**1. Computational experiments**

We carry out two absolute evaluations based on (a) Optimal solution on small-scale problems and (b) Estimated optimal solution for large-scale problems to understand the performance of the proposed Heuristic neural network (HNN) on randomly generated problems. In order to generate meaningful test instances, an experimental design from minimizing total weighted tardiness on batch-processing machines research paper was used as shown in table 1.Table 1 contains proposed experimental design for 160 small scale problems.

Table 2 contains the proposed experimental design for 640 large scale problems.

|  |  |  |  |
| --- | --- | --- | --- |
| No | Parameters | Levels | Number of levels |
| 1 | Number of jobs(N) | 10,12 | 2 |
| 2 | Release time of jobs(R) | Uniform distributions [1,20] , [1,30] | 2 |
| 3 | Processing time of jobs(P) | Uniform distributions [1,10] , [1,15] | 2 |
| 4 | Due date of jobs(D) | R+P+Uniform distributions [1,30] , [1,45] | 2 |
| 5 | Size of jobs(S) | Uniform distributions [4,10] , [4,14] | 2 |
| Number of problem configurations |  |  | 2x2x2x2x2=32 |
| Problem instance per configuration |  |  | 5 |

Table 1-Small Scale problem

Table 2 contains proposed experimental design for 640 large scale problems

|  |  |  |  |
| --- | --- | --- | --- |
| No | Parameters | Levels | Number of levels |
| 1 | Number of jobs(N) | 25,50,75,100 | 4 |
| 2 | Release time of jobs(R) | Uniform distributions [1,20] , [1,30] | 2 |
| 3 | Processing time of jobs(P) | Uniform distributions [1,10] , [1,15] | 2 |
| 4 | Due date of jobs(D) | R+P+Uniform distributions [1,30] , [1,45] | 2 |
| 5 | Size of jobs(S) | Uniform distributions [4,10] , [4,14] | 2 |
| Number of problem configurations |  |  | 4x2x2x2x2=64 |
| Problem instance per configuration |  |  | 10 |

Table 2-Large Scale problem

There are two variants of the proposed algorithm. One is a greedy approach and other is HNN approach.

(a)The greedy approach includes the following variants

(i)Size

(ii)ERT( Earliest Release time)

(iii)LPT(Longest Processing time)

(iv)EDD(Earliest Due-date)

(v)FDD(Flow Due-date)=release time of a job+processing time of a job

(vi)ODD(Operational Due-date)=release time of a job+3\*(processing time of a job)

(vii)CI

(viii)LST

(b)The HNN approach includes all the HNN variants of the above listed greedy algorithms.

For small scale problems learning rate alpha is set to 0.02 which was found experimentally to give the best results.

