           | -                         |
|                      | <i>h</i>        | 0                  | 1                         | 1                         | 1                  | -                         |
| DF4                  | (10,20)         | 7.850e+0(4.671e-3) | 7.782e+0(2.463e-2)        | 7.894e+0(1.067e-2)        | 7.671e+0(6.295e-2) | <b>7.987e+0(1.219e-2)</b> |
|                      | <i>p</i>        | 8.073e-1           | 8.418e-1                  | 8.303e-1                  | 6.735e-1           | -                         |
|                      | <i>h</i>        | 0                  | 0                         | 1                         | 0                  | -                         |
| DF5                  | (10,20)         | 1.718e+0(4.654e-4) | <b>1.741e+0(2.519e-4)</b> | 1.709e+0(1.148e-3)        | 1.536e+0(4.837e-2) | 1.733e+0(6.715e-4)        |
|                      | <i>p</i>        | 4.639e-5           | 4.118e-6                  | 1.518e-3                  | 2.034e-9           | -                         |
|                      | <i>h</i>        | 1                  | 1                         | 1                         | 1                  | -                         |
| DF6                  | (10,20)         | 1.693e+0(6.972e-3) | 9.867e-1(7.302e-2)        | 1.319e+0(2.038e-2)        | 1.983e-1(1.478e-1) | <b>1.701e+0(1.304e-2)</b> |
|                      | <i>p</i>        | 2.282e-1           | 3.526e-6                  | 4.204e-3                  | 2.331e-8           | -                         |
|                      | <i>h</i>        | 0                  | 1                         | 1                         | 1                  | -                         |
| DF7                  | (10,20)         | 3.295e+0(1.129e-2) | 3.285e+0(3.334e-2)        | 3.004e+0(6.918e-2)        | 3.219e+0(3.223e-2) | <b>3.379e+0(2.634e-3)</b> |
|                      | <i>p</i>        | 4.856e-3           | 1.171e-2                  | 3.081e-8                  | 6.912e-4           | -                         |
|                      | <i>h</i>        | 1                  | 1                         | 1                         | 1                  | -                         |
| DF8                  | (10,20)         | 1.775e+0(7.223e-4) | 1.724e+0(3.578e-3)        | 1.718e+0(6.773e-3)        | 1.760e+0(5.633e-3) | <b>1.786e+0(1.304e-3)</b> |
|                      | <i>p</i>        | 2.226e-1           | 2.530e-4                  | 8.073e-1                  | 3.112e-1           | -                         |
|                      | <i>h</i>        | 0                  | 1                         | 1                         | 0                  | -                         |
| DF9                  | (10,20)         | 1.593e+0(2.881e-2) | <b>1.632e+0(3.032e-2)</b> | 1.335e+0(6.376e-2)        | 1.161e+0(1.610e-1) | 1.600e+0(6.017e-3)        |
|                      | <i>p</i>        | 3.329e-1           | 1.163e-2                  | 1.194e-6                  | 4.616e-10          | -                         |
|                      | <i>h</i>        | 0                  | 1                         | 1                         | 1                  | -                         |
| DF10                 | (10,20)         | 1.676e+0(9.811e-3) | 1.595e+0(4.367e-2)        | <b>1.795e+0(4.964e-3)</b> | 1.606e+0(2.226e-2) | 1.762e+0(8.146e-3)        |
|                      | <i>p</i>        | 5.106e-1           | 3.042e-1                  | 6.414e-1                  | 2.772e-1           | -                         |
|                      | <i>h</i>        | 0                  | 0                         | 0                         | 0                  | -                         |
| DF11                 | (10,20)         | 1.730e-1(6.925e-4) | 8.559e-2(1.093e-2)        | 2.184e-1(2.013e-2)        | 2.013e-1(4.002e-3) | <b>2.108e+0(1.564e-3)</b> |
|                      | <i>p</i>        | 2.051e-3           | 4.086e-7                  | 5.106e-1                  | 4.918e-1           | -                         |
|                      | <i>h</i>        | 1                  | 1                         | 0                         | 0                  | -                         |
| DF12                 | (10,20)         | 3.454e+0(3.233e-2) | <b>3.558e+0(1.486e-3)</b> | 3.445e+0(2.309e-2)        | 3.208e+0(3.708e-2) | 3.472e+0(7.913e-3)        |
|                      | <i>p</i>        | 1.120e-1           | 4.857e-5                  | 5.997e-1                  | 1.167e-5           | -                         |
