Annual Rotation Scheduling for Medical Residents Through Optimization

William Pozehl
Amy Cohn
University of Michigan
ISERC June 2016
Our thanks to the students who have helped design, implement, and build schedules with our tools over the years.

Our thanks to the Chief Residents and Program Directors who have collaborated with us.
Residents are physicians who have completed medical school and are providing patient care while under the supervision of more senior attending physicians to continue their training.
What is residency scheduling?

- Assigning residents to times and places to provide patient care and receive advanced training
- Many programs (e.g. Pediatrics, Internal Medicine, Surgery)
- Many residents (varying seniority, requirements, personal needs)
- Many services (e.g. NICU, PICU, OB/Gyn)
- All need to be matched together under many complex rules
Traditional Scheduling Approach

1. Build rotation templates
2. Adjust for coverage and educational needs
3. Renegotiate after reaching a dead-end

<table>
<thead>
<tr>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APRIL</th>
<th>MAY</th>
<th>JUNE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLUE</td>
<td>MAIZE</td>
<td>PLA</td>
<td>SVA</td>
<td>SICU</td>
<td>BLUE</td>
<td>WHITE</td>
<td>PLA</td>
<td>STX</td>
<td>VA G&amp;V</td>
<td>VA CT</td>
<td>DSP</td>
</tr>
<tr>
<td>VA G&amp;V</td>
<td>PLA</td>
<td>MAIZE</td>
<td>WHITE</td>
<td>ACS</td>
<td>BLUE</td>
<td>SICU</td>
<td>BLUE</td>
<td>PLA</td>
<td>STX</td>
<td>STX</td>
<td>VA CT</td>
</tr>
<tr>
<td>VA CT</td>
<td>PLA</td>
<td>BLUE</td>
<td>DSP</td>
<td>VA G&amp;V</td>
<td>ACS</td>
<td>SICU</td>
<td>BLUE</td>
<td>MAIZE</td>
<td>WHITE</td>
<td>SVA</td>
<td>SVA</td>
</tr>
<tr>
<td>MAIZE</td>
<td>VA CT</td>
<td>VA G&amp;V</td>
<td>BLUE</td>
<td>SVA</td>
<td>WHITE</td>
<td>ACS</td>
<td>SICU</td>
<td>BLUE</td>
<td>STX</td>
<td>PLA</td>
<td>DSP</td>
</tr>
</tbody>
</table>
Why is it difficult?

- Challenges of general scheduling problems
- **Plus** challenges of personnel scheduling (preferences, retention, quality of life)
- **Plus** challenges of educational requirements
- **Plus** challenges of patient care
Block Scheduling: The Problem

1. TK description of the block scheduling problem in general
TK specific details about our peds problem, i.e. size, types of residents, list of general rules
Peds Block Scheduling: Approach One

1. $x_{rsm} = 1$ if resident $r$ is assigned to service for month $m$, else $0$

1. Problem: In rare cases, months can be split between services
   - TK Examples
Peds Block Scheduling: Approach Two

1. $x_{rsh} = 1$ if resident $r$ is assigned to service for half-month $h$ (e.g. $h = July 1 – 15$), else 0

1. TK explain constraints to enforce valid half-month combinations

1. Problem: TK discuss number of constraints needed
P is the set of valid “service pairs”

TK something about how many there are, relative to number of services (so how does number of variables change?)

$x_{rpm} = 1$ if resident $r$ is assigned to service pair $p$ for month $m$, else $0$
Peds Block Scheduling: Approach Three

- TK number of constraints
- TK number of variables
- TK run time for feasibility problems
TK discuss how we solve using metrics and bounds
TK how many years we’ve solved, how long the process took, Chief response
IM/FM Block Scheduling

1 Internal Medicine Residency Program
   – 3-year program
   – 44 residents per year

1 Medicine-Pediatrics Residency Program
   – 4-year program
   – 8 residents per year

1 TK how they connect to Peds

1 TK Goals for this year
   – Solve IM and FM with the same approach
   – Integrate all three if possible
IM/FM Block Scheduling

1 TK experience: 1) Size of integrated model; 2) run times (feasibility, optimality); experience in building
Block Scheduling: Lessons Learned

1. Collaboration is key to getting the details right, buy-in, success of implementation.
2. Variable definition key to tractability.
3. Integer programming can have significant real-world impact on quality of schedules and therefore resident satisfaction and patient care.
Next Steps

1. New modeling approaches to better accommodate all three programs (TK Let’s not say what it is!)

2. Better tools for collecting data, interacting with the Chiefs and Program Directors

3. Tools for modifying schedules throughout the year
We graciously thank these organizations for supporting this work:

Seth Bonder Foundation

THE DOCTORS COMPANY
Questions and Discussion