The following table contains the total weighted tardiness as computed using each of the greedy as well as the HNN variants of the greedy algorithms as listen above.The first 8 columns correspond to the solution by greedy approach and the next 8 columns correspond to the solution using HNN variant.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Instance Number | | Size | | LPT | | ERT | | EDD | | FDD | | ODD | | | LST | | CI | | Size-ANN | | LPT-ANN | | ERT-ANN | | EDD-ANN | | FDD-ANN | | | ODD-ANN | | LST-ANN | CI-ANN |
| 1 | | 1070 | | 335 | | 105 | | 396 | | 377 | | 381 | | | 396 | | 884 | | 30 | | 30 | | 30 | | 30 | | 62 | | | 30 | | 30 | 44 |
| 2 | | 627 | | 448 | | 555 | | 62 | | 243 | | 491 | | | 54 | | 398 | | 30 | | 30 | | 30 | | 30 | | 30 | | | 30 | | 30 | 30 |
| 3 | | 437 | | 513 | | 40 | | 31 | | 31 | | 31 | | | 31 | | 326 | | 31 | | 31 | | 31 | | 31 | | 31 | | | 31 | | 31 | 31 |
| 4 | | 572 | | 510 | | 252 | | 373 | | 149 | | 389 | | | 303 | | 211 | | 102 | | 151 | | 102 | | 102 | | 102 | | | 102 | | 102 | 102 |
| 5 | | 375 | | 176 | | 0 | | 98 | | 20 | | 0 | | | 0 | | 249 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 6 | | 167 | | 71 | | 150 | | 32 | | 78 | | 432 | | | 38 | | 246 | | 16 | | 16 | | 16 | | 16 | | 16 | | | 16 | | 23 | 16 |
| 7 | | 905 | | 1088 | | 452 | | 206 | | 324 | | 342 | | | 206 | | 842 | | 65 | | 65 | | 65 | | 65 | | 65 | | | 65 | | 65 | 65 |
| 8 | | 641 | | 419 | | 466 | | 816 | | 268 | | 447 | | | 414 | | 1027 | | 140 | | 132 | | 132 | | 132 | | 132 | | | 132 | | 132 | 137 |
| 9 | | 1475 | | 1636 | | 304 | | 433 | | 228 | | 366 | | | 560 | | 1163 | | 182 | | 228 | | 182 | | 182 | | 182 | | | 182 | | 182 | 182 |
| 10 | | 791 | | 1160 | | 96 | | 371 | | 114 | | 225 | | | 266 | | 1144 | | 7 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 35 | 0 |
| 11 | | 155 | | 34 | | 5 | | 0 | | 5 | | 70 | | | 0 | | 268 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 12 | | 293 | | 144 | | 0 | | 104 | | 20 | | 146 | | | 48 | | 403 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 13 | | 336 | | 346 | | 56 | | 0 | | 36 | | 0 | | | 0 | | 254 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 14 | | 396 | | 466 | | 130 | | 83 | | 144 | | 461 | | | 49 | | 594 | | 22 | | 40 | | 22 | | 22 | | 22 | | | 22 | | 28 | 34 |
| 15 | | 36 | | 30 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 16 | | 536 | | 705 | | 382 | | 120 | | 301 | | 280 | | | 482 | | 984 | | 69 | | 106 | | 69 | | 89 | | 69 | | | 89 | | 69 | 69 |
| 17 | | 268 | | 468 | | 132 | | 108 | | 120 | | 111 | | | 88 | | 368 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 18 | | 363 | | 645 | | 141 | | 0 | | 194 | | 153 | | | 59 | | 593 | | 0 | | 4 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 19 | | 770 | | 550 | | 70 | | 55 | | 160 | | 164 | | | 91 | | 594 | | 16 | | 20 | | 16 | | 16 | | 16 | | | 16 | | 16 | 16 |
| 20 | | 288 | | 395 | | 449 | | 505 | | 293 | | 360 | | | 273 | | 365 | | 37 | | 37 | | 37 | | 37 | | 43 | | | 43 | | 37 | 37 |
| 21 | | 828 | | 558 | | 409 | | 363 | | 158 | | 158 | | | 771 | | 829 | | 158 | | 149 | | 78 | | 126 | | 78 | | | 78 | | 78 | 78 |
| 22 | | 745 | | 828 | | 63 | | 185 | | 152 | | 144 | | | 182 | | 338 | | 56 | | 56 | | 56 | | 56 | | 56 | | | 56 | | 56 | 56 |
| 23 | | 459 | | 483 | | 250 | | 430 | | 131 | | 349 | | | 538 | | 1143 | | 29 | | 91 | | 29 | | 29 | | 29 | | | 29 | | 44 | 114 |
| 24 | | 858 | | 1089 | | 939 | | 643 | | 956 | | 650 | | | 991 | | 1203 | | 498 | | 498 | | 501 | | 498 | | 560 | | | 560 | | 498 | 498 |
| 25 | | 393 | | 1344 | | 677 | | 1461 | | 616 | | 454 | | | 382 | | 1316 | | 159 | | 183 | | 159 | | 191 | | 159 | | | 159 | | 159 | 168 |
| 26 | | 585 | | 1078 | | 657 | | 823 | | 688 | | 714 | | | 877 | | 1352 | | 352 | | 299 | | 352 | | 299 | | 352 | | | 314 | | 299 | 299 |
| 27 | | 630 | | 712 | | 295 | | 611 | | 173 | | 344 | | | 801 | | 947 | | 119 | | 153 | | 119 | | 119 | | 119 | | | 119 | | 119 | 119 |
| 28 | | 881 | | 1191 | | 308 | | 487 | | 328 | | 528 | | | 846 | | 1460 | | 308 | | 308 | | 308 | | 305 | | 305 | | | 305 | | 308 | 305 |
| 29 | | 2416 | | 3150 | | 2334 | | 2062 | | 1890 | | 2098 | | | 2222 | | 1994 | | 1696 | | 1696 | | 1701 | | 1688 | | 1688 | | | 1688 | | 1688 | 1688 |
| 30 | | 693 | | 611 | | 609 | | 694 | | 652 | | 663 | | | 612 | | 886 | | 240 | | 355 | | 240 | | 240 | | 240 | | | 240 | | 240 | 240 |
| 31 | | 418 | | 451 | | 396 | | 48 | | 343 | | 306 | | | 48 | | 554 | | 20 | | 48 | | 20 | | 20 | | 20 | | | 20 | | 20 | 20 |
| 32 | | 396 | | 240 | | 165 | | 167 | | 12 | | 63 | | | 161 | | 571 | | 4 | | 12 | | 4 | | 4 | | 4 | | | 4 | | 4 | 4 |
| 33 | | 510 | | 995 | | 373 | | 8 | | 105 | | 105 | | | 42 | | 1052 | | 8 | | 8 | | 8 | | 8 | | 8 | | | 8 | | 8 | 36 |
| 34 | | 782 | | 702 | | 353 | | 404 | | 205 | | 279 | | | 567 | | 744 | | 80 | | 107 | | 80 | | 80 | | 80 | | | 80 | | 80 | 80 |
| 35 | | 1120 | | 896 | | 469 | | 362 | | 330 | | 293 | | | 388 | | 1106 | | 238 | | 256 | | 219 | | 219 | | 219 | | | 219 | | 219 | 219 |
| 36 | | 1299 | | 1072 | | 1261 | | 1122 | | 931 | | 921 | | | 849 | | 1590 | | 451 | | 478 | | 451 | | 451 | | 450 | | | 459 | | 451 | 451 |
| 37 | | 387 | | 839 | | 370 | | 114 | | 270 | | 449 | | | 352 | | 1069 | | 15 | | 15 | | 15 | | 15 | | 15 | | | 15 | | 15 | 15 |
| 38 | | 1708 | | 680 | | 1027 | | 140 | | 743 | | 999 | | | 188 | | 1390 | | 116 | | 116 | | 116 | | 116 | | 116 | | | 126 | | 116 | 196 |
| 39 | | 893 | | 533 | | 335 | | 615 | | 320 | | 177 | | | 439 | | 722 | | 6 | | 6 | | 6 | | 6 | | 6 | | | 6 | | 6 | 6 |
| 40 | | 35 | | 325 | | 135 | | 0 | | 0 | | 158 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 41 | | 768 | | 506 | | 60 | | 98 | | 108 | | 234 | | | 98 | | 330 | | 54 | | 54 | | 54 | | 54 | | 54 | | | 54 | | 54 | 54 |
| 42 | | 153 | | 589 | | 158 | | 116 | | 213 | | 211 | | | 122 | | 292 | | 35 | | 62 | | 35 | | 35 | | 35 | | | 35 | | 35 | 35 |
| 43 | | 497 | | 379 | | 208 | | 72 | | 220 | | 403 | | | 213 | | 609 | | 24 | | 24 | | 24 | | 24 | | 32 | | | 31 | | 24 | 70 |
| 44 | | 644 | | 624 | | 523 | | 80 | | 523 | | 195 | | | 85 | | 1078 | | 55 | | 62 | | 62 | | 55 | | 55 | | | 55 | | 55 | 62 |
| 45 | | 811 | | 737 | | 219 | | 0 | | 243 | | 114 | | | 0 | | 974 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 46 | | 445 | | 566 | | 91 | | 293 | | 102 | | 290 | | | 293 | | 943 | | 0 | | 18 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 47 | | 1331 | | 1446 | | 780 | | 76 | | 758 | | 667 | | | 181 | | 1775 | | 76 | | 81 | | 76 | | 76 | | 76 | | | 76 | | 76 | 76 |
| 48 | | 463 | | 1470 | | 1287 | | 1532 | | 188 | | 347 | | | 1532 | | 873 | | 56 | | 56 | | 56 | | 86 | | 56 | | | 56 | | 56 | 56 |
| 49 | | 519 | | 782 | | 88 | | 267 | | 511 | | 690 | | | 267 | | 1583 | | 72 | | 72 | | 72 | | 72 | | 72 | | | 72 | | 72 | 72 |
| 50 | | 400 | | 1127 | | 0 | | 76 | | 0 | | 197 | | | 120 | | 269 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 51 | | 387 | | 546 | | 136 | | 105 | | 132 | | 22 | | | 101 | | 427 | | 15 | | 15 | | 15 | | 15 | | 15 | | | 15 | | 15 | 15 |
| 52 | | 258 | | 194 | | 122 | | 70 | | 122 | | 210 | | | 70 | | 328 | | 42 | | 42 | | 42 | | 42 | | 42 | | | 42 | | 42 | 42 |
