|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Problem size | J | I | B | F | Time | | | | |
| MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid |
| Small | 8 | 2 | 1 | 1 |  |  | 88.6577 | 15.1166 | 8.2399 |
|  | 3 | 2 | 1 |  |  | 92.1496 | 14.5907 | 12.2438 |
| 10 | 3 | 1 | 1 |  |  | 92.4004 | 14.9771 | 7.3456 |
|  | 3 | 2 | 1 |  |  | 86.283 | 14.7471 | 8.5845 |
|  | 4 | 2 | 2 |  |  | 92.9171 | 15.0371 | 9.0437 |
| 12 | 3 | 1 | 1 |  |  | 73.9626 | 15.0546 | 8.0472 |
|  | 3 | 2 | 1 |  |  | 74.8597 | 14.5348 | 8.7451 |
|  | 4 | 2 | 2 |  |  | 95.6354 | 14.7744 | 11.3038 |
| Medium | 15 | 4 | 2 | 1 |  |  | 82.8064 | 15.4054 | 15.4937 |
|  | 6 | 3 | 2 |  |  | 83.941 | 16.1566 | 13.7903 |
| 20 | 4 | 2 | 1 |  |  | 67.4338 | 16.0538 | 8.6386 |
|  | 6 | 3 | 2 |  |  | 72.5659 | 15.9565 | 8.2809 |
| 25 | 4 | 2 | 1 |  |  | 73.4431 | 18.7302 | 12.8359 |
|  | 6 | 3 | 2 |  |  | 64.2536 | 18.7325 | 12.6845 |
| 30 | 4 | 2 | 1 |  |  |  | 20.3039 | 14.9096 |
|  | 6 | 3 | 2 |  |  |  | 21.2672 | 15.1431 |
| Large | 40 | 8 | 3 | 2 |  |  |  | 22.626 | 20.2552 |
|  | 10 | 4 | 3 |  |  |  | 22.0326 | 17.7729 |
| 50 | 10 | 3 | 2 |  |  |  | 25.5885 | 21.2376 |
|  | 12 | 4 | 3 |  |  |  | 31.9129 | 31.7191 |
| 60 | 12 | 3 | 2 |  |  |  | 32.1423 | 33.7411 |
|  | 15 | 4 | 3 |  |  |  | 32.4666 | 32.0186 |
| 80 | 15 | 3 | 2 |  |  |  | 51.9088 | 56.5761 |
|  | 20 | 4 | 3 |  |  |  | 52.5774 | 57.3463 |

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| Problem size | J | I | B | F | NPS | | | | |  | MID | | | | |  | DM | | | | |
| MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid | MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid | MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid |
| Small | 8 | 2 | 1 | 1 |  |  | 2 | 2 | 5 |  |  |  | 1.2071 | 1.2071 | 1.2768 |  |  |  | 42.6465 | 42.6465 | 11.4467 |
|  | 3 | 2 | 1 |  |  | 6 | 6 | 10 |  |  |  | 1.1616 | 1.1808 | 1.0147 |  |  |  | 21.8308 | 20.394 | 49.2291 |
| 10 | 3 | 1 | 1 |  |  | 4 | 5 | 8 |  |  |  | 0.88682 | 0.88722 | 1.0015 |  |  |  | 27.3542 | 27.3542 | 28.4317 |
|  | 3 | 2 | 1 |  |  | 3 | 5 | 10 |  |  |  | 1.2215 | 1.0662 | 0.91347 |  |  |  | 18.9451 | 29.5771 | 56.6637 |
|  | 4 | 2 | 2 |  |  | 8 | 8 | 7 |  |  |  | 1.1074 | 1.1092 | 1.2913 |  |  |  | 39.4873 | 39.4873 | 62.3476 |
| 12 | 3 | 1 | 1 |  |  | 15 | 17 | 11 |  |  |  | 0.88168 | 0.87407 | 1.0738 |  |  |  | 94.8112 | 96.8442 | 40.5446 |
|  | 3 | 2 | 1 |  |  | 26 | 27 | 25 |  |  |  | 0.8711 | 0.88426 | 0.95438 |  |  |  | 77.4498 | 75.598 | 99.4901 |
|  | 4 | 2 | 2 |  |  | 2 | 2 | 6 |  |  |  | 1.2071 | 1.2071 | 1.1665 |  |  |  | 12.659 | 15.308 | 11.2472 |
| Medium | 15 | 4 | 2 | 1 |  |  | 6 | 7 | 5 |  |  |  | 1.1471 | 1.1509 | 0.8857 |  |  |  | 32.755 | 32.8921 | 37.0345 |
|  | 6 | 3 | 2 |  |  | 15 | 18 | 10 |  |  |  | 0.83844 | 0.78606 | 1.1278 |  |  |  | 64.1825 | 57.793 | 78.0877 |
