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

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Problem formulation and approach

The problem we will be studying concerns assigning a set of tasks, occuring at fixed times throughout the work day, to a fixed work force of library staff. A feasible schedule would be a schedule where all tasks are assigned to the staff. Furthermore, the generated schedule should also be robust, in the sense that the stand-in staff should be as evenly divided at each task as possible.

The Personnel Task Scheduling Problem (PTSP) has a definition very similar to our problem and probably what it would be categorized as. However, a significant hindrance is the lack of literature on the subject. A close relative to the PTSP is called Shift minimization personnel task scheduling problem (SMPTSP) and is a more well-researched area. Our mathematical model and literature study will thus, to a large extent, focus on this problem.

The problem at hand requires a solution to an integer linear task assignment problem with a heterogeneous work force. Papers like Loucks and Jacobs, 1991 focused on a similar problem with a slight difference; in their problem the demand for staff increases as the workload grows at different times of the day. Their approach is to, at a certain hour, assign tasks one at the time to workers based on their qualifications and availability. This, however, does not have to be considered in our case since the demand of personnel is fixed in time. Another difference is that their problem involves shift scheduling, while ours does not as the shifts for the library staff are predetermined.

Our approach for developing a model for the problem is to initially create a feasible schedule in AMPL using CPLEX. Thereafter it will be iteratively improved based on feedback from the library staff. The process will continue until a schedule which satisfies the demands of the staff is created.

After generating schedules using the mathematical model, a heuristic method will be implemented and used to solve the problem. This makes it possible to remove the use of CPLEX. The reason for this is because it is expensive for a library to purchase such a software. Also, it is likely that an implemented heuristic method can produce a solution of good enough quality.

The current programming environment under consideration is Microsoft Visual Basic, since the staff is already familiar with Microsoft Excel. The heuristic approach will be chosen after consulting the existing literature. If it appears to be too simple to solve the mathematical problem and depending on the time available, we may complicate the problem by for example adding constraints or choose a different objective function with the purpose of creating a better schedule.

Planned references

Roberts and Escudero, 1983a, 1983b; Loucks and Jacobs, 1991; Tsang and Voudouris, 1997; Duffuaa and Al-Sultan, 1999; Ernst et al., 2004; Eiselt and Marianov, 2006; Mohan, 2008; Choi, Hwang and Park, 2009; Hojati and Patil, 2010; Krishnamoorthy et al., 2011; Akbari, Zandieh, Dorri, 2012; Smet et al., 2014; Baatar et al., 2015;

Milestones

The master thesis is scheduled to continue until the end of the semester, which occurs at June 6th. Completions of the report will be done during the summer and might continue into the autumn. The oral presentation is currently set for week 23. Regarding the half-time check, our recommendation would be right after Easter, around week 14.

Time plan

In table 1 below the planned workflow is presented with estimation of time duration for each activity. Observe that these are only preliminary and can come to vary a bit.

Table 1: Time plan for activities. Half time evaluation and thesis presentation weeks in orange. Blue for work schedule, red for thesis schedule and green for presentation schedule.

Week/Activity	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
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The letters represent the following activities:

(A) Study of Literature

(B) Develop: Mathematical model

(C) Develop: Heuristic

(D) Develop: Another model/heuristic

(E) Write Chapter 1: Introduction (background, method etc)

(F) Write Chapter 2: Related work

(G) Write Chapter 3: Mathematical model

(H) Write Chapter 4: Heuristic (Visual Basic)

(I) Write Chapter 5: Another model

(J) Write Chapter 6: Computational results

(K) Write Chapter 7 and 8: Discussion/Summary and Conclusion

(L) Thesis Presentation and Preparation