| 53 | | 338 | | 331 | | 168 | | 112 | | 30 | | 108 | | | 114 | | 173 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 54 | | 8 | | 81 | | 0 | | 9 | | 67 | | 0 | | | 9 | | 72 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 55 | | 232 | | 163 | | 64 | | 0 | | 72 | | 96 | | | 0 | | 168 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 56 | | 611 | | 2286 | | 264 | | 73 | | 586 | | 677 | | | 169 | | 927 | | 30 | | 52 | | 30 | | 30 | | 30 | | | 30 | | 30 | 30 |
| 57 | | 855 | | 685 | | 211 | | 33 | | 197 | | 197 | | | 33 | | 495 | | 10 | | 16 | | 10 | | 10 | | 10 | | | 10 | | 10 | 28 |
| 58 | | 609 | | 350 | | 325 | | 325 | | 241 | | 587 | | | 325 | | 762 | | 133 | | 133 | | 133 | | 133 | | 133 | | | 133 | | 133 | 133 |
| 59 | | 850 | | 324 | | 99 | | 54 | | 174 | | 469 | | | 252 | | 895 | | 27 | | 36 | | 27 | | 27 | | 27 | | | 27 | | 27 | 27 |
| 60 | | 96 | | 1267 | | 143 | | 143 | | 186 | | 186 | | | 143 | | 1137 | | 52 | | 73 | | 52 | | 52 | | 52 | | | 52 | | 52 | 52 |
| 61 | | 466 | | 997 | | 252 | | 181 | | 216 | | 665 | | | 248 | | 716 | | 46 | | 70 | | 46 | | 46 | | 46 | | | 46 | | 84 | 46 |
| 62 | | 1212 | | 596 | | 240 | | 109 | | 247 | | 493 | | | 644 | | 1321 | | 181 | | 106 | | 106 | | 106 | | 106 | | | 106 | | 106 | 106 |
| 63 | | 604 | | 961 | | 184 | | 183 | | 284 | | 833 | | | 183 | | 685 | | 92 | | 111 | | 92 | | 92 | | 92 | | | 92 | | 92 | 92 |
| 64 | | 803 | | 1224 | | 286 | | 527 | | 130 | | 348 | | | 527 | | 1176 | | 130 | | 130 | | 130 | | 130 | | 130 | | | 130 | | 130 | 130 |
| 65 | | 885 | | 331 | | 370 | | 856 | | 457 | | 633 | | | 236 | | 1174 | | 188 | | 152 | | 152 | | 235 | | 188 | | | 160 | | 200 | 152 |
| 66 | | 1929 | | 2288 | | 265 | | 370 | | 290 | | 215 | | | 370 | | 1249 | | 146 | | 146 | | 146 | | 146 | | 146 | | | 146 | | 146 | 158 |
| 67 | | 1013 | | 460 | | 149 | | 313 | | 344 | | 773 | | | 185 | | 444 | | 115 | | 115 | | 115 | | 115 | | 115 | | | 121 | | 115 | 115 |
| 68 | | 2793 | | 2735 | | 892 | | 1514 | | 1412 | | 1071 | | | 1821 | | 3163 | | 465 | | 465 | | 465 | | 465 | | 465 | | | 465 | | 465 | 465 |
| 69 | | 412 | | 705 | | 123 | | 137 | | 164 | | 195 | | | 174 | | 563 | | 99 | | 130 | | 99 | | 99 | | 99 | | | 99 | | 99 | 99 |
| 70 | | 677 | | 613 | | 360 | | 219 | | 363 | | 363 | | | 360 | | 777 | | 191 | | 191 | | 191 | | 191 | | 191 | | | 191 | | 191 | 191 |
| 71 | | 898 | | 682 | | 123 | | 172 | | 216 | | 261 | | | 172 | | 1395 | | 69 | | 69 | | 69 | | 69 | | 69 | | | 69 | | 69 | 69 |
| 72 | | 616 | | 339 | | 66 | | 259 | | 394 | | 356 | | | 260 | | 284 | | 4 | | 4 | | 4 | | 4 | | 4 | | | 4 | | 4 | 4 |
| 73 | | 566 | | 511 | | 232 | | 40 | | 45 | | 17 | | | 45 | | 350 | | 4 | | 0 | | 0 | | 0 | | 0 | | | 4 | | 0 | 4 |
| 74 | | 635 | | 837 | | 658 | | 238 | | 450 | | 484 | | | 249 | | 940 | | 108 | | 108 | | 108 | | 108 | | 108 | | | 108 | | 108 | 108 |
| 75 | | 603 | | 651 | | 136 | | 247 | | 548 | | 242 | | | 301 | | 492 | | 48 | | 48 | | 48 | | 48 | | 48 | | | 48 | | 48 | 48 |
| 76 | | 1960 | | 2512 | | 1886 | | 2215 | | 1765 | | 1619 | | | 2368 | | 1868 | | 501 | | 501 | | 501 | | 501 | | 501 | | | 530 | | 501 | 501 |
| 77 | | 675 | | 903 | | 503 | | 281 | | 250 | | 650 | | | 398 | | 637 | | 131 | | 186 | | 145 | | 131 | | 131 | | | 131 | | 131 | 131 |
| 78 | | 271 | | 349 | | 35 | | 36 | | 174 | | 196 | | | 36 | | 279 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 79 | | 1211 | | 1223 | | 283 | | 84 | | 197 | | 338 | | | 84 | | 162 | | 84 | | 162 | | 84 | | 84 | | 84 | | | 84 | | 84 | 84 |
| 80 | | 721 | | 443 | | 110 | | 0 | | 40 | | 194 | | | 0 | | 1078 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 81 | | 1376 | | 601 | | 313 | | 803 | | 439 | | 576 | | | 856 | | 1342 | | 121 | | 123 | | 121 | | 182 | | 139 | | | 121 | | 139 | 169 |
| 82 | | 566 | | 551 | | 206 | | 80 | | 197 | | 281 | | | 80 | | 499 | | 63 | | 80 | | 63 | | 63 | | 63 | | | 63 | | 80 | 80 |
| 83 | | 741 | | 891 | | 150 | | 29 | | 115 | | 132 | | | 29 | | 1232 | | 29 | | 37 | | 29 | | 29 | | 29 | | | 29 | | 29 | 29 |
| 84 | | 747 | | 393 | | 156 | | 308 | | 126 | | 333 | | | 96 | | 554 | | 63 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 85 | | 281 | | 163 | | 200 | | 374 | | 247 | | 281 | | | 384 | | 460 | | 36 | | 35 | | 36 | | 36 | | 55 | | | 36 | | 51 | 36 |
| 86 | | 1133 | | 1420 | | 747 | | 113 | | 408 | | 375 | | | 413 | | 1222 | | 100 | | 180 | | 100 | | 100 | | 100 | | | 100 | | 100 | 100 |
| 87 | | 1004 | | 987 | | 814 | | 308 | | 204 | | 377 | | | 1474 | | 1562 | | 226 | | 249 | | 180 | | 249 | | 167 | | | 167 | | 168 | 204 |
| 88 | | 2667 | | 3110 | | 1371 | | 1775 | | 1243 | | 1603 | | | 1775 | | 2699 | | 974 | | 974 | | 890 | | 890 | | 890 | | | 890 | | 982 | 943 |
| 89 | | 550 | | 1028 | | 181 | | 381 | | 375 | | 137 | | | 414 | | 542 | | 0 | | 13 | | 0 | | 0 | | 0 | | | 0 | | 0 | 6 |
| 90 | | 1474 | | 556 | | 348 | | 326 | | 542 | | 729 | | | 285 | | 1173 | | 69 | | 36 | | 22 | | 36 | | 45 | | | 22 | | 56 | 41 |
| 91 | | 692 | | 735 | | 57 | | 0 | | 189 | | 182 | | | 42 | | 660 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 92 | | 357 | | 259 | | 81 | | 49 | | 81 | | 86 | | | 263 | | 347 | | 8 | | 22 | | 0 | | 0 | | 0 | | | 0 | | 0 | 6 |
| 93 | | 200 | | 307 | | 96 | | 110 | | 84 | | 221 | | | 169 | | 307 | | 12 | | 0 | | 0 | | 21 | | 0 | | | 6 | | 0 | 0 |
| 94 | | 84 | | 321 | | 213 | | 53 | | 41 | | 40 | | | 53 | | 311 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 95 | | 284 | | 280 | | 165 | | 4 | | 138 | | 80 | | | 4 | | 192 | | 4 | | 4 | | 4 | | 4 | | 0 | | | 0 | | 4 | 0 |
| 96 | | 1268 | | 440 | | 276 | | 432 | | 354 | | 384 | | | 286 | | 993 | | 110 | | 28 | | 30 | | 42 | | 24 | | | 30 | | 28 | 24 |
| 97 | | 664 | | 1473 | | 382 | | 493 | | 429 | | 560 | | | 449 | | 439 | | 55 | | 70 | | 54 | | 54 | | 55 | | | 71 | | 54 | 55 |
| 98 | | 588 | | 907 | | 102 | | 172 | | 12 | | 18 | | | 172 | | 665 | | 12 | | 18 | | 12 | | 12 | | 12 | | | 12 | | 12 | 12 |
| 99 | | 970 | | 656 | | 284 | | 696 | | 266 | | 589 | | | 637 | | 968 | | 0 | | 26 | | 0 | | 0 | | 0 | | | 0 | | 13 | 26 |
| 100 | | 962 | | 1279 | | 573 | | 853 | | 449 | | 454 | | | 825 | | 1006 | | 78 | | 91 | | 78 | | 78 | | 78 | | | 91 | | 78 | 78 |
| 101 | | 716 | | 1824 | | 965 | | 1864 | | 920 | | 577 | | | 684 | | 1780 | | 324 | | 324 | | 325 | | 413 | | 334 | | | 324 | | 324 | 339 |
| 102 | | 866 | | 978 | | 801 | | 493 | | 380 | | 311 | | | 719 | | 1134 | | 115 | | 236 | | 115 | | 111 | | 115 | | | 115 | | 111 | 111 |
| 103 | | 1121 | | 849 | | 216 | | 247 | | 295 | | 281 | | | 252 | | 1060 | | 139 | | 143 | | 120 | | 120 | | 120 | | | 120 | | 120 | 120 |
| 104 | | 1123 | | 1805 | | 536 | | 942 | | 633 | | 687 | | | 748 | | 1051 | | 427 | | 404 | | 365 | | 445 | | 353 | | | 365 | | 404 | 353 |
| 105 | | 617 | | 1268 | | 1473 | | 568 | | 810 | | 690 | | | 562 | | 1508 | | 376 | | 392 | | 443 | | 376 | | 382 | | | 378 | | 400 | 378 |
| 106 | | 922 | | 1509 | | 905 | | 1018 | | 956 | | 910 | | | 973 | | 1211 | | 487 | | 641 | | 487 | | 634 | | 634 | | | 664 | | 634 | 671 |
| 107 | | 2224 | | 1264 | | 1620 | | 622 | | 862 | | 599 | | | 745 | | 1865 | | 278 | | 246 | | 313 | | 212 | | 232 | | | 212 | | 212 | 242 |