| 20 | 4 | 2 | 1 |  |  | 35 | 59 | 21 |  |  |  | 0.85143 | 0.82995 | 1.0446 |  |  |  | 142.3899 | 157.3448 | 150.4566 |
|  | 6 | 3 | 2 |  |  | 51 | 32 | 35 |  |  |  | 0.84974 | 0.90486 | 1.0688 |  |  |  | 94.8081 | 87.4814 | 141.3404 |
| 25 | 4 | 2 | 1 |  |  | 32 | 16 | 28 |  |  |  | 0.79432 | 0.84737 | 1.1495 |  |  |  | 161.6318 | 130.6256 | 191.3738 |
|  | 6 | 3 | 2 |  |  | 31 | 39 | 50 |  |  |  | 1.0235 | 0.88597 | 1.1708 |  |  |  | 184.3406 | 274.9976 | 164.9684 |
| 30 | 4 | 2 | 1 |  |  |  | 29 | 33 |  |  |  |  | 0.97069 | 1.1626 |  |  |  |  | 122.1123 | 266.0303 |
|  | 6 | 3 | 2 |  |  |  | 8 | 26 |  |  |  |  | 0.99644 | 1.0073 |  |  |  |  | 46.3132 | 170.0448 |
| Large | 40 | 8 | 3 | 2 |  |  |  | 25 | 43 |  |  |  |  | 0.99636 | 0.9603 |  |  |  |  | 216.6345 | 737.7513 |
|  | 10 | 4 | 3 |  |  |  | 15 | 24 |  |  |  |  | 0.69092 | 1.1472 |  |  |  |  | 248.8079 | 124.4317 |
| 50 | 10 | 3 | 2 |  |  |  | 18 | 55 |  |  |  |  | 0.74572 | 1.1836 |  |  |  |  | 115.8795 | 494.6096 |
|  | 12 | 4 | 3 |  |  |  | 38 | 25 |  |  |  |  | 0.80655 | 1.0515 |  |  |  |  | 364.9533 | 437.9534 |
| 60 | 12 | 3 | 2 |  |  |  | 43 | 22 |  |  |  |  | 0.77285 | 0.99932 |  |  |  |  | 165.4826 | 284.2811 |
|  | 15 | 4 | 3 |  |  |  | 23 | 12 |  |  |  |  | 0.69773 | 1.357 |  |  |  |  | 224.6829 | 322.1378 |
| 80 | 15 | 3 | 2 |  |  |  | 52 | 36 |  |  |  |  | 0.88638 | 1.045 |  |  |  |  | 249.3265 | 344.4207 |
|  | 20 | 4 | 3 |  |  |  | 48 | 10 |  |  |  |  | 0.5452 | 1.3779 |  |  |  |  | 357.8739 | 444.1816 |

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| Problem size | J | I | B | F | SNS | | | | |  | RAS | | | | |  | QM | | | | |
| MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid | MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid | MOEA/D | NSGA-II | PESA-II | SPEA-II | Hybrid |
| Small | 8 | 2 | 1 | 1 |  |  | 0.29289 | 0.29289 | 0.16851 |  |  |  | 4.7609 | 4.7609 | 5.3745 |  |  |  |  |  |  |
|  | 3 | 2 | 1 |  |  | 0.10765 | 0.1251 | 0.23127 |  |  |  | 7.3047 | 7.2852 | 6.5721 |  |  |  |  |  |  |
| 10 | 3 | 1 | 1 |  |  | 0.4081 | 0.35343 | 0.17965 |  |  |  | 13.7244 | 13.944 | 10.9233 |  |  |  |  |  |  |
|  | 3 | 2 | 1 |  |  | 0.20859 | 0.33671 | 0.28985 |  |  |  | 7.8969 | 8.3472 | 6.02 |  |  |  |  |  |  |
|  | 4 | 2 | 2 |  |  | 0.26967 | 0.26669 | 0.13971 |  |  |  | 8.5405 | 8.5519 | 7.0635 |  |  |  |  |  |  |
| 12 | 3 | 1 | 1 |  |  | 0.20869 | 0.19702 | 0.11876 |  |  |  | 8.8508 | 8.865 | 8.878 |  |  |  |  |  |  |
|  | 3 | 2 | 1 |  |  | 0.10581 | 0.10374 | 0.12986 |  |  |  | 12.4218 | 12.4564 | 9.0445 |  |  |  |  |  |  |
|  | 4 | 2 | 2 |  |  | 0.29289 | 0.29289 | 0.16664 |  |  |  | 12.6146 | 12.4833 | 9.4166 |  |  |  |  |  |  |
| Medium | 15 | 4 | 2 | 1 |  |  | 0.13101 | 0.12044 | 0.31756 |  |  |  | 12.9252 | 13.2953 | 11.0827 |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  | 0.28955 | 0.28727 | 0.24957 |  |  |  | 17.3215 | 17.3294 | 13.1962 |  |  |  |  |  |  |
