Automatic shift generation for the pediatric hospitals of Hamburg

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Companies that operate 24 hours a day, seven days a week, such as factories or hospitals, need to solve a common problem: how to schedule employees in multiple daily shifts so that each shift is staffed by enough employees to maintain operations.

The following (actual, but simplified) case comes from Hamburg, where we are looking to schedule 22 doctors for the paediatric units of 5 hospitals.

1 General setup

The central question any schedule has to answer is "when does person X work?". In our case, we have some general conditions for that:

- Each day during the work week is divided into three 8-hour shifts[1]. Each weekend day is divided into two 12-hour shifts[2].

- Every shift has to be worked

- All doctors are either working or have a day off.

- A doctor can only have up to one shift a day[3].

- A doctor can work at most 12 days in a row.

1. **Formulate and implement the general setup.**

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[1]Starting 6am, 2pm and 10pm
[2]Starting 6am and 6pm
[3]A shift is counted to the day when the shift starts: so the night shifts starting at 10pm count to that day.

2 Making it more realistic

The general setup in section 1 captures the critical dynamics of the system, however it will most likely not produce a realistic schedule. For that, we have to consider a few more conditions:

- Not all doctors can work in all hospitals due to lack of experience or the current rotation.

- Pregnant woman are not allowed to take shifts starting at 10pm or 12-hour shifts.

- Night shifts have to be grouped into blocks of 3 nights, with 3 days off afterwards.

2. **Formulate and implement the additional constraints.**

3 Making a good schedule

Now we have all the rules implemented (stuff we cannot violate), i.e. a solution to the problem we implemented so far will be a feasible schedule, but everybody would probably complain.

The reason is that we are talking about people and they have wishes regarding their allocation.

3. **Formulate and implement the allocation satisfaction as the objective function.**