| 108 | | 2494 | | 3295 | | 1315 | | 1513 | | 1023 | | 1136 | | | 1840 | | 3337 | | 574 | | 590 | | 459 | | 459 | | 459 | | | 459 | | 479 | 459 |
| 109 | | 1721 | | 2289 | | 1301 | | 1921 | | 956 | | 549 | | | 2009 | | 3195 | | 330 | | 433 | | 446 | | 397 | | 330 | | | 400 | | 482 | 330 |
| 110 | | 2606 | | 2745 | | 1535 | | 1035 | | 1407 | | 1519 | | | 3026 | | 2365 | | 570 | | 570 | | 570 | | 570 | | 570 | | | 570 | | 570 | 570 |
| 111 | | 701 | | 697 | | 442 | | 207 | | 377 | | 431 | | | 465 | | 950 | | 114 | | 36 | | 34 | | 21 | | 21 | | | 36 | | 21 | 36 |
| 112 | | 1456 | | 967 | | 433 | | 577 | | 1108 | | 676 | | | 697 | | 1502 | | 100 | | 100 | | 100 | | 100 | | 139 | | | 100 | | 100 | 100 |
| 113 | | 692 | | 840 | | 111 | | 94 | | 103 | | 40 | | | 117 | | 141 | | 16 | | 16 | | 16 | | 16 | | 16 | | | 16 | | 16 | 16 |
| 114 | | 390 | | 300 | | 144 | | 0 | | 23 | | 103 | | | 0 | | 353 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 115 | | 670 | | 565 | | 316 | | 323 | | 562 | | 470 | | | 425 | | 796 | | 109 | | 124 | | 78 | | 99 | | 78 | | | 88 | | 101 | 202 |
| 116 | | 638 | | 1112 | | 909 | | 379 | | 586 | | 755 | | | 685 | | 1216 | | 28 | | 96 | | 93 | | 142 | | 56 | | | 28 | | 28 | 28 |
| 117 | | 1432 | | 2510 | | 889 | | 1470 | | 1241 | | 1235 | | | 1213 | | 1471 | | 595 | | 595 | | 616 | | 595 | | 616 | | | 616 | | 595 | 595 |
| 118 | | 610 | | 324 | | 434 | | 276 | | 242 | | 230 | | | 51 | | 944 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 8 | 30 |
| 119 | | 1922 | | 2293 | | 277 | | 450 | | 27 | | 218 | | | 450 | | 2593 | | 21 | | 57 | | 21 | | 21 | | 21 | | | 21 | | 42 | 48 |
| 120 | | 474 | | 1503 | | 186 | | 60 | | 256 | | 189 | | | 209 | | 627 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 121 | | 779 | | 710 | | 105 | | 104 | | 139 | | 321 | | | 200 | | 1455 | | 65 | | 65 | | 65 | | 65 | | 65 | | | 65 | | 65 | 65 |
| 122 | | 453 | | 649 | | 464 | | 123 | | 185 | | 148 | | | 205 | | 676 | | 51 | | 73 | | 16 | | 16 | | 16 | | | 16 | | 16 | 16 |
| 123 | | 307 | | 111 | | 78 | | 7 | | 78 | | 165 | | | 46 | | 364 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 124 | | 613 | | 583 | | 899 | | 239 | | 980 | | 971 | | | 134 | | 736 | | 71 | | 71 | | 71 | | 71 | | 71 | | | 104 | | 71 | 71 |
| 125 | | 1067 | | 425 | | 117 | | 266 | | 317 | | 280 | | | 306 | | 1171 | | 9 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 126 | | 1348 | | 1134 | | 330 | | 190 | | 652 | | 548 | | | 589 | | 987 | | 120 | | 120 | | 76 | | 120 | | 76 | | | 120 | | 76 | 120 |
| 127 | | 1787 | | 2663 | | 240 | | 591 | | 1086 | | 400 | | | 582 | | 2304 | | 144 | | 204 | | 132 | | 132 | | 132 | | | 132 | | 132 | 144 |
| 128 | | 1599 | | 1867 | | 340 | | 77 | | 394 | | 347 | | | 77 | | 1281 | | 98 | | 77 | | 77 | | 77 | | 77 | | | 77 | | 77 | 77 |
| 129 | | 2064 | | 1405 | | 76 | | 1200 | | 444 | | 785 | | | 1152 | | 1876 | | 6 | | 24 | | 0 | | 76 | | 0 | | | 16 | | 6 | 42 |
| 130 | | 346 | | 2453 | | 1185 | | 63 | | 1123 | | 506 | | | 52 | | 2358 | | 52 | | 154 | | 137 | | 52 | | 143 | | | 52 | | 52 | 52 |
| 131 | | 385 | | 484 | | 0 | | 18 | | 24 | | 238 | | | 216 | | 230 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 132 | | 328 | | 325 | | 62 | | 262 | | 6 | | 226 | | | 262 | | 393 | | 0 | | 8 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 133 | | 294 | | 737 | | 369 | | 159 | | 483 | | 1025 | | | 159 | | 1076 | | 114 | | 133 | | 114 | | 114 | | 114 | | | 125 | | 125 | 125 |
| 134 | | 800 | | 148 | | 144 | | 468 | | 170 | | 515 | | | 401 | | 911 | | 14 | | 15 | | 14 | | 14 | | 14 | | | 15 | | 35 | 28 |
| 135 | | 996 | | 648 | | 586 | | 202 | | 530 | | 406 | | | 482 | | 790 | | 34 | | 122 | | 34 | | 34 | | 34 | | | 34 | | 34 | 34 |
| 136 | | 272 | | 219 | | 0 | | 0 | | 0 | | 171 | | | 0 | | 132 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 137 | | 1048 | | 580 | | 506 | | 588 | | 632 | | 691 | | | 1009 | | 1253 | | 38 | | 54 | | 39 | | 77 | | 39 | | | 50 | | 48 | 38 |
| 138 | | 505 | | 528 | | 68 | | 16 | | 29 | | 182 | | | 90 | | 553 | | 0 | | 8 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 139 | | 657 | | 848 | | 87 | | 8 | | 408 | | 457 | | | 8 | | 1262 | | 8 | | 8 | | 8 | | 8 | | 8 | | | 8 | | 8 | 8 |
| 140 | | 529 | | 674 | | 69 | | 355 | | 57 | | 100 | | | 198 | | 470 | | 18 | | 18 | | 17 | | 18 | | 17 | | | 17 | | 18 | 18 |
| 141 | | 1252 | | 1115 | | 566 | | 666 | | 768 | | 327 | | | 506 | | 1032 | | 265 | | 227 | | 182 | | 227 | | 227 | | | 260 | | 220 | 227 |
| 142 | | 1508 | | 1199 | | 970 | | 1691 | | 457 | | 621 | | | 1421 | | 1563 | | 386 | | 337 | | 337 | | 424 | | 337 | | | 337 | | 337 | 382 |
| 143 | | 2062 | | 1826 | | 292 | | 192 | | 292 | | 669 | | | 192 | | 1755 | | 165 | | 157 | | 157 | | 157 | | 157 | | | 157 | | 173 | 173 |
| 144 | | 1652 | | 765 | | 574 | | 689 | | 383 | | 716 | | | 516 | | 1748 | | 274 | | 237 | | 237 | | 191 | | 202 | | | 191 | | 282 | 248 |
| 145 | | 1287 | | 1055 | | 448 | | 1169 | | 933 | | 489 | | | 1193 | | 1036 | | 238 | | 267 | | 207 | | 207 | | 207 | | | 238 | | 238 | 238 |
| 146 | | 1817 | | 1885 | | 797 | | 271 | | 771 | | 550 | | | 519 | | 1227 | | 213 | | 330 | | 213 | | 213 | | 213 | | | 213 | | 213 | 213 |
| 147 | | 3356 | | 1987 | | 728 | | 1235 | | 728 | | 1464 | | | 1235 | | 3500 | | 584 | | 554 | | 476 | | 467 | | 467 | | | 467 | | 446 | 467 |
| 148 | | 1404 | | 1989 | | 1000 | | 847 | | 1813 | | 449 | | | 611 | | 2400 | | 183 | | 344 | | 189 | | 183 | | 229 | | | 183 | | 183 | 189 |
| 149 | | 2549 | | 2946 | | 1652 | | 652 | | 749 | | 275 | | | 652 | | 1571 | | 334 | | 245 | | 352 | | 175 | | 175 | | | 175 | | 175 | 175 |
| 150 | | 2460 | | 979 | | 627 | | 904 | | 751 | | 771 | | | 936 | | 1209 | | 501 | | 351 | | 295 | | 295 | | 295 | | | 295 | | 307 | 295 |
| 151 | | 1043 | | 1656 | | 958 | | 385 | | 473 | | 941 | | | 488 | | 1770 | | 210 | | 350 | | 210 | | 210 | | 210 | | | 210 | | 210 | 210 |
| 152 | | 1100 | | 945 | | 212 | | 384 | | 0 | | 125 | | | 54 | | 1618 | | 34 | | 42 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 153 | | 1412 | | 1512 | | 376 | | 152 | | 571 | | 544 | | | 614 | | 613 | | 60 | | 98 | | 60 | | 60 | | 60 | | | 74 | | 60 | 60 |
| 154 | | 378 | | 956 | | 70 | | 77 | | 184 | | 111 | | | 140 | | 229 | | 0 | | 0 | | 0 | | 0 | | 0 | | | 0 | | 0 | 0 |
| 155 | | 492 | | 361 | | 191 | | 170 | | 119 | | 326 | | | 170 | | 497 | | 45 | | 53 | | 45 | | 45 | | 45 | | | 53 | | 53 | 45 |
| 156 | | 1498 | | 389 | | 92 | | 47 | | 93 | | 223 | | | 165 | | 1286 | | 14 | | 14 | | 0 | | 0 | | 0 | | | 0 | | 14 | 22 |
| 157 | | 1241 | | 1590 | | 606 | | 638 | | 293 | | 555 | | | 638 | | 1799 | | 70 | | 176 | | 70 | | 70 | | 70 | | | 70 | | 140 | 70 |
| 158 | | 1614 | | 638 | | 185 | | 1077 | | 407 | | 1195 | | | 529 | | 952 | | 69 | | 136 | | 69 | | 69 | | 78 | | | 130 | | 69 | 69 |
| 159 | | 1923 | | 1882 | | 414 | | 1523 | | 798 | | 1357 | | | 227 | | 1260 | | 98 | | 154 | | 59 | | 122 | | 59 | | | 202 | | 82 | 82 |
| 160 | | 1179 | | 1953 | | 1281 | | 1184 | | 1146 | | 1453 | | | 1122 | | 2202 | | 557 | | 590 | | 612 | | 558 | | 558 | | | 558 | | 558 | 558 |
|  |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  |  | |