|                      | <i>h</i>        | 0                  | 1                         | 0                         | 1                  | -                         |
| DF13                 | (10,20)         | 6.847e+0(1.276e-2) | 7.208e+0(5.115e-2)        | <b>7.299e+0(4.584e-2)</b> | 6.398e+0(1.300e-1) | 7.284e+0(2.605e-2)        |
|                      | <i>p</i>        | 8.417e-5           | 5.592e-1                  | 9.117e-1                  | 2.879e-6           | -                         |
|                      | <i>h</i>        | 1                  | 0                         | 0                         | 1                  | -                         |
| DF14                 | (10,20)         | 9.242e-1(8.952e-3) | 1.098e+0(7.441e-3)        | 1.097e+0(6.171e-3)        | 1.015e+0(1.820e-2) | <b>1.100e+0(2.155e-3)</b> |
|                      | <i>p</i>        | 1.327e-2           | 9.352e-1                  | 9.441e-1                  | 2.170e-1           | -                         |
|                      | <i>h</i>        | 1                  | 0                         | 0                         | 0                  | -                         |
| $\ddagger/\dagger/l$ |                 | 6/1/7              | 5/5/4                     | 8/0/6                     | 9/0/5              | -                         |

Table 4. Mean and standard deviation values of MSP obtained by five algorithms for  $(n_t, \tau_t)=(5,20)$

| Fun.                  | $(n_t, \tau_t)$ | MOEA/D-FD                 | TrDMOEA            | DNSGAA                    | PPS                | PFPA                      |
|-----------------------|-----------------|---------------------------|--------------------|---------------------------|--------------------|---------------------------|
| DF1                   | (5,20)          | <b>9.007e-3(1.134e-4)</b> | 1.482e-2(7.141e-3) | 1.151e-2(5.758e-4)        | 1.002e-1(3.494e-2) | 1.101e-2(4.279e-3)        |
|                       | <i>p</i>        | 1.761e-1                  | 3.644e-2           | 3.917e-2                  | 2.154e-10          | -                         |
|                       | <i>h</i>        | 0                         | 1                  | 1                         | 1                  | -                         |
| DF2                   | (5,20)          | <b>1.142e-2(2.119e-4)</b> | 8.111e-2(5.302e-2) | 1.144e-2(1.507e-3)        | 7.540e-2(3.698e-2) | 1.110e-1(3.258e-2)        |
|                       | <i>p</i>        | 3.020e-11                 | 1.087e-1           | 6.956e-11                 | 2.813e-2           | -                         |
|                       | <i>h</i>        | 1                         | 0                  | 1                         | 1                  | -                         |
| DF3                   | (5,20)          | <b>1.180e-2(6.091e-4)</b> | 1.914e-1(5.276e-2) | 1.686e-2(3.526e-3)        | 6.683e-1(4.728e-1) | 3.509e-2(1.264e-2)        |
|                       | <i>p</i>        | 3.020e-11                 | 2.370e-10          | 3.020e-11                 | 2.921e-9           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 1                  | -                         |
| DF4                   | (5,20)          | 8.899e-2(8.435e-3)        | 1.926e-1(1.559e-3) | <b>5.038e-2(1.242e-2)</b> | 2.953e+0(8.708e+0) | 1.270e-1(9.902e-2)        |
|                       | <i>p</i>        | 7.251e-4                  | 1.169e-3           | 2.052e-3                  | 5.570e-3           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 1                  | -                         |
| DF5                   | (5,20)          | <b>1.036e-2(1.994e-4)</b> | 2.973e-2(1.921e-2) | 1.546e-2(1.354e-3)        | 3.986e-1(2.958e-1) | 2.103e-2(6.557e-3)        |
|                       | <i>p</i>        | 1.154e-1                  | 2.753e-1           | 8.418e-1                  | 2.034e-9           | -                         |
|                       | <i>h</i>        | 0                         | 0                  | 0                         | 1                  | -                         |
| DF6                   | (5,20)          | <b>2.009e-1(5.631e-2)</b> | 3.859e+0(1.792e+0) | 4.897e-1(4.314e-2)        | 6.470e+1(4.073e+1) | 2.985e+0(5.189e-1)        |
|                       | <i>p</i>        | 1.174e-9                  | 6.889e-4           | 1.254e-7                  | 1.492e-6           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 1                  | -                         |
| DF7                   | (5,20)          | 2.961e-2(1.732e-3)        | 1.372e+3(5.626e+1) | 2.109e-2(1.237e-2)        | 2.068e-2(3.954e-3) | <b>7.292e-3(2.453e-4)</b> |
