Scheduling Residents in the C.S. Mott Children's Hospital Emergency Department

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Problem Statement

Background

The C.S. Mott Pediatric Emergency Department (ED) at Michigan Medicine is:

- A Level 1 Pediatric Trauma Center
- Visited by 25,000 patients per year
- Staffed by 5 residency programs

Importance of Schedule Quality

Poor quality schedules can negatively impact:

- Workflow
- Training quality and burnout rates
- Patient access, care quality, safety, and satisfaction

Traditional Approach

Hand-made schedule built by chief resident or administrator, requiring around 20 hours per month

Benefits	Drawbacks
Intimate Knowledge	Time-Consuming
Administrative Consolidation	Cognitively Demanding

The Challenge

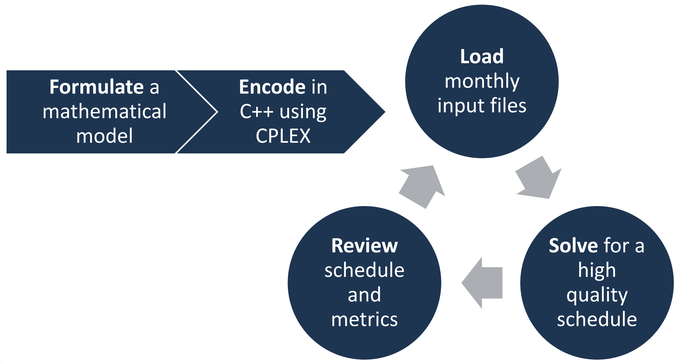
Scheduling residents in the ED involves an overwhelming number of governing rules and preferences the scheduler must abide and consider. Additionally, the schedule that is the best based on one metric may not be the best based on another metric.

Research Goals

- Work with chief residents to learn the scheduling rules and understand how trade-offs should be made between metrics
- Formulate a mathematical model and build a computerized tool which generates high-quality schedules

Quality ↑ Time ↓

Solution Approach



Decisions

Do we assign a resident *r* to shift type *s* on date *d*?

$$x_{rsd} \in \{0, 1\}, \qquad \forall\, \mathbf{r} \in \mathbf{R}, \mathbf{s} \in \mathbf{S}, \mathbf{d} \in \mathbf{D}$$

Constraints

All rules must be satisfied for a schedule to be considered feasible

- ❑ All shifts require a resident
- ❑ 10 hour rest rule (ACGME)
- ❑ Resident work conflicts (conferences and clinics)
- ❑ Varying working dates and time off-requests
- ❑ Certain shifts can only be staffed by seniors
- ❑ Residents can only work 5 consecutive days
- ❑ And more…

Example: Work-Rest Rule

Residents must get at least 10 hours off-duty between ending one shift and beginning another

$$x_{rsd} + \sum_{\substack{(s',d') \in \\ \{within\ 10\ hrs\ of\ (s,d)\}}} x_{rs'd'} \leq 1, \qquad \forall\, \mathbf{r} \in \mathbf{R}, \mathbf{s} \in \mathbf{S}, \mathbf{d} \in \mathbf{D}$$

Metrics

Determining an acceptable balance of the metrics can be difficult as some have an impact on the overall schedule and others impact individual residents. Additionally, the needs of the chief resident can shift from month to month.

- ❑ Number of Post Continuity Clinic Shifts Assigned
- ❑ Number of Bad Sleep Patterns Assigned
- ❑ Equitable Number of Assignments per Resident
- ❑ Flex Shift Coverage
- ❑ Vacation Requests Denied
- ❑ And more…

Below is a sample metric report, used to evaluate schedule quality.

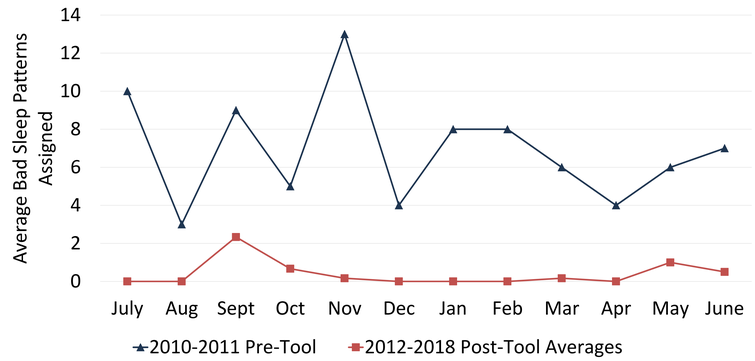
Resident Name	Longest Work Period	Number of Shifts	Number of Night Shifts	Number of Post-CC Shifts	Number of Bad Sleep Patterns
Resident_A	4	9 (9,11)	3 (0, 4)	0 (0, 0)	0
Resident_B	2	7 (7, 9)	3 (0, 4)	0 (0, 0)	0
Resident_C	2	9 (9,11)	3 (0, 4)	0 (0, 0)	0

Impact/Results

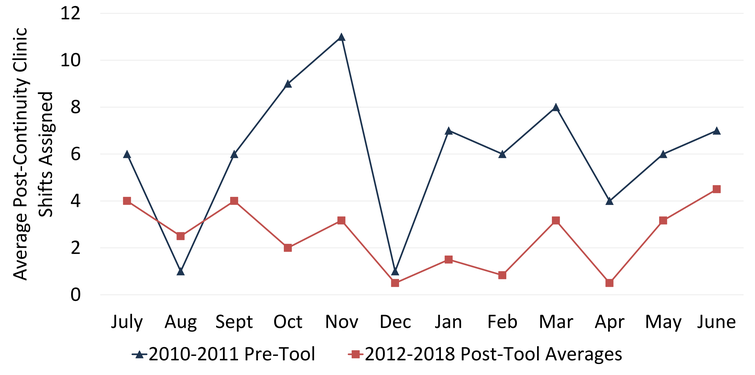
Effect on Scheduling Effort

20 hours per month → 1 hour per month

Effect on Bad Sleep Patterns



Effect on Post-Continuity Clinic Shifts



Conclusion

- Decreased production time of each schedule
- Increased adaptability based on feedback
- Improved schedule quality

Future Work

- Formulating more metrics to better evaluate schedule quality
- Further automation of the schedule making process
- Creation of tools to aid chief resident in reviewing the schedule

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