Table-comparison of TWT

It can be observed that the ANN variants always have lower TWT than the greedy algorithms. To understand this completely as solution named EOS is defined.

Estimated optimal solution(EOS) ,computed based on Weibull distribution as discussed in Rardin and Uzsoy(2001),is considered as a benchmark solution.The following table contains the comparison of EOS calculated using all the 16 variants discussed above with the optimal solution for 160 cases.The difference between EOS and optimal solution is also listed in the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| Instance Number | EOS | Optimal Solution | Difference |
| 1 | 30 | 21 | 9 |
| 2 | 30 | 0 | 30 |
| 3 | 31 | 0 | 31 |
| 4 | 102 | 0 | 102 |
| 5 | 0 | 0 | 0 |
| 6 | 16 | 0 | 16 |
| 7 | 65 | 44 | 21 |
| 8 | 132 | 92 | 40 |
| 9 | 182 | 42 | 140 |
| 10 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 |
| 14 | 22 | 12 | 10 |
| 15 | 0 | 0 | 0 |
| 16 | 69 | 89 | -20 |
| 17 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 |
| 19 | 16 | 0 | 16 |
| 20 | 37 | 12 | 25 |
| 21 | 78 | 0 | 78 |
| 22 | 56 | 56 | 0 |
| 23 | 29 | 29 | 0 |
| 24 | 498 | 213 | 285 |
| 25 | 159 | 32 | 127 |
| 26 | 299 | 181 | 118 |
| 27 | 119 | 0 | 119 |
| 28 | 305 | 30 | 275 |
| 29 | 1688 | 813 | 875 |
| 30 | 240 | 225 | 15 |
| 31 | 20 | 18 | 2 |
| 32 | 4 | 0 | 4 |
| 33 | 8 | 0 | 8 |
| 34 | 80 | 0 | 80 |
| 35 | 219 | 78 | 141 |
| 36 | 450 | 381 | 69 |
| 37 | 15 | 5 | 10 |
| 38 | 116 | 55 | 61 |
| 39 | 6 | 6 | 0 |
| 40 | 0 | 0 | 0 |
| 41 | 54 | 0 | 54 |
| 42 | 35 | 0 | 35 |
| 43 | 24 | 7 | 17 |
| 44 | 55 | 0 | 55 |
| 45 | 0 | 0 | 0 |
| 46 | 0 | 0 | 0 |
| 47 | 76 | 50 | 26 |
| 48 | 56 | 36 | 20 |
| 49 | 72 | 50 | 22 |
| 50 | 0 | 0 | 0 |
| 51 | 15 | 0 | 15 |
| 52 | 42 | 0 | 42 |
| 53 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 |
| 55 | 0 | 0 | 0 |
| 56 | 30 | 30 | 0 |
| 57 | 10 | 10 | 0 |
| 58 | 133 | 46 | 87 |
| 59 | 27 | 18 | 9 |
| 60 | 52 | 52 | 0 |
| 61 | 46 | 46 | 0 |
| 62 | 106 | 46 | 60 |
| 63 | 92 | 70 | 22 |
| 64 | 130 | 77 | 53 |
| 65 | 152 | 152 | 0 |
| 66 | 146 | 144 | 2 |
| 67 | 115 | 10 | 105 |
| 68 | 465 | 182 | 283 |
| 69 | 99 | 0 | 99 |
| 70 | 191 | 0 | 191 |
| 71 | 69 | 16 | 53 |
| 72 | 4 | 0 | 4 |
| 73 | 0 | 0 | 0 |
| 74 | 108 | 0 | 108 |
| 75 | 48 | 0 | 48 |
| 76 | 501 | 110 | 391 |
| 77 | 131 | 96 | 35 |
| 78 | 0 | 0 | 0 |
| 79 | 84 | 13 | 71 |
| 80 | 0 | 0 | 0 |
| 81 | 121 | 97 | 24 |
| 82 | 63 | 0 | 63 |
| 83 | 29 | 7 | 22 |
| 84 | 0 | 0 | 0 |
| 85 | 35 | 0 | 35 |
| 86 | 100 | 44 | 56 |
| 87 | 167 | 162 | 5 |
| 88 | 890 | 326 | 564 |
| 89 | 0 | 0 | 0 |
| 90 | 22 | 14 | 8 |
| 91 | 0 | 0 | 0 |
| 92 | 0 | 0 | 0 |
| 93 | 0 | 0 | 0 |
| 94 | 0 | 0 | 0 |
| 95 | 0 | 0 | 0 |
| 96 | 24 | 0 | 24 |
| 97 | 54 | 12 | 42 |
| 98 | 12 | 0 | 12 |
| 99 | 0 | 0 | 0 |
| 100 | 78 | 0 | 78 |
| 101 | 324 | 168 | 156 |
| 102 | 111 | 29 | 82 |
| 103 | 120 | 11 | 109 |
| 104 | 353 | 301 | 52 |
| 105 | 376 | 225 | 151 |
| 106 | 487 | 385 | 102 |
| 107 | 212 | 196 | 16 |
| 108 | 459 | 554 | -95 |
| 109 | 330 | 330 | 0 |
| 110 | 570 | 570 | 0 |
| 111 | 21 | 7 | 14 |
| 112 | 100 | 90 | 10 |
| 113 | 16 | 0 | 16 |
| 114 | 0 | 0 | 0 |
| 115 | 78 | 27 | 51 |
| 116 | 28 | 0 | 28 |
| 117 | 595 | 334 | 261 |
| 118 | 0 | 0 | 0 |
| 119 | 21 | 0 | 21 |
| 120 | 0 | 0 | 0 |
| 121 | 65 | 10 | 55 |
| 122 | 16 | 0 | 16 |
| 123 | 0 | 0 | 0 |
| 124 | 71 | 0 | 71 |
| 125 | 0 | 0 | 0 |
| 126 | 76 | 72 | 4 |
| 127 | 132 | 132 | 0 |
| 128 | 77 | 0 | 77 |
| 129 | 0 | 16 | -16 |
| 130 | 52 | 52 | 0 |
| 131 | 0 | 0 | 0 |
| 132 | 0 | 0 | 0 |
| 133 | 114 | 51 | 63 |
| 134 | 14 | 7 | 7 |
| 135 | 34 | 0 | 34 |
| 136 | 0 | 0 | 0 |
| 137 | 38 | 0 | 38 |
| 138 | 0 | 0 | 0 |
| 139 | 8 | 0 | 8 |
| 140 | 17 | 0 | 17 |
| 141 | 180.55 | 143 | 37.55 |
| 142 | 337 | 184 | 153 |
| 143 | 157 | 115 | 42 |
| 144 | 191 | 14 | 177 |
| 145 | 207 | 35 | 172 |
| 146 | 213 | 21 | 192 |
| 147 | 445.85 | 413 | 32.85 |
| 148 | 183 | 83 | 100 |
| 149 | 175 | 138 | 37 |
| 150 | 295 | 348 | -53 |
| 151 | 210 | 73 | 137 |
| 152 | 0 | 0 | 0 |
| 153 | 60 | 28 | 32 |
| 154 | 0 | 0 | 0 |
| 155 | 45 | 0 | 45 |
| 156 | 0 | 0 | 0 |
| 157 | 70 | 0 | 70 |
| 158 | 69 | 15 | 54 |
| 159 | 59 | 139 | -80 |
| 160 | 557 | 131 | 426 |

Table-Comparison of EOS and optimal solution

It can be observed that for 50 instances the EOS and optimal solution match.

RPD =[(heuristic algorithm solution – EOS)/EOS]\*100

The average of the RPD values for all 5 instances of each of the 32 configurations is computed. The following table contains the comparison of ARPD.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Combination | Size | LPT | ERT | EDD | FDD | ODD | LST | CI | Size-ANN | LPT-ANN | ERT-ANN | EDD-ANN | FDD-ANN | ODD-ANN | LST-ANN | CI-ANN |
| 10\_20\_10\_30\_6 | 76445.43 | 36073 | 435.22 | 19918 | 4382.6 | 597.61 | 299.41 | 50826.4 | 0 | 9.61 | 0 | 0 | 21.33 | 0 | 0 | 9.33 |
| 10\_20\_10\_30\_10 | 158866.4 | 232587 | 19550.6 | 74395 | 22983 | 45673 | 53355.2 | 229570 | 1401.21 | 5.05 | 0 | 0 | 0 | 0 | 7009 | 0.76 |
| 10\_20\_10\_45\_6 | 164340 | 111204 | 12298.2 | 20855 | 12311 | 43599 | 9624.55 | 185520 | 0 | 16.36 | 0 | 0 | 0 | 0 | 5.45 | 10.91 |
| 10\_20\_10\_45\_10 | 127413.5 | 223645 | 54980.9 | 21917 | 63186 | 53221 | 29741 | 193365 | 0 | 815.72 | 0 | 5.8 | 3.24 | 9.04 | 0 | 0 |
| 10\_20\_15\_30\_6 | 778.82 | 884.68 | 322.65 | 565.3 | 201.02 | 315.84 | 621.58 | 1235.4 | 20.51 | 63.98 | 0.12 | 16.33 | 2.49 | 2.49 | 10.34 | 59.75 |
| 10\_20\_15\_30\_10 | 189.16 | 258.11 | 92.13 | 171.9 | 73.33 | 120.31 | 226.09 | 342.79 | 3.84 | 15.59 | 3.9 | 0 | 3.55 | 1 | 0.2 | 0 |
| 10\_20\_15\_45\_6 | 3870.78 | 4295.8 | 2184.58 | 937.1 | 646.89 | 880.01 | 1035.18 | 6226 | 1.74 | 78.13 | 0 | 0 | 0 | 0 | 0 | 70 |
| 10\_20\_15\_45\_10 | 10764.88 | 67980 | 28763.1 | 2196 | 1516.2 | 32922 | 1922.82 | 4062.32 | 0.04 | 1.24 | 0.04 | 0.04 | 0 | 2.12 | 0.04 | 13.84 |
| 10\_30\_10\_30\_6 | 163140.2 | 148387 | 44196 | 111.7 | 49055 | 23334 | 234.42 | 195909 | 0 | 17.97 | 2.55 | 0 | 6.67 | 5.83 | 0 | 40.88 |
| 10\_30\_10\_30\_10 | 169599.8 | 339663 | 18829.4 | 74381 | 20749 | 97831 | 83208.9 | 243559 | 0 | 3601.3 | 0 | 10.71 | 0 | 0 | 0 | 0 |
| 10\_30\_10\_45\_6 | 116198.9 | 115780 | 46599.4 | 24333 | 33994 | 40889 | 24728 | 83285.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10\_30\_10\_45\_10 | 2775.47 | 3573.9 | 675.21 | 158.5 | 921.33 | 1252.6 | 369.2 | 2722.86 | 0 | 41.41 | 0 | 0 | 0 | 0 | 0 | 36 |
| 10\_30\_15\_30\_6 | 702.58 | 886.7 | 187.53 | 232.8 | 182.39 | 600.06 | 281.25 | 944.86 | 18.89 | 14.56 | 0 | 10.92 | 4.74 | 1.05 | 22.84 | 0 |
| 10\_30\_15\_30\_10 | 614.67 | 617.67 | 63.13 | 120.8 | 131.43 | 187.35 | 134.03 | 479.46 | 0 | 6.26 | 0 | 0 | 0 | 1.04 | 0 | 1.64 |
| 10\_30\_15\_45\_6 | 116829.1 | 104439 | 46864.2 | 9412 | 11264 | 5366.1 | 10441.4 | 72123.4 | 800 | 0 | 0 | 0 | 0 | 800 | 0 | 800 |
| 10\_30\_15\_45\_10 | 198809.6 | 158869 | 29159.5 | 7291 | 42896 | 78184 | 7315.29 | 271550 | 0 | 26.97 | 2.14 | 0 | 0 | 1.16 | 0 | 0 |
| 12\_20\_10\_30\_6 | 150398.7 | 79502 | 31454.9 | 61912 | 25476 | 66956 | 19526.3 | 112213 | 12600.6 | 11.24 | 0.57 | 10.65 | 14.4 | 0.57 | 17.51 | 13.9 |
| 12\_20\_10\_30\_10 | 111666.8 | 206498 | 36714.1 | 76516 | 75547 | 28139 | 83278.1 | 109878 | 51.68 | 2640.4 | 1.56 | 22.55 | 20.91 | 0 | 33.1 | 1223 |
| 12\_20\_10\_45\_6 | 323400 | 380400 | 122400 | 43200 | 106600 | 121800 | 106200 | 363400 | 4800 | 5200 | 800 | 5000 | 0 | 1200 | 800 | 1200 |
| 12\_20\_10\_45\_10 | 196449.3 | 133872 | 57408.4 | 1E+05 | 53709 | 118394 | 128223 | 195876 | 72.04 | 5222.6 | 5 | 15 | 0.37 | 14.63 | 2603 | 5200 |
| 12\_20\_15\_30\_6 | 383.51 | 500.02 | 248.61 | 228.6 | 153.37 | 114.11 | 186.05 | 530.62 | 8.08 | 30.1 | 5.03 | 10.71 | 1.66 | 1.51 | 4.17 | 1.03 |
| 12\_20\_15\_30\_10 | 452.09 | 459.83 | 280 | 219.2 | 172.46 | 129.95 | 318.35 | 547.7 | 11.24 | 21.48 | 16.56 | 10.1 | 7.92 | 11.51 | 16.12 | 10.39 |
| 12\_20\_15\_45\_6 | 79915.61 | 61972 | 29447.3 | 432.9 | 5373.5 | 21236 | 757.48 | 72105.5 | 96.52 | 26.08 | 12.38 | 5.38 | 7.8 | 16.85 | 5.9 | 46.08 |
| 12\_20\_15\_45\_10 | 219074.3 | 368402 | 124883 | 67889 | 100026 | 84528 | 52898.6 | 317528 | 0 | 82.86 | 47.13 | 81.43 | 20.71 | 0.71 | 1620 | 6026 |
| 12\_30\_10\_30\_6 | 275718.6 | 108334 | 39805.6 | 54793 | 79490 | 89497 | 70695.5 | 308440 | 1843.75 | 71.25 | 0 | 0 | 0 | 9.3 | 0 | 0 |
| 12\_30\_10\_30\_10 | 413893.9 | 283050 | 15787.3 | 2E+05 | 89590 | 157410 | 230603 | 376968 | 1218.85 | 4861.7 | 32.69 | 15212 | 35 | 3212 | 1200 | 8413 |
| 12\_30\_10\_45\_6 | 144320.3 | 162462 | 12955.2 | 56755 | 6579.4 | 93894 | 96424.3 | 126495 | 0 | 1656.5 | 0 | 0 | 0 | 3.36 | 31.93 | 21.93 |
| 12\_30\_10\_45\_10 | 158156.4 | 152558 | 14105 | 3887 | 7159.7 | 72164 | 18724 | 141307 | 1.18 | 1609.6 | 0.53 | 21.7 | 0.53 | 6.32 | 6.44 | 1.18 |
| 12\_30\_15\_30\_6 | 688.19 | 509.32 | 160.85 | 283.7 | 179.64 | 180.52 | 234.14 | 613.78 | 24.97 | 15.76 | 4.98 | 10.31 | 6.3 | 11.8 | 18.93 | 18.82 |
| 12\_30\_15\_30\_10 | 832.69 | 786.57 | 348.09 | 209.2 | 339.71 | 150.09 | 208.88 | 696.02 | 38.34 | 45.23 | 22.24 | 0.95 | 5.98 | 0.95 | 0.82 | 1.6 |
| 12\_30\_15\_45\_6 | 296328.7 | 380962 | 56641.5 | 92303 | 37028 | 47556 | 39066.7 | 369934 | 6800 | 8429.6 | 0 | 0 | 0 | 8.22 | 3.56 | 0 |
| 12\_30\_15\_45\_10 | 301036.6 | 79067 | 18733.1 | 10373 | 19033 | 45537 | 33372.9 | 258416 | 2813.22 | 2883.1 | 1.97 | 21.39 | 2.64 | 66.19 | 2828 | 4408 |

