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

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Drawbacks</th>
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<tbody>
<tr>
<td>Intimate Knowledge</td>
<td>Time-Consuming</td>
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<tr>
<td>Administrative Consolidation</td>
<td>Cognitively Demanding</td>
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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

Solution Approach

Formulate a mathematical model
Encode in C++ using CPLEX
Load monthly input files
Review schedule and metrics
Solve for a high quality schedule

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

\[
 x_{r,s,d} \in \{0, 1\} \quad \forall r \in R, s \in S, d \in D
\]

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

\[
 x_{r,s,d} + \sum_{(s',d') \in \text{within 10 hrs of } (s,d)} x_{r,s',d'} \leq 1, \quad \forall r \in R, s \in S, d \in D
\]

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...

Impact/Results

Effect on Scheduling Effort

20 hours per month

Effect on Bad Sleep Patterns

Average Bad Sleep Patterns

July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June

2010-2011 Pre-Tool 2012-2018 Post-Tool Averages

Effect on Post-Continuity Clinic Shifts

Average Post-Continuity Clinic Shifts Assigned

July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June

2010-2011 Pre-Tool 2012-2018 Post-Tool Averages

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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