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| --- | --- | --- | --- | --- | --- | --- | --- |
| Problem size | J | I | B | F | Time | | |
| NSGA-II | Hybrid | MOEA/D |
| Small | 8 | 2 | 1 | 1 | 6.4396 | 3.7457 | 9.1928 |
|  | 3 | 2 | 1 | 6.3983 | 4.0428 | 10.4582 |
| 10 | 3 | 1 | 1 | 6.7213 | 3.7969 | 10.6174 |
|  | 3 | 2 | 1 | 6.8484 | 4.3560 | 11.2176 |
|  | 4 | 2 | 2 | 6.6140 | 3.7854 | 11.2312 |
| 12 | 3 | 1 | 1 | 6.7359 | 4.0392 | 11.4135 |
|  | 3 | 2 | 1 | 6.3839 | 3.6887 | 15.3533 |
|  | 4 | 2 | 2 | 6.4692 | 4.8324 | 11.0996 |
| Medium | 15 | 4 | 2 | 1 | 6.6534 | 3.7787 | 13.4106 |
|  | 6 | 3 | 2 | 7.0574 | 5.2955 | 12.6330 |
| 20 | 4 | 2 | 1 | 7.1017 | 4.1407 | 12.9990 |
|  | 6 | 3 | 2 | 6.9953 | 4.0546 | 12.6003 |
| 25 | 4 | 2 | 1 | 8.1506 | 4.9758 | 19.2928 |
|  | 6 | 3 | 2 | 8.0938 | 5.1809 | 14.9166 |
| 30 | 4 | 2 | 1 | 8.8394 | 5.7713 | 15.6416 |
|  | 6 | 3 | 2 | 9.5120 | 6.6504 | 16.4895 |
| Large | 40 | 8 | 3 | 2 | 9.9198 | 6.4978 | 17.1149 |
|  | 10 | 4 | 3 | 10.0053 | 6.1485 | 20.8698 |
| 50 | 10 | 3 | 2 | 11.5119 | 8.0329 | 20.2069 |
|  | 12 | 4 | 3 | 13.8102 | 10.2472 | 23.8072 |
| 60 | 12 | 3 | 2 | 14.1081 | 10.3775 | 23.2887 |
|  | 15 | 4 | 3 | 14.8974 | 11.8191 | 23.2809 |
| 80 | 15 | 3 | 2 | 23.5373 | 19.5768 | 35.1758 |
|  | 20 | 4 | 3 | 23.4585 | 20.1366 | 37.6978 |

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| Problem size | J | I | B | F | NPS | | |  | MID | | |  | DM | | |  |
| NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D |
| Small | 8 | 2 | 1 | 1 | 2 | 3 | 2 |  | 1.2071 | 1.3155 | 1.2071 |  | 42.6465 | 10.7703 | 41.5401 |  |
|  | 3 | 2 | 1 | 6 | 9 | 7 |  | 1.1795 | 1.1151 | 1.1859 |  | 20.3940 | 43.8891 | 23.4692 |  |
| 10 | 3 | 1 | 1 | 5 | 12 | 5 |  | 0.88722 | 1.0252 | 0.91668 |  | 27.3542 | 34.4032 | 36.7306 |  |
|  | 3 | 2 | 1 | 3 | 7 | 7 |  | 1.2215 | 1.1311 | 1.0401 |  | 18.9451 | 51.3152 | 37.1042 |  |
|  | 4 | 2 | 2 | 8 | 8 | 4 |  | 1.1074 | 1.2097 | 1.0127 |  | 39.4873 | 83.9914 | 51.7786 |  |
| 12 | 3 | 1 | 1 | 13 | 15 | 8 |  | 0.89456 | 1.1135 | 1.0065 |  | 95.5925 | 41.3555 | 95.5250 |  |
|  | 3 | 2 | 1 | 24 | 20 | 8 |  | 0.95882 | 1.1513 | 1.1218 |  | 67.1600 | 79.5679 | 75.3094 |  |
|  | 4 | 2 | 2 | 2 | 4 | 2 |  | 1.2071 | 1.1911 | 1.2071 |  | 15.3080 | 16.6700 | 12.6590 |  |
| Medium | 15 | 4 | 2 | 1 | 5 | 12 | 5 |  | 1.2178 | 1.043 | 0.97609 |  | 30.2292 | 55.4802 | 39.9962 |  |
|  | 6 | 3 | 2 | 13 | 10 | 7 |  | 0.79831 | 1.1832 | 1.0217 |  | 55.5388 | 70.9086 | 60.3789 |  |
| 20 | 4 | 2 | 1 | 34 | 18 | 7 |  | 0.75994 | 1.0533 | 1.0128 |  | 221.3999 | 60.2313 | 65.5290 |  |