Comparison of ARPD for all 32 configurations

It can be observed from the above table that on an average the ANN variant of Size algorithm is closest to the EOS.

Integrated ranks are calculated using the RPD values. The following table contains the the number of times each of the algorithms came at that specific rank. The last column shows the integrated ranks followed by the ranks according to the the integrated ranks.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Instance Number | Size | LPT | ERT | EDD | FDD | ODD | LST | CI | Size-ANN | LPT-ANN | ERT-ANN | EDD-ANN | FDD-ANN | ODD-ANN | LST-ANN | CI-ANN |
| 1 | 0 | 0 | 7 | 18 | 8 | 5 | 16 | 2 | 114 | 73 | 133 | 132 | 134 | 122 | 120 | 113 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 4 | 2 | 3 | 3 | 4 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 3 | 4 | 3 | 5 | 3 |
| 4 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 | 5 | 5 | 5 | 3 | 4 | 3 | 4 |
| 5 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 4 | 5 | 4 | 0 | 4 | 7 | 7 | 7 |
| 6 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 7 | 11 | 6 | 3 | 5 | 7 | 7 | 8 |
| 7 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 12 | 15 | 2 | 1 | 4 | 9 | 8 | 10 |
| 8 | 0 | 0 | 2 | 5 | 5 | 1 | 1 | 0 | 12 | 35 | 5 | 12 | 3 | 5 | 7 | 9 |
| 9 | 2 | 1 | 31 | 33 | 20 | 16 | 21 | 0 | 1 | 10 | 1 | 0 | 1 | 0 | 0 | 1 |
| 10 | 2 | 5 | 27 | 27 | 26 | 22 | 30 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 |
| 11 | 11 | 4 | 28 | 15 | 38 | 35 | 19 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 3 | 4 | 21 | 24 | 37 | 23 | 40 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 16 | 20 | 27 | 18 | 17 | 26 | 14 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 33 | 36 | 13 | 10 | 5 | 24 | 9 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 54 | 42 | 3 | 3 | 1 | 6 | 7 | 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 39 | 48 | 0 | 4 | 1 | 1 | 1 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Integrated rank | 14.4 | 14.5 | 10.7 | 9.86 | 10.5 | 11.4 | 10.3 | 14.7 | 2.54 | 4.36 | 1.76 | 1.81 | 1.71 | 2.08 | 2.14 | 2.44 |
| Rank | 14 | 15 | 12 | 9 | 11 | 13 | 10 | 16 | 7 | 8 | 2 | 3 | 1 | 4 | 5 | 6 |

Comparison of Integrated ranks

It can be observed from the above table that the ANN variant of FDD gives the best results as it’s rank is 1.

**(b)Large Scale problems**

640 large scale instances are generated randomly according to the experimental design discussed before.The TWT for each instance is calculated using the 16 algorithms. The estimated optimal solution can also be calculated using the formula mentioned earlier.

Learning rate alpha is set to 0.002 when number of jobs is 25,0.0002 when number of jobs is 50,0.00002 when number of jobs is 75 and 0.000002 for number of jobs is 100.

The ARPD is computed according to the formula discussed before.

The following table contains the ARPD for all 64 configurations.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Insrance Number | Size | LPT | ERT | EDD | FDD | ODD | LST | CI | Size-ANN | LPT-ANN | ERT-ANN | EDD-ANN | FDD-ANN | ODD-ANN | LST-ANN | CI-ANN |
| 1 | 233 | 269 | 132 | 183 | 100 | 101 | 184 | 178 | 58.1 | 17.7 | 84.2 | 29.9 | 10.8 | 24.7 | 73.6 | 63 |
| 2 | 157 | 173 | 79 | 89.4 | 54.3 | 49.8 | 94.1 | 82.4 | 24.5 | 11.5 | 18.7 | 12.6 | 9.58 | 6.95 | 26.9 | 31.2 |
| 3 | 726 | 685 | 377 | 312 | 296 | 261 | 383 | 245 | 207 | 119 | 326 | 9.57 | 71.8 | 93.6 | 204 | 179 |
| 4 | 228 | 284 | 128 | 157 | 112 | 107 | 155 | 126 | 34.7 | 19.5 | 40.6 | 29.7 | 15.9 | 22.2 | 41 | 38.8 |
| 5 | 135 | 141 | 112 | 99.2 | 62.8 | 37 | 101 | 103 | 27.8 | 21.4 | 20.1 | 18.6 | 15.7 | 10.6 | 38.2 | 39.6 |
| 6 | 118 | 132 | 77.8 | 65.1 | 52.7 | 38.4 | 93.1 | 79.2 | 23.6 | 16.3 | 6.51 | 16.7 | 9.54 | 11.9 | 21.3 | 24.4 |
| 7 | 275 | 277 | 181 | 155 | 82.4 | 50.2 | 202 | 190 | 58.9 | 42 | 75.3 | 35.3 | 12.8 | 5.04 | 58.5 | 62.7 |
| 8 | 138 | 133 | 91.2 | 87.8 | 58.8 | 47.6 | 90.8 | 98.4 | 28.6 | 11.4 | 7.21 | 18.3 | 7.28 | 11.8 | 22.1 | 25.1 |
| 9 | 431 | 519 | 195 | 290 | 165 | 237 | 275 | 242 | 127 | 25.7 | 119 | 45 | 31.2 | 57 | 133 | 118 |
| 10 | 235 | 295 | 117 | 165 | 106 | 107 | 143 | 127 | 45.4 | 9.79 | 33 | 30.6 | 8.16 | 26 | 50.7 | 44.4 |
| 11 | 809 | 956 | 334 | 295 | 373 | 326 | 309 | 330 | 258 | 94.1 | 235 | 31.8 | 97.3 | 90.9 | 199 | 247 |
| 12 | 505 | 511 | 142 | 250 | 132 | 193 | 233 | 250 | 96.5 | 21.8 | 117 | 11.3 | 25.2 | 29.5 | 91.9 | 105 |
| 13 | 150 | 158 | 69.9 | 97.7 | 64.3 | 59.9 | 105 | 96.4 | 36 | 4.56 | 20.8 | 17.4 | 10.2 | 22.2 | 38.7 | 34.6 |
| 14 | 106 | 133 | 62.3 | 76.8 | 65.3 | 51 | 82.9 | 66.7 | 20 | 6.77 | 8.51 | 13.2 | 9.23 | 9.57 | 22.1 | 21.4 |
| 15 | 310 | 345 | 124 | 130 | 133 | 109 | 157 | 171 | 62.7 | 12.9 | 29.6 | 26.3 | 15.6 | 29.1 | 82.1 | 76.1 |
| 16 | 215 | 219 | 94.4 | 123 | 90.7 | 80.2 | 142 | 100 | 48.5 | 3.94 | 37.2 | 34.3 | 19.2 | 18.8 | 46.9 | 42.2 |
| 17 | 115 | 120 | 95.5 | 89.8 | 67.8 | 39.2 | 106 | 96.2 | 51.2 | 48.7 | 81.9 | 42.7 | 25.6 | 5.59 | 58.5 | 57.1 |
| 18 | 93.2 | 113 | 86.2 | 72.3 | 63.3 | 28.2 | 95.7 | 74.4 | 37.4 | 40 | 61.4 | 33 | 23.3 | 4.36 | 47 | 46.5 |
| 19 | 140 | 139 | 107 | 113 | 73.7 | 29.5 | 119 | 117 | 64.7 | 55.1 | 100 | 52.6 | 31.4 | 5.68 | 64.6 | 68.2 |
| 20 | 85.5 | 102 | 70 | 68.1 | 52.3 | 24.3 | 80.7 | 73.4 | 26.6 | 29 | 51.7 | 28 | 14.5 | 1.33 | 36.8 | 38.4 |
| 21 | 105 | 102 | 93.1 | 76.2 | 52.3 | 20.2 | 98.5 | 91 | 51.8 | 47 | 83.7 | 37.8 | 18.8 | 2.25 | 52.4 | 50.8 |
| 22 | 70.6 | 92.4 | 59 | 56.3 | 28.9 | 11 | 74.8 | 57.9 | 29.2 | 28 | 29.1 | 22 | 11.3 | 0.66 | 35.1 | 33.3 |
| 23 | 106 | 111 | 97 | 85.8 | 56.6 | 22 | 111 | 96.8 | 48.3 | 54.1 | 86.2 | 42.9 | 23.4 | 3.53 | 55.7 | 59 |
| 24 | 86.2 | 99.5 | 69.2 | 65.7 | 37.6 | 15.6 | 85.7 | 69.9 | 34.7 | 34.4 | 37.2 | 25.4 | 15.7 | 1.45 | 38.8 | 40.6 |
| 25 | 138 | 145 | 67.7 | 84.7 | 52.8 | 37.1 | 91.5 | 87.1 | 56.1 | 31.6 | 96.4 | 25.8 | 15.9 | 1.75 | 63.4 | 63.8 |
| 26 | 85.2 | 103 | 56.6 | 48.4 | 40.4 | 27.9 | 59.2 | 51.4 | 27.3 | 14.8 | 45.2 | 14.7 | 10.1 | 1.54 | 41.2 | 40.4 |
| 27 | 120 | 134 | 67.3 | 66.3 | 58.4 | 26.2 | 78.6 | 64.4 | 49.6 | 27.3 | 86.7 | 17.7 | 13.2 | 1.65 | 47.5 | 50.2 |
| 28 | 96.8 | 125 | 54.2 | 62.8 | 45.5 | 26.2 | 70.2 | 50.2 | 27.4 | 24.9 | 54.7 | 17.1 | 12.2 | 1.24 | 40 | 40.3 |
| 29 | 111 | 120 | 88.1 | 93.6 | 60.7 | 31.2 | 107 | 94.4 | 47.2 | 46.6 | 75.7 | 32.6 | 26.7 | 4.24 | 58 | 59.3 |
| 30 | 68.8 | 80.5 | 53.4 | 43.1 | 37 | 16.1 | 57.6 | 52.6 | 26.1 | 19.3 | 24.2 | 16.5 | 11.2 | 2.11 | 27.9 | 28.7 |
| 31 | 120 | 122 | 74.5 | 82 | 53.4 | 25.5 | 86.5 | 75.2 | 48.3 | 37.2 | 84.7 | 32 | 17.3 | 2.28 | 54.9 | 56.9 |
| 32 | 88.1 | 97.1 | 65.6 | 50.5 | 45.8 | 20.1 | 55.8 | 55.1 | 32.3 | 20.5 | 27.5 | 20.7 | 16.1 | 2.32 | 34.3 | 38.6 |
| 33 | 101 | 99.9 | 81.6 | 70 | 56.9 | 21.3 | 90.1 | 80.1 | 59.6 | 53.7 | 76 | 46.3 | 30.8 | 4.55 | 58.8 | 63.8 |
| 34 | 76.6 | 90.4 | 66.3 | 58.8 | 45.5 | 18.3 | 69.6 | 62.4 | 40 | 45.6 | 69.6 | 36.1 | 26.7 | 4.16 | 49.2 | 46.1 |
| 35 | 120 | 112 | 101 | 97.7 | 75 | 37.7 | 106 | 101 | 71.9 | 70.7 | 87.6 | 63.3 | 46.7 | 14 | 72.2 | 78.1 |
| 36 | 80.7 | 91.2 | 69.9 | 66.2 | 49.9 | 23.6 | 77.4 | 67.4 | 43.4 | 47.5 | 73.1 | 43.3 | 28.6 | 6.38 | 45.7 | 47.3 |
| 37 | 90.7 | 95.9 | 90.9 | 71.6 | 52.5 | 17.7 | 93.2 | 89 | 60.4 | 65.2 | 79.9 | 47.6 | 31.3 | 3.34 | 64.5 | 63.6 |
| 38 | 73.8 | 83.8 | 71.2 | 59.3 | 41.6 | 15.9 | 75.4 | 66 | 37.5 | 48.6 | 72.2 | 35.9 | 23.9 | 3.23 | 45.2 | 44.7 |
| 39 | 102 | 102 | 102 | 86.7 | 51.3 | 15.7 | 111 | 101 | 63.3 | 68.5 | 85.3 | 58.6 | 28.9 | 2.49 | 72.1 | 72.3 |
| 40 | 84.5 | 98 | 77.9 | 75.6 | 47.1 | 20.3 | 85.8 | 78.5 | 46.6 | 57.1 | 82.8 | 52.5 | 28.9 | 4.41 | 50.5 | 54.5 |
| 41 | 88.5 | 89.5 | 65.8 | 69.5 | 51.6 | 23.4 | 77.8 | 63.9 | 44.3 | 39.3 | 60.8 | 36.4 | 26.1 | 5.12 | 52.5 | 54.6 |
| 42 | 69.7 | 80.8 | 47.4 | 55.8 | 38.1 | 25.1 | 57.8 | 49.7 | 30.6 | 30.4 | 61.2 | 26.9 | 19.4 | 4.56 | 35.6 | 38 |
| 43 | 105 | 104 | 67.4 | 66.1 | 52.2 | 20.6 | 75.3 | 74.4 | 54.1 | 41.1 | 75.5 | 37.2 | 24.8 | 4.21 | 59.6 | 58.2 |
| 44 | 83.2 | 98.5 | 60.8 | 63.5 | 43.5 | 22.1 | 69 | 58.6 | 43.2 | 40.3 | 71.3 | 33.9 | 24.5 | 4.53 | 43.9 | 41 |
| 45 | 100 | 91.7 | 75.1 | 66.3 | 54.1 | 23.5 | 86.5 | 77.2 | 61.2 | 53 | 76.1 | 42.2 | 30 | 5.22 | 59.4 | 58.7 |
| 46 | 74.2 | 85 | 68.4 | 55.3 | 47.1 | 21.8 | 72.6 | 64.8 | 37.5 | 45.3 | 70.4 | 33.8 | 28.5 | 5.31 | 43.7 | 43.9 |
| 47 | 95.6 | 94.9 | 78 | 71.5 | 55.3 | 24 | 90.8 | 77 | 55.2 | 51.9 | 71.4 | 47.7 | 31 | 5.29 | 57.4 | 59.6 |
| 48 | 79.9 | 102 | 73.1 | 63.9 | 52.2 | 26.2 | 78.5 | 70.6 | 42.8 | 50.1 | 79.5 | 40.5 | 29.9 | 6.36 | 50.1 | 53.3 |
| 49 | 127 | 121 | 115 | 108 | 86.3 | 51.9 | 121 | 114 | 87.1 | 90.5 | 103 | 82.6 | 65.8 | 30.7 | 94.7 | 95.6 |
| 50 | 66.6 | 79.1 | 57.9 | 54.4 | 38.6 | 8.84 | 59.5 | 55.6 | 40.7 | 43.7 | 64.7 | 37.1 | 23.4 | 1.14 | 41.4 | 42.6 |
| 51 | 82.2 | 80.2 | 72.9 | 75.8 | 54.6 | 17.5 | 80.2 | 75.3 | 52.5 | 51 | 63.1 | 54.1 | 32.1 | 4.05 | 57.4 | 58.8 |
| 52 | 69.4 | 80.2 | 61.3 | 54.7 | 38.4 | 11 | 63.2 | 59.5 | 42.1 | 42.4 | 64.2 | 39.9 | 23.8 | 1.61 | 45.4 | 45.1 |
| 53 | 81.7 | 79.1 | 77 | 65 | 41 | 10.5 | 80.5 | 75.6 | 53.5 | 57.5 | 65.5 | 47.6 | 27 | 1.65 | 58.2 | 58.8 |
| 54 | 63.3 | 75.1 | 62.9 | 44.4 | 34.4 | 7.42 | 61.1 | 58.9 | 41.5 | 45.4 | 66.6 | 31.7 | 21.1 | 0.89 | 43.6 | 44.1 |
| 55 | 82.9 | 84 | 86.3 | 76.6 | 46.3 | 11.9 | 93.2 | 88.4 | 58 | 62.7 | 70.8 | 56.9 | 29.8 | 1.7 | 63.8 | 63.7 |
| 56 | 68.4 | 81.2 | 73.1 | 54.9 | 39.5 | 10.4 | 71.9 | 61.5 | 46.2 | 52.7 | 72 | 40.6 | 22.4 | 1.46 | 48.4 | 49.4 |
| 57 | 74.8 | 74.4 | 59.6 | 55.2 | 43.6 | 18.1 | 63.5 | 60.2 | 41.2 | 39.5 | 55.6 | 39 | 26.2 | 4.52 | 50.4 | 49.6 |
| 58 | 54.4 | 65.9 | 45.2 | 41.3 | 32.9 | 12.6 | 49.1 | 45.7 | 29.4 | 30.5 | 50.3 | 26.8 | 19.8 | 2.87 | 31.1 | 30.3 |
| 59 | 81.8 | 86.7 | 67.7 | 66 | 51.7 | 25.6 | 68.7 | 63.3 | 48.7 | 46.2 | 61.5 | 47.6 | 32.7 | 9.46 | 58.1 | 56.9 |
| 60 | 58.2 | 62.2 | 46.3 | 46.4 | 34.5 | 12.5 | 52.9 | 42.3 | 27.6 | 30.5 | 48.8 | 32.4 | 20.4 | 2.9 | 32.4 | 31.7 |
| 61 | 77.4 | 78.3 | 69.5 | 59.6 | 45.7 | 14.3 | 76.7 | 72 | 48.5 | 50.4 | 60.5 | 40.4 | 28.8 | 2.85 | 55.3 | 55.1 |
| 62 | 65.4 | 75.7 | 56.5 | 44.6 | 36.8 | 11.7 | 55.1 | 50.9 | 40.9 | 43.8 | 64.8 | 31.3 | 22 | 1.96 | 40.6 | 41.6 |
| 63 | 75.1 | 75.3 | 75 | 61.3 | 45.5 | 17.7 | 71 | 63.4 | 44.5 | 50.4 | 62.6 | 44.3 | 29.9 | 4.12 | 53.2 | 55 |
| 64 | 63.2 | 77.6 | 57.1 | 56.8 | 36.8 | 10.3 | 66.3 | 57.1 | 39.9 | 40.6 | 62.9 | 40.4 | 24.3 | 1.46 | 43 | 39.9 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Comparison of ARPD values

