# Project 5

Mitchell Hansen

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## 1 INTRODUCTION

For our final lab we took Dr. Davendra's three flow shop optimization problems, the first being vanilla (FSS), the second being blocking (FSSB), and the third being no-wait (FSSNW). We were provided the skeleton code for these labs already, they were only missing the method of generating the schedules. After completing the scheduler we completed the rest of the test trials in the lab.

## 2 METHODS

We closely followed the implimentation details on both Dr. Davendra's PDF, along with some other online resources to get the scheduling completed. We also modified the original code to run all 120 test cases for each of the three flow shop methods at once. These all printed out into the console where we then formatted and copied the data.

The flow shop algorithm itself is a heuristic on the scheduling problem which avoids brute force methods of determining optimal scheduling for concurrent tasks with multiple workers. This allows the program to return accurate results in little time, but has the downside that there is no guarentee that the results will be the actual optimum.

## 3 ANALYSIS

The three algorithms tested ran in acceptable times and produced seemingly accurate results. When compared with other test data found online, the results agreed. Other than prima facia impressions about the algorithm we gained little insight into how well this particular algorithm preformed against others of the same class.

# 4 CONCLUSION

This lab was an interesting detour away from our rigerous study of optimizing our original 15 functions. It's hard to tell exactly how good or bad our results were, but it was interesting to see optimization done in a different context.

# 5 RESULTS

**Flow Shop Results**

| Test case | FSS | Time(ms) | FSSB | Time(ms) | FSSNW | Time(ms) |
|---|---|---|---|---|---|---|
| 1 | 1297 | 0 | 1428 | 0 | 17091 | 0 |
| 2 | 1383 | 0 | 1445 | 0 | 18245 | 0 |
| 3 | 1189 | 0 | 1466 | 0 | 17929 | 0 |
| 4 | 1340 | 0 | 1529 | 0 | 18938 | 0 |
| 5 | 1277 | 0 | 1408 | 0 | 16657 | 0 |
| 6 | 1224 | 0 | 1459 | 0 | 16623 | 0 |
| 7 | 1289 | 0 | 1479 | 0 | 16812 | 0 |
| 8 | 1238 | 0 | 1516 | 0 | 16743 | 0 |
| 9 | 1259 | 0 | 1446 | 0 | 17288 | 0 |
| 10 | 1167 | 0 | 1381 | 0 | 16283 | 0 |
| 11 | 1707 | 1 | 1799 | 0 | 26305 | 0 |
| 12 | 1731 | 1 | 1922 | 0 | 27937 | 0 |
| 13 | 1604 | 2 | 1742 | 0 | 23435 | 0 |
| 14 | 1463 | 1 | 1665 | 0 | 23664 | 0 |
| 15 | 1486 | 1 | 1679 | 0 | 24546 | 0 |
| 16 | 1521 | 1 | 1672 | 0 | 23350 | 0 |
| 17 | 1536 | 1 | 1694 | 0 | 23410 | 0 |
| 18 | 1655 | 1 | 1837 | 0 | 25954 | 0 |
| 19 | 1653 | 1 | 1814 | 0 | 24379 | 0 |
| 20 | 1686 | 1 | 1820 | 0 | 26449 | 0 |
| 21 | 2396 | 2 | 2504 | 1 | 41291 | 1 |
| 22 | 2205 | 2 | 2370 | 1 | 40726 | 2 |
| 23 | 2451 | 2 | 2580 | 1 | 40938 | 1 |
| 24 | 2299 | 2 | 2408 | 1 | 40171 | 1 |
| 25 | 2370 | 2 | 2507 | 1 | 40726 | 1 |
| 26 | 2352 | 2 | 2447 | 1 | 39985 | 1 |
| 27 | 2359 | 2 | 2445 | 1 | 41381 | 1 |
| 28 | 2324 | 2 | 2416 | 1 | 40210 | 1 |
| 29 | 2326 | 2 | 2468 | 1 | 41029 | 1 |
| 30 | 2304 | 2 | 2410 | 1 | 40052 | 1 |
| 31 | 2729 | 10 | 3301 | 4 | 90040 | 4 |
| 32 | 2919 | 11 | 3473 | 4 | 93956 | 5 |
| 33 | 2734 | 10 | 3294 | 4 | 88526 | 5 |
| 34 | 2849 | 10 | 3348 | 4 | 93002 | 5 |
| 35 | 2870 | 10 | 3433 | 4 | 94648 | 5 |
| 36 | 2861 | 9 | 3387 | 4 | 91854 | 5 |
| 37 | 2776 | 9 | 3235 | 4 | 86024 | 5 |
| 38 | 2716 | 9 | 3307 | 4 | 90668 | 5 |
| 39 | 2600 | 9 | 3130 | 4 | 86204 | 5 |
| 40 | 2801 | 10 | 3369 | 4 | 94282 | 5 |
| 41 | 3221 | 12 | 3923 | 9 | 124255 | 10 |
| 42 | 3099 | 13 | 3779 | 9 | 119557 | 10 |
| 43 | 3051 | 12 | 3723 | 9 | 116540 | 10 |
| 44 | 3201 | 12 | 3905 | 9 | 120373 | 10 |
| 45 | 3153 | 11 | 3848 | 8 | 125511 | 10 |
| 46 | 3185 | 13 | 3900 | 9 | 118536 | 10 |
| 47 | 3239 | 12 | 3987 | 9 | 125846 | 10 |
| 48 | 3204 | 15 | 3842 | 9 | 122633 | 10 |
| 49 | 3054 | 25 | 3833 | 9 | 116951 | 10 |
| 50 | 3275 | 18 | 3947 | 9 | 122137 | 10 |
| 51 | 4133 | 39 | 4755 | 18 | 186401 | 22 |
| 52 | 3953 | 37 | 4544 | 18 | 172949 | 22 |
| 53 | 3941 | 34 | 4571 | 19 | 177161 | 23 |
| 54 | 3989 | 33 | 4681 | 19 | 167367 | 23 |
| 55 | 3995 | 38 | 4539 | 19 | 177463 | 22 |
| 56 | 3895 | 37 | 4589 | 20 | 173601 | 23 |
| 57 | 3917 | 38 | 4593 | 20 | 177406 | 21 |
| 58 | 4030 | 28 | 4580 | 19 | 175451 | 22 |
| 59 | 4028 | 33 | 4531 | 20 | 176227 | 22 |

# 6 RESULTS

**Flow Shop Results**

| Test case | FSS | Time(ms) | FSSB | Time(ms) | FSSNW | Time(ms) |
|---|---|---|---|---|---|---|
| 60 | 3934 | 36 | 4651 | 19 | 175613 | 21 |
| 61 | 5527 | 55 | 6637 | 31 | 341593 | 37 |
| 62 | 5308 | 62 | 6520 | 33 | 348559 | 38 |
| 63 | 5235 | 56 | 6379 | 33 | 330137 | 38 |
| 64 | 5025 | 54 | 6176 | 32 | 322463 | 37 |
| 65 | 5298 | 54 | 6488 | 32 | 327590 | 37 |
| 66 | 5154 | 55 | 6270 | 32 | 337158 | 39 |
| 67 | 5324 | 51 | 6567 | 32 | 345018 | 39 |
| 68 | 5137 | 56 | 6464 | 31 | 327843 | 38 |
| 69 | 5514 | 51 | 6673 | 33 | 347061 | 38 |
| 70 | 5371 | 52 | 6776 | 32 | 340545 | 37 |
| 71 | 5895 | 97 | 7526 | 70 | 446080 | 78 |
| 72 | 5540 | 93 | 7258 | 66 | 427988 | 76 |
| 73 | 5832 | 104 | 7323 | 67 | 439027 | 78 |
| 74 | 6073 | 95 | 7584 | 68 | 469628 | 80 |
| 75 | 5643 | 95 | 7330 | 66 | 428141 | 76 |
| 76 | 5474 | 101 | 7158 | 69 | 421132 | 79 |
| 77 | 5751 | 98 | 7330 | 69 | 435170 | 80 |
| 78 | 5803 | 105 | 7273 | 67 | 446972 | 77 |
| 79 | 6058 | 98 | 7577 | 67 | 445413 | 80 |
| 80 | 5913 | 110 | 7528 | 68 | 450267 | 78 |
| 81 | 6651 | 193 | 8225 | 139 | 614406 | 166 |
| 82 | 6599 | 182 | 8206 | 143 | 617564 | 164 |
| 83 | 6630 | 215 | 8328 | 144 | 607365 | 169 |
| 84 | 6585 | 197 | 8337 | 141 | 605765 | 165 |
| 85 | 6724 | 190 | 8300 | 143 | 596913 | 164 |
| 86 | 6646 | 182 | 8330 | 141 | 594087 | 159 |
| 87 | 6639 | 186 | 8406 | 142 | 613865 | 165 |
| 88 | 6775 | 186 | 8455 | 144 | 624521 | 161 |
| 89 | 6721 | 190 | 8266 | 141 | 606648 | 166 |
| 90 | 6784 | 188 | 8403 | 139 | 620298 | 165 |
| 91 | 11058 | 767 | 14456 | 500 | 1.67E+06 | 603 |
| 92 | 10756 | 741 | 14329 | 507 | 1.62E+06 | 596 |
| 93 | 11200 | 852 | 14443 | 508 | 1.66E+06 | 618 |
| 94 | 11057 | 899 | 14456 | 516 | 1.62E+06 | 609 |
| 95 | 10711 | 739 | 14393 | 507 | 1.63E+06 | 597 |
| 96 | 10571 | 735 | 14188 | 508 | 1.63E+06 | 602 |
| 97 | 11061 | 797 | 14608 | 507 | 1.66E+06 | 610 |
| 98 | 10923 | 784 | 14559 | 502 | 1.65E+06 | 598 |
| 99 | 10605 | 716 | 14261 | 514 | 1.68E+06 | 640 |
| 100 | 10931 | 828 | 14383 | 507 | 1.65E+06 | 611 |
| 101 | 11708 | 1443 | 15622 | 1146 | 2.18E+06 | 1231 |
| 102 | 11907 | 1449 | 15786 | 1131 | 2.17E+06 | 1237 |
| 103 | 11890 | 1389 | 15806 | 1151 | 2.16E+06 | 1283 |
| 104 | 11844 | 1375 | 15746 | 1138 | 2.17E+06 | 1261 |
| 105 | 11764 | 1443 | 15796 | 1145 | 2.20E+06 | 1259 |
| 106 | 11711 | 1415 | 15797 | 1154 | 2.17E+06 | 1246 |
| 107 | 11845 | 1409 | 15792 | 1126 | 2.17E+06 | 1254 |
| 108 | 11816 | 1390 | 15639 | 1127 | 2.18E+06 | 1285 |
| 109 | 11795 | 1392 | 15686 | 1147 | 2.18E+06 | 1269 |
| 110 | 11920 | 1430 | 15837 | 1131 | 2.17E+06 | 1253 |
| 111 | 26816 | 20256 | 38041 | 18297 | 1.26E+07 | 19606 |
| 112 | 27288 | 20394 | 38392 | 18548 | 1.29E+07 | 19688 |
| 113 | 26996 | 21038 | 38037 | 18479 | 1.25E+07 | 19909 |
| 114 | 27008 | 20406 | 38209 | 18396 | 1.25E+07 | 19819 |
| 115 | 27048 | 21262 | 38050 | 19064 | 1.26E+07 | 19521 |
| 116 | 27261 | 21020 | 38328 | 18799 | 1.27E+07 | 19643 |
| 117 | 26937 | 21114 | 38145 | 18743 | 1.24E+07 | 19588 |
| 118 | 27267 | 21146 | 38104 | 19047 | 1.27E+07 | 19801 |
| 119 | 26776 | 20656 | 38075 | 19440 | 1.24E+07 | 19979 |
| 120 | 27160 | 20129 | 38333 | 19678 | 1.25E+07 | 20100 |