|                       | <i>p</i>        | 3.020e-11                 | 4.504e-11          | 4.975e-11                 | 1.206e-10          | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 1                  | -                         |
| DF8                   | (5,20)          | 1.730e-2(7.035e-4)        | 6.123e-2(4.043e-2) | 1.583e-2(5.138e-3)        | 7.443e-2(2.676e-2) | <b>1.215e-2(4.424e-3)</b> |
|                       | <i>p</i>        | 1.003e-3                  | 9.941e-1           | 6.669e-3                  | 1.861e-6           | -                         |
|                       | <i>h</i>        | 1                         | 0                  | 1                         | 1                  | -                         |
| DF9                   | (5,20)          | <b>1.156e-2(1.397e-3)</b> | 2.522e-1(8.904e-2) | 5.082e-2(8.492e-3)        | 8.843e-1(4.800e-1) | 1.845e-1(4.600e-2)        |
|                       | <i>p</i>        | 4.077e-11                 | 1.072e-2           | 7.088e-8                  | 8.841e-7           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 1                  | -                         |
| DF10                  | (5,20)          | <b>3.024e-2(1.648e-2)</b> | 3.644e-1(1.845e-1) | 8.129e-2(1.049e-2)        | 7.955e-1(2.165e-1) | 1.020e+0(1.202e-1)        |
|                       | <i>p</i>        | 3.020e-11                 | 4.351e-11          | 3.020e-11                 | 2.597e-5           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 1                  | -                         |
| DF11                  | (5,20)          | <b>2.413e-2(4.173e-4)</b> | 7.066e-2(1.358e-2) | 5.316e-2(1.051e-3)        | 5.470e-2(4.152e-3) | 5.135e-2(2.358e-3)        |
|                       | <i>p</i>        | 3.020e-11                 | 5.909e-9           | 3.368e-4                  | 8.418e-1           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 0                  | -                         |
| DF12                  | (5,20)          | <b>1.874e-2(8.696e-3)</b> | 3.253e-1(9.878e-3) | 9.812e-2(1.325e-2)        | 7.505e-1(1.077e-1) | 6.183e-1(2.639e-2)        |
|                       | <i>p</i>        | 3.020e-11                 | 1.558e-8           | 3.020e-11                 | 7.245e-2           | -                         |
|                       | <i>h</i>        | 1                         | 1                  | 1                         | 0                  | -                         |
| DF13                  | (5,20)          | <b>1.562e-1(4.104e-3)</b> | 3.645e-1(1.788e-1) | 1.624e-1(9.435e-3)        | 2.587e+0(7.769e-1) | 9.345e-1(3.328e-2)        |
|                       | <i>p</i>        | 3.183e-3                  | 5.493e-1           | 1.766e-3                  | 1.249e-5           | -                         |
|                       | <i>h</i>        | 1                         | 0                  | 1                         | 1                  | -                         |
| DF14                  | (5,20)          | <b>1.658e-2(5.116e-4)</b> | 3.095e-1(5.030e-2) | 9.323e-2(5.728e-2)        | 3.700e-1(1.458e-1) | 6.532e-1(1.450e-2)        |
|                       | <i>p</i>        | 3.020e-11                 | 3.225e-1           | 3.646e-8                  | 3.255e-1           | -                         |
|                       | <i>h</i>        | 1                         | 0                  | 1                         | 0                  | -                         |
| $\ddagger/\ddagger/l$ |                 | 2/10/2                    | 8/1/5              | 5/8/1                     | 9/2/3              | -                         |

Table 5. Mean and standard deviation values of MSP obtained by five algorithms for  $(n_r, \tau_r)=(10,10)$

| Fun.                  | $(n_r, \tau_r)$ | MOEA/D-FD                 | TrDMOEA            | DNSGAA                    | PPS                | PFFA                      |
|-----------------------|-----------------|---------------------------|--------------------|---------------------------|--------------------|---------------------------|
| DF1                   | (10,10)         | 8.153e-3(1.007e-4)        | 1.155e-2(6.465e-3) | 1.119e-2(5.224e-4)        | 1.110e-1(3.643e-2) | <b>6.473e-3(1.323e-3)</b> |
|                       | $p$             | 3.020e-11                 | 1.410e-9           | 6.695e-11                 | 7.389e-11          | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF2                   | (10,10)         | <b>1.157e-2(2.434e-4)</b> | 9.109e-2(1.584e-2) | 1.105e-2(1.057e-3)        | 7.791e-2(2.159e-2) | 2.823e+0(4.096e+0)        |