The following table contains the the number of times each algorithm came a corresponding rank. The last two rows shows the integrated ranks as well as the ranks according to the integrated ranks .

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Insrance Number | Size | LPT | ERT | EDD | FDD | ODD | LST | CI | Size-ANN | LPT-ANN | ERT-ANN | EDD-ANN | FDD-ANN | ODD-ANN | LST-ANN | CI-ANN |
| 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 6 | 40 | 21 | 30 | 42 | 501 | 1 | 2 |
| 2 | 0 | 0 | 0 | 0 | 0 | 324 | 1 | 0 | 10 | 36 | 23 | 43 | 161 | 33 | 1 | 6 |
| 3 | 0 | 0 | 1 | 2 | 4 | 71 | 1 | 2 | 18 | 42 | 21 | 80 | 347 | 37 | 10 | 6 |
| 4 | 0 | 0 | 0 | 9 | 84 | 30 | 0 | 1 | 81 | 82 | 26 | 194 | 55 | 26 | 32 | 27 |
| 5 | 0 | 0 | 3 | 10 | 68 | 28 | 1 | 7 | 115 | 117 | 31 | 125 | 21 | 17 | 49 | 49 |
| 6 | 1 | 0 | 7 | 18 | 67 | 33 | 0 | 6 | 125 | 100 | 17 | 63 | 9 | 13 | 91 | 95 |
| 7 | 0 | 0 | 8 | 20 | 68 | 17 | 2 | 8 | 102 | 85 | 19 | 49 | 4 | 10 | 129 | 115 |
| 8 | 3 | 0 | 15 | 13 | 68 | 24 | 4 | 21 | 71 | 66 | 28 | 33 | 1 | 3 | 138 | 139 |
| 9 | 2 | 0 | 26 | 29 | 81 | 41 | 7 | 34 | 65 | 51 | 50 | 17 | 0 | 0 | 114 | 114 |
| 10 | 13 | 7 | 73 | 69 | 85 | 23 | 25 | 55 | 31 | 17 | 78 | 4 | 0 | 0 | 51 | 54 |
| 11 | 28 | 6 | 131 | 130 | 55 | 15 | 71 | 109 | 8 | 1 | 77 | 1 | 0 | 0 | 14 | 24 |
| 12 | 49 | 30 | 100 | 125 | 27 | 12 | 91 | 131 | 7 | 3 | 56 | 1 | 0 | 0 | 5 | 6 |
| 13 | 63 | 21 | 106 | 102 | 18 | 11 | 134 | 127 | 1 | 0 | 74 | 0 | 0 | 0 | 4 | 2 |
| 14 | 100 | 58 | 96 | 71 | 11 | 7 | 138 | 83 | 0 | 0 | 82 | 0 | 0 | 0 | 1 | 1 |
| 15 | 208 | 168 | 49 | 27 | 3 | 4 | 106 | 38 | 0 | 0 | 37 | 0 | 0 | 0 | 0 | 0 |
| 16 | 173 | 350 | 25 | 13 | 1 | 0 | 59 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Integrated ranks | 14.35 | 15.16 | 12.03 | 11.34 | 7.92 | 4.44 | 13.2 | 11.88 | 6.39 | 5.55 | 9.78 | 4.62 | 2.84 | 1.62 | 7.46 | 7.52 |
| Rank | 15 | 16 | 13 | 11 | 9 | 3 | 14 | 12 | 6 | 5 | 10 | 4 | 2 | 1 | 7 | 8 |

Integrated ranks

It can be observed from the above table that the ANN variant of ODD(operational due date) gives the best results because it has the lowest integrated ranks.

The major drawback of the ILP(using LINGO set code) procedure is that it’s computational time is very high. Hence IPL procedure cannot be used for large-scale problems. The proposed heuristic procedure on the other hand yields close to optimal results in lesser time.The following table contains the computational time for 10 instances with the number of jobs=100 in seconds.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No | Size-Ann | ERT-ANN | LPT-ANN | EDD-ANN | FDD-ANN | ODD-ANN | LST-ANN | CI-ANN |
| 1 | 2.811847 | 2.640039 | 2.68687 | 2.577549 | 2.686871 | 2.718079 | 2.59311 | 2.671214 |
| 2 | 2.811888 | 2.733701 | 2.671251 | 2.624357 | 2.827498 | 2.811838 | 2.718111 | 2.718145 |
| 3 | 2.82741 | 2.718116 | 2.90557 | 2.608765 | 2.905539 | 2.671252 | 2.624387 | 2.749326 |
| 4 | 2.843116 | 2.731663 | 2.858736 | 2.608763 | 2.718108 | 2.671249 | 2.624386 | 2.65566 |
| 5 | 2.811809 | 2.733765 | 2.827432 | 2.499473 | 2.718117 | 2.843084 | 2.640038 | 2.668312 |
| 6 | 2.827464 | 2.639975 | 2.733736 | 2.733727 | 2.765026 | 2.983675 | 2.577522 | 2.827464 |
| 7 | 2.733789 | 2.764978 | 2.718111 | 2.608747 | 2.655576 | 2.968058 | 3.061802 | 2.968085 |
| 8 | 2.780544 | 2.686872 | 2.78063 | 2.671216 | 2.67125 | 2.665498 | 2.796203 | 2.764948 |
| 9 | 2.889949 | 2.686874 | 3.24926 | 2.65563 | 2.655627 | 2.811806 | 2.702456 | 2.827463 |
| 10 | 2.983675 | 2.76501 | 2.780548 | 2.561898 | 2.593174 | 2.671251 | 2.764978 | 2.938951 |
| Average | 2.832149 | 2.710099 | 2.821214 | 2.615012 | 2.719679 | 2.781579 | 2.710299 | 2.778957 |

Table-Computational time