Block Scheduling for Surgical Residency Programs using Combinatorial Optimization

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PROBLEM STATEMENT

Surgical Residency Programs at the University of Michigan

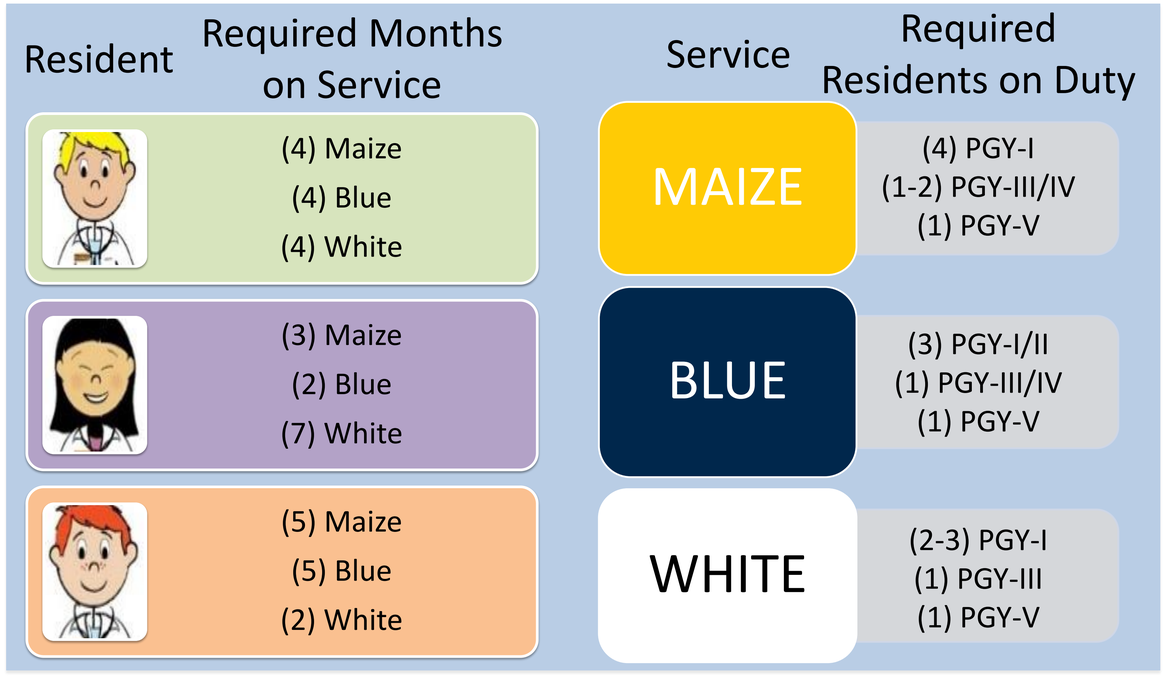
The University of Michigan offers 105 accredited residency and fellowship programs, including more than a dozen dedicated to surgical specialties. The amount of time each resident spends on the various services in the hospital depends on their respective year and discipline. The assignment of residents to services for these monthly rotations is known as the block schedule.

Challenges in Block Scheduling for Surgical Residents

At the University of Michigan, the block schedule for surgical residents is interdependent across several services and residency programs. The Education Director for the General Surgery Program is charged with coordinating negotiations amongst all the service administrators and program directors. This process is resource-intensive and error-prone.

Project Goal

We aim to improve the efficiency and quality of the block schedule using combinatorial optimization techniques.



Sets

R: residents
C: resident categories
S: services
M: months

Parameters

$a_{rc} \in \{0,1\}$: whether resident $\boldsymbol{r}$ fits category $\boldsymbol{c}$, $\forall\, r \in R, c \in C$

$\mathcal{L}_{csm}, \mathcal{U}_{csm}$: lower, upper bounds on staffing of residents fitting category $\boldsymbol{c}$ in service $\boldsymbol{s}$ during month $\boldsymbol{m}$, $\forall\, c \in C, s \in S, m \in M$

λ_{rs}, μ_{rs}: lower, upper bounds on months resident $\boldsymbol{r}$ must spend on service $\boldsymbol{s}$, $\forall\, r \in R, s \in S$

Decision Variables

$x_{rsm} \in \{0,1\}$: whether resident $\boldsymbol{r}$ is assigned to service $\boldsymbol{s}$ in month $\boldsymbol{m}$, $\forall\, r \in R, s \in S, m \in M$

Constraints

$$\sum_{s \in S} x_{rsm} = 1, \qquad \forall\, r \in R, m \in M \qquad [1]$$

$$\lambda_{rs} \leq \sum_{m \in M} x_{rsm} \leq \mu_{rs}, \qquad \forall\, r \in R, s \in S \qquad [2]$$

$$\mathcal{L}_{csm} \leq \sum_{r \in R} a_{rc} x_{rsm} \leq \mathcal{U}_{csm}, \qquad \forall\, c \in C, s \in S, m \in M \qquad [3]$$

MODEL

Base Model

The surgical block schedule is represented by a binary integer programming model featuring three key rules, illustrated in the figure above and displayed in the formulation at left:

- [1] Every resident gets assigned to one service each month
- [2] Residents must satisfy their yearly educational requirements
- [3] Services must satisfy their monthly coverage requirements

Full Model

In addition to these generalized rules, several rules unique to specific disciplines and years must also be incorporated in the model. These include rules regarding relationships between assignments in consecutive months and distributing experiences on certain services throughout the year.

IMPLEMENTATION

AY 2015 Testing

The base model rapidly produces a feasible schedule for the 2015 academic year's cohort, which comprises 75 residents from 6 residency programs rotating on 41 services.

AY 2016 Enactment

The full model will be used to create the 2016 academic year's schedule, for which the cohort is expected to comprise 103 residents from 7 residency programs rotating on 45 services.

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