|  | 6 | 3 | 2 | 35 | 27 | 6 |  | 0.85848 | 1.0811 | 1.0071 |  | 62.9232 | 104.0932 | 74.2896 |  |
| 25 | 4 | 2 | 1 | 20 | 15 | 4 |  | 0.89604 | 1.2433 | 0.94152 |  | 193.1032 | 217.4616 | 202.3217 |  |
|  | 6 | 3 | 2 | 29 | 23 | 10 |  | 0.95488 | 1.0704 | 0.87347 |  | 313.9602 | 341.4862 | 179.2789 |  |
| 30 | 4 | 2 | 1 | 28 | 17 | 3 |  | 0.95112 | 1.018 | 0.92579 |  | 118.2066 | 254.4034 | 277.8121 |  |
|  | 6 | 3 | 2 | 9 | 14 | 4 |  | 0.77857 | 0.83705 | 0.96328 |  | 82.2560 | 29.1405 | 95.05510 |  |
| Large | 40 | 8 | 3 | 2 | 29 | 22 | 4 |  | 0.98687 | 0.94546 | 1.1332 |  | 252.2011 | 555.8149 | 78.8927 |  |
|  | 10 | 4 | 3 | 15 | 32 | 7 |  | 0.72445 | 0.96391 | 1.0621 |  | 185.2255 | 117.6464 | 89.3846 |  |
| 50 | 10 | 3 | 2 | 26 | 31 | 6 |  | 0.53111 | 1.2652 | 0.99246 |  | 231.3724 | 702.7936 | 627.1908 |  |
|  | 12 | 4 | 3 | 41 | 26 | 7 |  | 0.79443 | 0.94391 | 1.1787 |  | 235.3222 | 400.1603 | 277.0560 |  |
| 60 | 12 | 3 | 2 | 35 | 25 | 8 |  | 0.83815 | 1.0571 | 1.0646 |  | 192.6229 | 222.1746 | 175.5162 |  |
|  | 15 | 4 | 3 | 34 | 31 | 4 |  | 0.81653 | 0.94037 | 0.84576 |  | 214.6931 | 254.5107 | 192.6460 |  |
| 80 | 15 | 3 | 2 | 32 | 34 | 7 |  | 0.71412 | 0.94944 | 1.0471 |  | 394.5263 | 218.1734 | 364.1583 |  |
|  | 20 | 4 | 3 | 24 | 19 | 4 |  | 0.87323 | 1.2602 | 0.78446 |  | 205.8851 | 408.3436 | 436.4994 |  |

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| Problem size | J | I | B | F | SNS | | |  | RAS | | |  | QM | | |
| NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D | NSGA-II | Hybrid | MOEA/D |
| Small | 8 | 2 | 1 | 1 | 0.29289 | 0.17100 | 0.29289 |  | 0.56637 | 0.10727 | 0.54511 |  |  |  |  |
|  | 3 | 2 | 1 | 0.12356 | 0.23232 | 0.15290 |  | 0.49501 | 0.79807 | 0.49608 |  |  |  |  |
| 10 | 3 | 1 | 1 | 0.35343 | 0.21249 | 0.33552 |  | 0.27704 | 0.36614 | 0.34861 |  |  |  |  |
|  | 3 | 2 | 1 | 0.20859 | 0.10274 | 0.21788 |  | 0.24505 | 0.43953 | 0.48078 |  |  |  |  |
|  | 4 | 2 | 2 | 0.26967 | 0.13735 | 0.30060 |  | 0.49601 | 0.92559 | 0.68419 |  |  |  |  |
| 12 | 3 | 1 | 1 | 0.22202 | 0.13300 | 0.22954 |  | 0.68729 | 0.41411 | 0.70416 |  |  |  |  |
|  | 3 | 2 | 1 | 0.15245 | 0.12799 | 0.17904 |  | 0.56075 | 0.74174 | 0.65430 |  |  |  |  |
|  | 4 | 2 | 2 | 0.29289 | 0.17414 | 0.29289 |  | 0.20697 | 0.12222 | 0.18623 |  |  |  |  |
| Medium | 15 | 4 | 2 | 1 | 0.14247 | 0.14438 | 0.31553 |  | 0.36883 | 0.26653 | 0.22961 |  |  |  |  |
|  | 6 | 3 | 2 | 0.31702 | 0.25840 | 0.30567 |  | 0.47497 | 0.78000 | 0.80979 |  |  |  |  |
