World’s Hardest Sudoku: Scheduling Residents in the C.S. Mott Pediatric 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

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.

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

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.

<table>
<thead>
<tr>
<th>Resident Name</th>
<th>Longest Work Period</th>
<th>Number of Shifts</th>
<th>Number of Night Shifts</th>
<th>Number of Post-CC Shifts</th>
<th>Number of Bad Sleep Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident_A</td>
<td>9 (9,11)</td>
<td>3 (0, 4)</td>
<td>0 (0, 0)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Resident_B</td>
<td>7 (7, 9)</td>
<td>3 (0, 4)</td>
<td>0 (0, 0)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Resident_C</td>
<td>9 (9,11)</td>
<td>3 (0, 4)</td>
<td>0 (0, 0)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Impact/Results

- Effect on Scheduling Effort
  - 20 hours per month to 1 hour per month

- Effect on Bad Sleep Patterns

- Effect on Post-Continuity Clinic Shifts

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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