| 20 | 4 | 2 | 1 |  |  | 0.15848 | 0.1193 | 0.25791 |  |  |  | 13.4456 | 13.7233 | 14.9049 |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  | 0.17937 | 0.18503 | 0.087296 |  |  |  | 21.3212 | 22.4472 | 19.2584 |  |  |  |  |  |  |
| 25 | 4 | 2 | 1 |  |  | 0.21313 | 0.21988 | 0.1453 |  |  |  | 13.9942 | 13.361 | 14.9199 |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  | 0.25925 | 0.21858 | 0.088658 |  |  |  | 16.4263 | 16.5954 | 13.7901 |  |  |  |  |  |  |
| 30 | 4 | 2 | 1 |  |  |  | 0.14701 | 0.12632 |  |  |  |  | 18.316 | 16.1261 |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  |  | 0.31918 | 0.22227 |  |  |  |  | 20.4422 | 18.5044 |  |  |  |  |  |  |
| Large | 40 | 8 | 3 | 2 |  |  |  | 0.25151 | 0.2302 |  |  |  |  | 25.7747 | 21.0302 |  |  |  |  |  |  |
|  | 10 | 4 | 3 |  |  |  | 0.32154 | 0.18247 |  |  |  |  | 22.383 | 19.7054 |  |  |  |  |  |  |
| 50 | 10 | 3 | 2 |  |  |  | 0.38846 | 0.079507 |  |  |  |  | 28.2417 | 25.1413 |  |  |  |  |  |  |
|  | 12 | 4 | 3 |  |  |  | 0.34886 | 0.10347 |  |  |  |  | 26.4048 | 25.1865 |  |  |  |  |  |  |
| 60 | 12 | 3 | 2 |  |  |  | 0.2401 | 0.18724 |  |  |  |  | 24.8018 | 26.5015 |  |  |  |  |  |  |
|  | 15 | 4 | 3 |  |  |  | 0.28557 | 0.13086 |  |  |  |  | 32.5136 | 28.1735 |  |  |  |  |  |  |
| 80 | 15 | 3 | 2 |  |  |  | 0.19734 | 0.11212 |  |  |  |  | 43.3951 | 36.2053 |  |  |  |  |  |  |
|  | 20 | 4 | 3 |  |  |  | 0.28457 | 0.1747 |  |  |  |  | 49.8598 | 42.9505 |  |  |  |  |  |  |

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| Problem size | J | I | B | F | NPS | | |  | MID | | |  | DM | | |  | SNS | | |  | RAS | | |  | QM | | |  | Time | | |
| NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D |
| Small | 8 | 2 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 3 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | 3 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 3 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 4 | 2 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | 3 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 3 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 4 | 2 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Medium | 15 | 4 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 | 4 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25 | 4 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 30 | 4 | 2 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Large | 40 | 8 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 10 | 4 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 50 | 10 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 12 | 4 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 | 12 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 15 | 4 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 80 | 15 | 3 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 20 | 4 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |