Master thesis

# Work Distribution for a Heterogeneous Library Staff - A Personnel Task Scheduling Problem

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LiTH - MAT - EX - - 04 / 04 - - SE

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# Abstract

The distribution of tasks to a heterogeneous work force at libraries and other service institutions is time consuming for manual schedulers, but well suited for optimization softwares. The problem studied concerns five types of tasks, two types of worker qualifications and around 100 tasks per week.

During weekends there is a demand for staff members. Also, worker satisfaction is taken into account to avoid unfairness and fatigue.

The main objective is to create a optimal ten week rotating schedule, in which the stand-in staff members are evenly distributed. That results in a robust schedule, as absence of staff members is a common issue.

A mathematical model is formulated for the problem, which is solved using the commercial solver, CPLEX and by using two different large neighbourhood search heuristic implementations. The first heuristic assigns complete week blocks to the staff members, while the second distributes one task at a time. The latter heuristic works better than the former and achieves results comparable to those of the commercial solver. Our conclusion is that the second heuristic works better because it focuses on finding a good weekend distribution, before creating the rest of the schedule.

**Keywords:** Optimization, Scheduling, Task distribution, LNS, Weekend Scheduling, Heterogeneous workforce

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# Nomenclature

Most of the reoccurring terms and abbreviations are described here.

## Optimization terms

| | |
|---|---|
| Heuristic | An algorithm designed to find feasible, but not necessarily optimal, solutions. |

## Library terms

| | |
|---|---|
| Fetch list | The library task of collecting books from shelves, to be delivered elsewhere. |
| Library on wheels | The task of driving a library bus with books to remote areas of town. |

## Abbreviations

| | |
|---|---|
| Exp | Service counter (sv. expeditionsdisken) |
| Info | Information counter (sv. informationsdisken) |
| PL | Fetch list (sv. plocklistan) |
| BokB | Library on wheels (sv. bokbussen) |
| HB | Hageby library |

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# Problem definitions

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# Week block table

Table B.1: Number of assignable unique blocks for the workers based on their availability and qualification.

| Worker | Weekend | Weekrest | Weekday |
|---|---|---|---|
| 1 | 532 | 347 | 1580 |
| 2 | 1580 | 1580 | 1580 |
| 3 | 1063 | 347 | 1580 |
| 4 | 557 | 165 | 779 |
| 5 | 261 | 130 | 531 |
| 6 | 532 | 130 | 1580 |
| 7 | 261 | 130 | 531 |
| 8 | 261 | 29 | 531 |
| 9 | 115 | 12 | 247 |
| 10 | 532 | 130 | 1580 |
| 11 | 9 | 8 | 8 |
| 12 | 1063 | 347 | 1580 |
| 13 | 771 | 92 | 1190 |
| 14 | 265 | 29 | 489 |
| 15 | 51 | 18 | 120 |
| 16 | 495 | 130 | 843 |
| 17 | 237 | 69 | 267 |
| 18 | 532 | 279 | 1580 |
| 19 | 495 | 47 | 843 |
| 20 | 532 | 130 | 1580 |
| 21 | 227 | 227 | 227 |
| 22 | 2 | 1 | 1 |
| 23 | 3 | 2 | 2 |
| 24 | 11 | 5 | 47 |
| 25 | 1063 | 279 | 1580 |
| 26 | 5 | 4 | 4 |
| 27 | 213 | 106 | 425 |
| 28 | 2 | 2 | 2 |
| 29 | 426 | 106 | 1281 |
| 30 | 127 | 126 | 455 |
| 31 | 495 | 130 | 843 |
| 32 | 261 | 29 | 531 |
| 33 | 72 | 45 | 306 |
| 34 | 425 | 425 | 425 |
| 35 | 91 | 20 | 221 |
| 36 | 55 | 27 | 101 |
| 37 | 1063 | 347 | 1580 |
| 38 | 3 | 1 | 1 |
| 39 | 2 | 1 | 1 |