|                       | $p$             | 3.020e-11                 | 1.453e-1           | 3.020e-11                 | 1.120e-1           | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 0                  | -                         |
| DF3                   | (10,10)         | 1.488e-2(4.903e-4)        | 1.934e-1(1.176e-1) | <b>1.388e-2(2.668e-3)</b> | 5.324e-1(3.303e-1) | 1.954e-2(1.400e-2)        |
|                       | $p$             | 3.020e-11                 | 1.302e-3           | 3.020e-11                 | 8.153e-11          | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF4                   | (10,10)         | 9.628e-2(9.741e-3)        | 2.801e-1(2.005e-2) | 5.425e-2(1.655e-2)        | 6.327e-1(2.152e+0) | <b>3.969e-2(1.431e-2)</b> |
|                       | $p$             | 9.049e-2                  | 2.283e-2           | 6.627e-1                  | 1.681e-4           | -                         |
|                       | $h$             | 0                         | 1                  | 0                         | 1                  | -                         |
| DF5                   | (10,10)         | 1.015e-2(1.539e-4)        | 2.073e-1(1.432e-1) | 1.419e-2(2.932e-3)        | 3.102e-1(1.535e-1) | <b>7.777e-3(3.608e-3)</b> |
|                       | $p$             | 3.020e-11                 | 3.097e-1           | 2.610e-10                 | 1.329e-10          | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 1                  | -                         |
| DF6                   | (10,10)         | <b>1.569e-1(2.206e-2)</b> | 3.678e+0(3.714e-1) | 5.331e-1(3.932e-2)        | 7.450e+1(3.365e+1) | 2.192e+0(2.897e-1)        |
|                       | $p$             | 3.690e-11                 | 3.010e-7           | 1.777e-10                 | 5.106e-1           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 0                  | -                         |
| DF7                   | (10,10)         | 2.810e-2(7.358e-4)        | 1.906e+2(1.134e+1) | 2.251e-2(7.525e-3)        | 1.812e-2(2.106e-3) | <b>7.677e-3(1.835e-4)</b> |
|                       | $p$             | 3.564e-4                  | 4.616e-10          | 9.883e-3                  | 6.121e-10          | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF8                   | (10,10)         | 1.951e-2(8.917e-3)        | 1.360e-1(1.541e-1) | 1.595e-2(5.023e-3)        | 9.125e-2(3.940e-2) | <b>1.590e-2(3.841e-3)</b> |
|                       | $p$             | 7.221e-6                  | 1.759e-1           | 1.385e-6                  | 2.597e-5           | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 1                  | -                         |
| DF9                   | (10,10)         | <b>1.168e-2(1.170e-3)</b> | 4.862e-1(1.173e-1) | 4.980e-2(7.482e-3)        | 6.686e-1(3.574e-1) | 2.530e-1(1.278e-1)        |
|                       | $p$             | 3.020e-11                 | 3.790e-1           | 3.020e-11                 | 1.606e-6           | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 1                  | -                         |
| DF10                  | (10,10)         | <b>3.947e-2(2.235e-2)</b> | 3.057e-1(1.941e-2) | 8.301e-2(1.473e-2)        | 9.253e-1(2.448e-1) | 1.022e+0(1.132e-1)        |
|                       | $p$             | 3.020e-11                 | 3.018e-11          | 3.020e-11                 | 1.076e-2           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF11                  | (10,10)         | <b>2.395e-2(3.900e-4)</b> | 1.288e-1(1.769e-2) | 5.336e-2(1.217e-3)        | 5.418e-2(3.689e-3) | 5.149e-2(2.198e-3)        |
|                       | $p$             | 3.020e-11                 | 1.236e-3           | 3.770e-4                  | 6.309e-1           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 0                  | -                         |
| DF12                  | (10,10)         | <b>1.097e-2(6.747e-3)</b> | 4.197e-1(7.550e-2) | 8.986e-2(1.302e-2)        | 7.576e-1(1.038e-1) | 6.401e-1(2.961e-2)        |
|                       | $p$             | 3.020e-11                 | 6.121e-10          | 3.020e-11                 | 5.188e-2           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 0                  | -                         |
| DF13                  | (10,10)         | <b>1.507e-1(3.759e-3)</b> | 5.447e-1(1.341e-1) | 1.579e-1(9.422e-3)        | 2.267e+0(9.289e-1) | 8.896e-1(3.264e-2)        |
|                       | $p$             | 2.254e-4                  | 1.461e-5           | 1.114e-3                  | 4.353e-5           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF14                  | (10,10)         | <b>1.634e-1(4.688e-4)</b> | 4.563e-1(1.826e-1) | 8.831e-2(5.312e-2)        | 3.328e-1(1.062e-1) | 6.249e-1(1.581e-2)        |
|                       | $p$             | 3.020e-11                 | 3.741e-3           | 1.558e-8                  | 2.398e-1           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 0                  | -                         |
| $\ddagger/\ddagger/l$ |                 | 4/9/1                     | 6/5/3              | 5/5/4                     | 8/1/5              | -                         |

Table 6. Mean and standard deviation values of MSP obtained by five algorithms for  $(n_r, \tau_r)=(10,20)$

| Fun.                  | $(n_r, \tau_r)$ | MOEA/D-FD                 | TrDMOEA            | DNSGAA                    | PPS                | PFFA                      |
|-----------------------|-----------------|---------------------------|--------------------|---------------------------|--------------------|---------------------------|
| DF1                   | (10,20)         | 8.483e-3(1.011e-4)        | 3.311e-2(1.079e-2) | 7.669e-3(5.291e-4)        | 6.887e-2(2.043e-2) | <b>5.873e-3(2.333e-3)</b> |
|                       | $p$             | 2.879e-6                  | 5.367e-4           | 4.033e-3                  | 4.616e-10          | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF2                   | (10,20)         | 1.110e-2(2.392e-4)        | 2.654e-2(2.991e-3) | <b>7.524e-3(9.557e-3)</b> | 7.160e-2(3.515e-2) | 1.807e-1(3.082e-2)        |
|                       | $p$             | 4.975e-11                 | 1.359e-7           | 6.066e-11                 | 9.521e-4           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF3                   | (10,20)         | 1.166e-2(4.839e-4)        | 4.869e-2(4.307e-2) | <b>5.923e-3(1.695e-4)</b> | 3.768e-1(2.157e-1) | 1.682e-2(5.318e-2)        |
|                       | $p$             | 3.020e-11                 | 3.601e-11          | 3.020e-11                 | 9.756e-10          | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF4                   | (10,20)         | 1.207e-1(8.165e-3)        | 3.124e-1(1.519e-1) | 6.390e-2(2.094e-2)        | 2.843e+0(5.168e+0) | <b>3.560e-2(1.314e-2)</b> |
|                       | $p$             | 1.850e-8                  | 4.625e-2           | 1.596e-7                  | 1.248e-4           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF5                   | (10,20)         | 9.809e-3(1.202e-4)        | 4.026e-2(1.164e-2) | <b>7.676e-3(2.112e-4)</b> | 1.012e-1(5.111e-2) | 8.957e-3(4.785e-3)        |
|                       | $p$             | 3.368e-4                  | 4.035e-1           | 2.282e-1                  | 6.722e-10          | -                         |
|                       | $h$             | 1                         | 0                  | 0                         | 1                  | -                         |
| DF6                   | (10,20)         | <b>1.174e-1(2.998e-2)</b> | 4.886e+0(2.724e-1) | 2.069e-1(2.568e-2)        | 4.765e+1(2.884e+1) | 1.966e+0(3.708e-1)        |
|                       | $p$             | 2.372e-10                 | 5.841e-6           | 4.573e-9                  | 1.174e-9           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF7                   | (10,20)         | 1.865e-2(1.285e-3)        | 1.164e+3(1.147e+3) | 2.396e-2(9.059e-3)        | 1.673e-2(1.982e-3) | <b>6.685e-3(1.735e-4)</b> |
|                       | $p$             | 3.020e-11                 | 3.338e-11          | 3.020e-11                 | 1.311e-8           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF8                   | (10,20)         | 1.848e-2(1.100e-3)        | 7.476e-2(3.271e-2) | 1.590e-2(6.186e-3)        | 1.015e-1(5.671e-2) | <b>1.572e-2(6.289e-3)</b> |
|                       | $p$             | 5.012e-2                  | 1.174e-4           | 6.787e-2                  | 7.119e-9           | -                         |
|                       | $h$             | 0                         | 1                  | 0                         | 1                  | -                         |
| DF9                   | (10,20)         | <b>1.054e-2(8.937e-4)</b> | 2.816e-1(8.860e-2) | 4.097e-2(1.159e-2)        | 3.955e-1(1.687e-1) | 2.799e-1(1.714e-1)        |
|                       | $p$             | 3.690e-11                 | 1.297e-1           | 5.186e-7                  | 2.921e-2           | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 1                  | -                         |
| DF10                  | (10,20)         | <b>4.028e-2(1.551e-2)</b> | 3.042e-1(1.883e-2) | 9.307e-2(1.170e-2)        | 1.060e+0(2.206e-1) | 1.079e+0(6.657e-2)        |
|                       | $p$             | 3.020e-11                 | 4.351e-11          | 3.020e-11                 | 2.597e-5           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 1                  | -                         |
| DF11                  | (10,20)         | <b>2.347e-2(4.776e-4)</b> | 6.834e-2(1.956e-3) | 5.007e-2(1.142e-3)        | 4.900e-2(2.209e-3) | 5.019e-2(2.510e-3)        |
|                       | $p$             | 3.020e-11                 | 5.909e-9           | 3.368e-4                  | 8.418e-1           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 0                  | -                         |
| DF12                  | (10,20)         | <b>1.878e-2(1.032e-2)</b> | 2.425e-1(5.327e-2) | 8.364e-2(1.080e-2)        | 7.050e-1(1.003e-1) | 5.849e-1(1.542e-2)        |
|                       | $p$             | 3.020e-11                 | 1.558e-8           | 3.020e-11                 | 7.244e-2           | -                         |
|                       | $h$             | 1                         | 1                  | 1                         | 0                  | -                         |
| DF13                  | (10,20)         | 1.661e-1(3.742e-3)        | 4.874e-1(4.391e-2) | <b>1.116e-1(3.898e-3)</b> | 1.110e+0(3.715e-1) | 1.925e-1(2.277e-2)        |
|                       | $p$             | 3.183e-3                  | 5.493e-1           | 1.766e-3                  | 1.249e-5           | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 1                  | -                         |
| DF14                  | (10,20)         | <b>1.819e-2(5.114e-4)</b> | 2.086e-1(4.616e-2) | 4.395e-2(1.197e-2)        | 1.491e-1(3.352e-2) | 3.645e-1(1.378e-2)        |
|                       | $p$             | 3.020e-11                 | 3.225e-1           | 3.646e-8                  | 3.255e-1           | -                         |
|                       | $h$             | 1                         | 0                  | 1                         | 0                  | -                         |
| $\ddagger/\ddagger/l$ |                 | 4/9/1                     | 7/3/4              | 3/9/2                     | 9/2/3              | -                         |

Table 7. Experimental results comparison of different multiobjective optimization algorithms on MHV for  $(n_t, \tau_t)=(10,10)$

| Fun. | $(n_t, \tau_t)$       | MOMVO                     | MOALO              | MOGOA              | PFFPA                     |
|------|-----------------------|---------------------------|--------------------|--------------------|---------------------------|
| DF1  | (10,10)               | 1.647e+0(2.384e-3)        | 1.572e+0(9.218e-3) | 1.556e+0(1.419e-2) | <b>1.669e+0(1.209e-3)</b> |
|      | <i>p</i>              | 5.188e-2                  | 4.982e-4           | 9.031e-4           | -                         |
|      | <i>h</i>              | 0                         | 1                  | 1                  | -                         |
| DF2  | (10,10)               | 1.683e+0(1.435e-2)        | 1.398e+0(3.983e-2) | 1.456e+0(2.049e-2) | <b>1.775e+0(1.688e-2)</b> |
|      | <i>p</i>              | 2.531e-4                  | 2.610e-10          | 8.101e-10          | -                         |
|      | <i>h</i>              | 1                         | 1                  | 1                  | -                         |
| DF3  | (10,10)               | 1.475e+0(3.934e-2)        | 1.473e+0(1.990e-2) | 1.443e+0(2.119e-2) | <b>1.621e+0(8.150e-3)</b> |
|      | <i>p</i>              | 4.714e-4                  | 7.697e-4           | 1.114e-3           | -                         |
|      | <i>h</i>              | 1                         | 1                  | 1                  | -                         |
| DF4  | (10,10)               | 7.253e+0(2.398e-2)        | 6.613e+0(1.056e-1) | 6.785e+0(1.086e-1) | <b>7.588e+0(9.504e-3)</b> |
|      | <i>p</i>              | 5.395e-1                  | 2.838e-1           | 3.711e-1           | -                         |
|      | <i>h</i>              | 0                         | 0                  | 0                  | -                         |
| DF5  | (10,10)               | 1.728e+0(8.110e-4)        | 1.659e+0(9.534e-3) | 1.660e+0(8.226e-3) | <b>1.735e+0(2.456e-3)</b> |
|      | <i>p</i>              | 4.427e-3                  | 6.010e-8           | 1.254e-7           | -                         |
|      | <i>h</i>              | 1                         | 1                  | 1                  | -                         |
| DF6  | (10,10)               | 1.144e+0(2.130e-2)        | 1.019e+0(3.139e-2) | 1.065e+0(2.146e-2) | <b>1.209e+0(6.852e-3)</b> |
|      | <i>p</i>              | 7.502e-1                  | 3.231e-1           | 4.812e-1           | -                         |
|      | <i>h</i>              | 0                         | 0                  | 0                  | -                         |
| DF7  | (10,10)               | 3.338e+0(1.208e-2)        | 3.337e+0(1.724e-2) | 3.312e+0(2.168e-2) | <b>3.466e+0(1.888e-3)</b> |
|      | <i>p</i>              | 1.370e-3                  | 1.442e-3           | 1.585e-4           | -                         |
|      | <i>h</i>              | 1                         | 1                  | 1                  | -                         |
| DF8  | (10,10)               | 1.776e+0(4.664e-3)        | 1.729e+0(8.876e-3) | 1.739e+0(1.104e-2) | <b>1.783e+0(3.019e-3)</b> |
|      | <i>p</i>              | 5.493e-1                  | 1.335e-1           | 1.373e-1           | -                         |
|      | <i>h</i>              | 0                         | 0                  | 0                  | -                         |
| DF9  | (10,10)               | 1.395e+0(1.994e-2)        | 1.280e+0(1.649e-2) | 1.290e+0(1.727e-2) | <b>1.582e+0(1.071e-2)</b> |
|      | <i>p</i>              | 8.841e-7                  | 2.670e-9           | 2.195e-8           | -                         |
|      | <i>h</i>              | 1                         | 1                  | 1                  | -                         |
| DF10 | (10,10)               | 1.335e+0(1.345e-2)        | 1.154e+0(2.997e-2) | 1.176e+0(4.033e-2) | <b>1.376e+0(1.223e-2)</b> |
|      | <i>p</i>              | 2.519e-1                  | 2.317e-6           | 5.462e-6           | -                         |
|      | <i>h</i>              | 0                         | 1                  | 1                  | -                         |
| DF11 | (10,10)               | 3.676e-1(2.009e-3)        | 3.088e-1(8.351e-3) | 2.762e-1(4.246e-3) | <b>3.717e-1(2.936e-3)</b> |
|      | <i>p</i>              | 8.073e-1                  | 6.100e-1           | 5.011e-1           | -                         |
|      | <i>h</i>              | 0                         | 0                  | 0                  | -                         |
| DF12 | (10,10)               | <b>3.488e+0(8.165e-3)</b> | 3.358e+0(1.326e-2) | 3.385e+0(1.393e-2) | 3.464e+0(1.167e-2)        |
|      | <i>p</i>              | 3.042e-1                  | 9.926e-2           | 2.973e-1           | -                         |
|      | <i>h</i>              | 0                         | 1                  | 0                  | -                         |
| DF13 | (10,10)               | <b>7.380e+0(1.742e-2)</b> | 4.497e+0(1.769e-1) | 5.191e+0(6.517e-1) | 7.113e+0(3.531e-2)        |
|      | <i>p</i>              | 7.483e-2                  | 2.879e-6           | 6.356e-5           | -                         |
|      | <i>h</i>              | 0                         | 1                  | 1                  | -                         |
| DF14 | (10,10)               | 1.070e+0(2.663e-3)        | 8.175e-1(2.710e-1) | 9.449e-1(1.502e-1) | <b>1.073e+0(2.216e-3)</b> |
|      | <i>p</i>              | 7.845e-1                  | 5.804e-3           | 1.188e-1           | -                         |
|      | <i>h</i>              | 0                         | 1                  | 0                  | -                         |
|      | $\ddagger/\ddagger/t$ | 5/0/9                     | 10/0/3             | 8/0/6              | -                         |



Table 8. Experimental results comparison of different multiobjective optimization algorithms on MSP for  $(n_t, \tau_t)=(10,10)$

| Fun. | $(n_t, \tau_t)$       | MOMVO                     | MOALO              | MOGOA              | PFFPA                     |
|------|-----------------------|---------------------------|--------------------|--------------------|---------------------------|
| DF1  | (10,10)               | 7.962e-3(3.824e-4)        | 3.277e-2(1.292e-2) | 2.119e-2(4.378e-3) | <b>6.473e-3(1.323e-3)</b> |
|      | $p$                   | 2.377e-7                  | 5.072e-10          | 4.113e-7           | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