| 20 | 4 | 2 | 1 | 0.18988 | 0.24195 | 0.20837 |  | 1.05580 | 0.33971 | 0.33979 |  |  |  |  |
|  | 6 | 3 | 2 | 0.14899 | 0.13117 | 0.22619 |  | 0.41743 | 0.49420 | 0.29745 |  |  |  |  |
| 25 | 4 | 2 | 1 | 0.23996 | 0.10709 | 0.39059 |  | 0.36538 | 0.48401 | 0.29144 |  |  |  |  |
|  | 6 | 3 | 2 | 0.17610 | 0.12571 | 0.33443 |  | 1.03690 | 0.99084 | 0.48123 |  |  |  |  |
| 30 | 4 | 2 | 1 | 0.11092 | 0.24911 | 0.52945 |  | 0.18442 | 0.30112 | 0.26839 |  |  |  |  |
|  | 6 | 3 | 2 | 0.32840 | 0.21850 | 0.32904 |  | 0.15896 | 0.07973 | 0.23834 |  |  |  |  |
| Large | 40 | 8 | 3 | 2 | 0.26570 | 0.18736 | 0.26567 |  | 0.63128 | 0.71162 | 0.14436 |  |  |  |  |
|  | 10 | 4 | 3 | 0.38901 | 0.10819 | 0.14065 |  | 0.24026 | 0.2396 | 0.20861 |  |  |  |  |
| 50 | 10 | 3 | 2 | 0.35776 | 0.16013 | 0.21221 |  | 0.20539 | 1.0234 | 0.42979 |  |  |  |  |
|  | 12 | 4 | 3 | 0.17918 | 0.11544 | 0.23754 |  | 0.30148 | 0.53638 | 0.43779 |  |  |  |  |
| 60 | 12 | 3 | 2 | 0.18163 | 0.11213 | 0.16921 |  | 0.21860 | 0.22047 | 0.18306 |  |  |  |  |
|  | 15 | 4 | 3 | 0.20906 | 0.12496 | 0.53764 |  | 0.28342 | 0.30531 | 0.19260 |  |  |  |  |
| 80 | 15 | 3 | 2 | 0.20691 | 0.17419 | 0.17583 |  | 0.23598 | 0.11951 | 0.29762 |  |  |  |  |
|  | 20 | 4 | 3 | 0.22982 | 0.21936 | 0.51668 |  | 0.14572 | 0.44726 | 0.25830 |  |  |  |  |

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| Problem size | J | I | B | F | NPS | | |  | MID | | |  | DM | | |  | SNS | | |  | RAS | | |  | QM | | |
| 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 | 2 | 3 | 2 |  | 1.21 | 1.32 | 1.21 |  | 42.65 | 10.77 | 41.54 |  | 0.29 | 0.17 | 0.29 |  | 0.57 | 0.11 | 0.55 |  |  |  |  |
|  | 3 | 2 | 1 | 6 | 9 | 7 |  | 1.18 | 1.12 | 1.19 |  | 20.39 | 43.89 | 23.47 |  | 0.12 | 0.23 | 0.15 |  | 0.5 | 0.8 | 0.5 |  |  |  |  |
| 10 | 3 | 1 | 1 | 5 | 12 | 5 |  | 0.89 | 1.03 | 0.92 |  | 27.35 | 34.40 | 36.73 |  | 0.35 | 0.21 | 0.34 |  | 0.28 | 0.37 | 0.35 |  |  |  |  |
|  | 3 | 2 | 1 | 3 | 7 | 7 |  | 1.22 | 1.13 | 1.04 |  | 18.95 | 51.32 | 37.10 |  | 0.21 | 0.1 | 0.22 |  | 0.25 | 0.44 | 0.48 |  |  |  |  |
|  | 4 | 2 | 2 | 8 | 8 | 4 |  | 1.11 | 1.21 | 1.01 |  | 39.49 | 83.99 | 51.78 |  | 0.27 | 0.14 | 0.3 |  | 0.5 | 0.93 | 0.68 |  |  |  |  |
| 12 | 3 | 1 | 1 | 13 | 15 | 8 |  | 0.89 | 1.11 | 1.01 |  | 95.59 | 41.36 | 95.53 |  | 0.22 | 0.13 | 0.23 |  | 0.69 | 0.41 | 0.7 |  |  |  |  |
|  | 3 | 2 | 1 | 24 | 20 | 8 |  | 0.96 | 1.15 | 1.12 |  | 67.16 | 79.57 | 75.31 |  | 0.15 | 0.13 | 0.18 |  | 0.56 | 0.74 | 0.65 |  |  |  |  |
