Scheduling Family Medicine Residents at the American University of Beirut Medical to Clinics Using Optimization Methods With Multi-Objective Criteria and Priority Rules

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Problem Statement

Background
- Family Medicine (FM) is a specialized field of medicine that provides comprehensive care for families and individuals of all ages.
- The FM residency at the American University of Beirut Medical Center (AUMC) in Lebanon is a 4-year training program in which residents must complete rotations in different departments (Neurology, OB/GYN, Mental Health, etc.) in addition to their FM obligations.
- These obligations include clinic hours and night shifts at AUMC and FM clinics at multiple locations around Beirut.
- Each clinic location provides a unique educational experience — for example, one location is the equivalent of a Veterans Affairs hospital, while another serves patients in a refugee camp.

Solution Approach

Decisions
Do we assign a resident \( r \) to shift \( s \) on date \( d \) at location \( k \)?

\[ x_{r,s,d,k} = \begin{cases} 1 & \text{if resident } r \text{ is assigned to location } k \text{ on date } d \text{ on shift type } s \\ 0 & \text{otherwise}. \end{cases} \]

Constraints
All rules must be fulfilled for the schedule to be considered feasible
- Different rotations require different number of residents per shift
- Residents who worked a night shift the night before cannot be assigned to an afternoon shift the next day
- Certain clinic locations can only be staffed by seniors or a certain rotation
- Satisfy work and vacation requests
- And more...

Example: Home Base Rule
Each resident must complete at least one shift at the FMPC location each week.

\[ \sum_{d \in D} x_{r,FMPC,d,k} \geq 1, \quad r \in R \cup (w), \quad w \in W. \]

Metrics
Additional priority rules improve the quality of the overall schedule and for individual residents. These rules are sometimes in conflict with each other and must be balanced to determine the best possible schedule. For these priority rules, lower numbers are preferred.

- Number of residents that work more than one night shift a week
- Number of residents assigned to locations that do not match their difficulty level
- Number of residents assigned to "mis-matched" locations based on their rotation
- Location diversity of assigned shifts
- Number of excess shifts assigned to each resident
- Maintaining a uniform schedule for residents across a monthly period
- Maintain equity amongst weekday and weekend night shifts

Future Work

Modify the tool to include dynamic ranges that accommodates for a larger number of residents, clinic locations, and rotations in case the AUBMC residency program expands in the future.

Acknowledgements

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Traditional Approach

The challenge:
- The chief resident creates a new schedule every month, which is time and labor intensive.

The challenge:
- Create a schedule every month that ensures each clinic location is adequately staffed by residents according to their level of experience, their responsibilities at AUMC, and concurrent specialty rotations.
- The schedules should provide a fair, consistent distribution of workload among the residents as well as access to a diverse training experience over the course of the year.

Research Goal
- Create a tool that automates the scheduling process and is accessible to users without training in mathematical optimization or special-purpose software.

Impact/Results

Above: A snippet of a generated day shift schedule. The numbers in the parentheses correspond to the days of the month that the resident will work that month.
Note: The snippet omits three additional clinics that receive resident assignments.

Left: An example of the right schedule.
Note: The right schedule minimizes the number of residents who work more than one night shift in a week AND tries to provide equity to weekday - night shift assignments.