| DF2  | (10,10)               | <b>1.991e-2(2.307e-3)</b> | 8.287e+0(2.517e+0) | 1.032e-1(2.179e-2) | 2.823e+0(4.096e+0)        |
|      | $p$                   | 7.695e-8                  | 8.650e-1           | 7.958e-1           | -                         |
|      | $h$                   | 1                         | 0                  | 0                  | -                         |
| DF3  | (10,10)               | 2.875e-2(9.192e-3)        | 1.083e-1(7.265e-2) | 6.572e-2(2.488e-2) | <b>1.954e-2(1.400e-2)</b> |
|      | $p$                   | 6.526e-7                  | 4.182e-9           | 1.850e-8           | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
| DF4  | (10,10)               | 6.218e-2(1.683e-2)        | 7.557e-1(2.218e-1) | 3.374e-1(9.633e-2) | <b>3.969e-2(1.431e-2)</b> |
|      | $p$                   | 6.283e-6                  | 9.833e-8           | 3.081e-8           | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
| DF5  | (10,10)               | 8.392e-3(6.892e-4)        | 5.342e-2(2.370e-2) | 3.609e-2(9.194e-3) | <b>7.777e-3(3.608e-3)</b> |
|      | $p$                   | 5.264e-4                  | 1.011e-8           | 3.835e-6           | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
| DF6  | (10,10)               | <b>2.142e+0(5.666e-1)</b> | 9.819e+0(3.712e-1) | 4.018e+0(7.480e-1) | 2.192e+0(2.897e-1)        |
|      | $p$                   | 6.204e-1                  | 2.154e-10          | 1.680e-3           | -                         |
|      | $h$                   | 0                         | 1                  | 1                  | -                         |
| DF7  | (10,10)               | 3.167e-2(7.358e-4)        | 2.864e-2(2.891e-3) | 3.234e-2(4.062e-3) | <b>7.677e-3(1.835e-4)</b> |
|      | $p$                   | 6.696e-11                 | 6.066e-11          | 7.389e-11          | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
| DF8  | (10,10)               | 2.590e-2(6.090e-3)        | 8.745e-2(2.644e-2) | 4.724e-2(1.823e-2) | <b>1.590e-2(3.841e-3)</b> |
|      | $p$                   | 7.959e-3                  | 3.159e-10          | 6.377e-3           | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
| DF9  | (10,10)               | <b>1.688e-1(4.937e-2)</b> | 5.333e-1(1.709e-1) | 2.794e-1(7.423e-2) | 2.530e-1(1.278e-1)        |
|      | $p$                   | 8.418e-1                  | 1.748e-5           | 5.012e-1           | -                         |
|      | $h$                   | 0                         | 1                  | 0                  | -                         |
| DF10 | (10,10)               | <b>5.015e-1(9.902e-2)</b> | 1.208e+0(1.512e-1) | 1.204e+0(2.994e-1) | 1.022e+0(1.132e-1)        |
|      | $p$                   | 1.078e-6                  | 8.303e-1           | 4.202e-1           | -                         |
|      | $h$                   | 1                         | 0                  | 0                  | -                         |
| DF11 | (10,10)               | 5.337e-2(2.648e-3)        | 5.150e-2(8.685e-3) | 7.273e-2(1.277e-2) | <b>5.149e-2(2.198e-3)</b> |
|      | $p$                   | 1.857e-3                  | 1.442e-3           | 5.106e-1           | -                         |
|      | $h$                   | 1                         | 1                  | 0                  | -                         |
| DF12 | (10,10)               | <b>3.659e-1(2.586e-2)</b> | 6.846e-1(7.965e-2) | 6.587e-1(2.666e-2) | 6.401e-1(2.961e-2)        |
|      | $p$                   | 1.635e-5                  | 2.340e-1           | 3.329e-1           | -                         |
|      | $h$                   | 1                         | 0                  | 0                  | -                         |
| DF13 | (10,10)               | <b>2.813e-1(1.286e-1)</b> | 5.231e-1(2.165e-1) | 6.026e-1(1.142e-1) | 8.896e-1(3.264e-2)        |
|      | $p$                   | 1.493e-4                  | 6.952e-1           | 9.705e-1           | -                         |
|      | $h$                   | 1                         | 0                  | 0                  | -                         |
| DF14 | (10,10)               | <b>4.884e-1(3.585e-2)</b> | 9.038e+0(2.858e-1) | 7.095e+1(2.227e+2) | 6.249e-1(1.581e-2)        |
|      | $p$                   | 1.501e-2                  | 3.825e-9           | 6.549e-4           | -                         |
|      | $h$                   | 1                         | 1                  | 1                  | -                         |
|      | $\ddagger/\ddagger/l$ | 7/5/2                     | 10/0/4             | 8/0/6              | -                         |