|  | 4 | 2 | 2 | 2 | 4 | 2 |  | 1.21 | 1.19 | 1.21 |  | 15.31 | 16.67 | 12.66 |  | 0.29 | 0.17 | 0.29 |  | 0.21 | 0.12 | 0.19 |  |  |  |  |
| Medium | 15 | 4 | 2 | 1 | 5 | 12 | 5 |  | 1.22 | 1.04 | 0.98 |  | 30.23 | 55.48 | 40.00 |  | 0.14 | 0.14 | 0.32 |  | 0.37 | 0.27 | 0.23 |  |  |  |  |
|  | 6 | 3 | 2 | 13 | 10 | 7 |  | 0.8 | 1.18 | 1.02 |  | 55.54 | 70.91 | 60.38 |  | 0.32 | 0.26 | 0.31 |  | 0.47 | 0.78 | 0.81 |  |  |  |  |
| 20 | 4 | 2 | 1 | 34 | 18 | 7 |  | 0.76 | 1.05 | 1.01 |  | 221.4 | 60.23 | 65.53 |  | 0.19 | 0.24 | 0.21 |  | 1.06 | 0.34 | 0.34 |  |  |  |  |
|  | 6 | 3 | 2 | 35 | 27 | 6 |  | 0.86 | 1.08 | 1.01 |  | 62.92 | 104.0 | 74.29 |  | 0.15 | 0.13 | 0.23 |  | 0.42 | 0.49 | 0.3 |  |  |  |  |
| 25 | 4 | 2 | 1 | 20 | 15 | 4 |  | 0.9 | 1.24 | 0.94 |  | 193.1 | 217.4 | 202.3 |  | 0.24 | 0.11 | 0.39 |  | 0.37 | 0.48 | 0.29 |  |  |  |  |
|  | 6 | 3 | 2 | 29 | 23 | 10 |  | 0.95 | 1.07 | 0.87 |  | 313.9 | 341.4 | 179.2 |  | 0.18 | 0.13 | 0.33 |  | 1.04 | 0.99 | 0.48 |  |  |  |  |
| 30 | 4 | 2 | 1 | 28 | 17 | 3 |  | 0.95 | 1.02 | 0.93 |  | 118.2 | 254.4 | 277.8 |  | 0.11 | 0.25 | 0.53 |  | 0.18 | 0.3 | 0.27 |  |  |  |  |
|  | 6 | 3 | 2 | 9 | 14 | 4 |  | 0.78 | 0.84 | 0.96 |  | 82.26 | 29.14 | 95.06 |  | 0.33 | 0.22 | 0.33 |  | 0.16 | 0.08 | 0.24 |  |  |  |  |
| Large | 40 | 8 | 3 | 2 | 29 | 22 | 4 |  | 0.99 | 0.95 | 1.13 |  | 252.2 | 555.8 | 78.89 |  | 0.27 | 0.19 | 0.27 |  | 0.63 | 0.71 | 0.14 |  |  |  |  |
|  | 10 | 4 | 3 | 15 | 32 | 7 |  | 0.72 | 0.96 | 1.06 |  | 185.2 | 117.6 | 89.38 |  | 0.39 | 0.11 | 0.14 |  | 0.24 | 0.24 | 0.21 |  |  |  |  |
| 50 | 10 | 3 | 2 | 26 | 31 | 6 |  | 0.53 | 1.27 | 0.99 |  | 231.3 | 702.7 | 627.1 |  | 0.36 | 0.16 | 0.21 |  | 0.21 | 1.02 | 0.43 |  |  |  |  |
|  | 12 | 4 | 3 | 41 | 26 | 7 |  | 0.79 | 0.94 | 1.18 |  | 235.3 | 400.1 | 277.0 |  | 0.18 | 0.12 | 0.24 |  | 0.3 | 0.54 | 0.44 |  |  |  |  |
| 60 | 12 | 3 | 2 | 35 | 25 | 8 |  | 0.84 | 1.06 | 1.06 |  | 192.6 | 222.1 | 175.5 |  | 0.18 | 0.11 | 0.17 |  | 0.22 | 0.22 | 0.18 |  |  |  |  |
|  | 15 | 4 | 3 | 34 | 31 | 4 |  | 0.82 | 0.94 | 0.85 |  | 214.6 | 254.5 | 192.6 |  | 0.21 | 0.12 | 0.54 |  | 0.28 | 0.31 | 0.19 |  |  |  |  |
| 80 | 15 | 3 | 2 | 32 | 34 | 7 |  | 0.71 | 0.95 | 1.05 |  | 394.5 | 218.1 | 364.1 |  | 0.21 | 0.17 | 0.18 |  | 0.24 | 0.12 | 0.3 |  |  |  |  |
|  | 20 | 4 | 3 | 24 | 19 | 4 |  | 0.87 | 1.26 | 0.78 |  | 205.8 | 408.3 | 436.5 |  | 0.23 | 0.22 | 0.52 |  | 0.15 | 0.45 | 0.26 |  |  |  |  |

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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 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |