Creating a Computerized Tool to Schedule Dermatology Residents Each Month

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- Dr. Thomas Bander
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- Holley Comiskey
Presentation Outline

1. Background
2. Problem Formulation
3. Solution Approach
4. Remarks
Michigan Medicine

- 25 Residencies
- 1,199 Trainees
- 80 Fellowships
Dermatology Residency Program

- 3-year program (after PGY1 transitional year)
- 8 residents per class
Problem Statement

Chief residents must create monthly schedule staffing all residents

Residents must be assigned into clinical activities for the morning and afternoon of every weekday

Must meet:
- Resident educational requirements
- Activity coverage demands
Chief residents must also consider these types of requirements simultaneously when creating a monthly schedule.
Residents often have **conflicting requirements:**

- Block assignment
- Research
- Vacation
- Ad hoc assignments
- Continuity clinic
- Openings and closures
- Staffing level changes

Dermatology **clinics frequently change:**
Motivations

Schedules are **hand-built** by chief residents

Creating a monthly schedule requires **multiple days**

Schedules are often **not equitable** between residents and fail to satisfy resident preferences

Chief residents could **better use their time** caring for patients and advocating for resident needs
Research Goals

Increase accuracy and quality by taking into account monthly **requirements and changes**

Create a **computerized decision support tool** to aid in generating each month’s schedule

Feasible Schedule

- satisfies the hard rules presented by the chief residents

“Optimal” Schedule

- Work together to make trade off between preferences
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Set and Decision Variables

Sets

R: set of residents
A: set of activities
D: set of days in a given month

Decision variables

\[ x_{rad} = \begin{cases} 1, & \text{if assigning resident } r \text{ to activity } a \text{ on day } d \text{ in the morning} \\ 0, & \text{otherwise} \end{cases} \]

\[ y_{rad} = \begin{cases} 1, & \text{if assigning resident } r \text{ to activity } a \text{ on day } d \text{ in the afternoon} \\ 0, & \text{otherwise} \end{cases} \]
Constraints

Basic Assignment: (afternoon)
\[
\sum_{a \in A} x_{rad} = w_d \quad \forall r \in R, d \in D
\]

Coverage: (afternoon)
\[
lb_{adc}^P \leq \sum_{r \in R_c} x_{rad} \leq ub_{adc}^P \quad \forall a \in A, d \in D, c \in C
\]

AM/PM Prohibitions:
\[
x_{r_n a_n d_n} + y_{r_n a_n d_n} \leq 1 \quad \forall n \in N
\]

AM/PM Requirements:
\[
x_{r_c a_c d_c} - y_{r_c a_c d_c} = 0 \quad \forall c \in C
\]

Resident Prohibitions: (afternoon)
\[
y_{r_p a_p d_p} = 0 \quad \forall p \in P^x
\]

Preassignments: (afternoon)
\[
x_{r_h a_n d_h} = 1 \quad \forall h \in H^x
\]
Consider numerous metrics

- Weekly admin
- Balanced admin
- Travel
- Deviations from block schedule

Work with chief residents to determine satisfactory balance
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Process

Formulate
- A linear programming model using binary decision variables

Encode
- Written in C++ using CPLEX and implemented with Visual Studio

Load
- Input files are created each month with schedule requirements

Solve
- Software generates an feasible solution

Review
- Schedule and metrics reported for review by chief residents
Process cont.

Researchers and the chief residents iteratively revise the schedule

- Produce a schedule
- Review with chief residents
- Set bounds on metrics
- Identify undesirable characteristics

Improving one metric may worsen another
## Problem Size

<table>
<thead>
<tr>
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<tr>
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</table>
Scheduled monthly assignments from April 2017 – June 2018

<table>
<thead>
<tr>
<th>Name</th>
<th>Time</th>
<th>1-Mar Thu</th>
<th>2-Mar Fri</th>
<th>5-Mar Mon</th>
<th>6-Mar Tue</th>
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<tbody>
<tr>
<td>Resident 1</td>
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<td>Admin-Gen</td>
<td>TC</td>
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<td>Admin-Gen</td>
<td>VA-Path</td>
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<td>Mohs</td>
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<tr>
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<td>Mohs</td>
<td>Mohs</td>
<td>Mohs</td>
<td>TC-CC</td>
</tr>
</tbody>
</table>
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Conclusions

Created tools and processes to assign dermatology residents to shifts during a monthly planning horizon

Afforded leadership greater specificity of scheduling needs compared to manual construction

Freed chief residents to focus on more important tasks related to caring for patients and advocating for resident needs
Impact

- Rapidly-Generated, High-Quality Schedules
- Less Review Time Required By Chief Residents
- Improved Patient Experience
Future Work

Implement functionality to modify existing schedules with new requirements, applying minimal changes

Implement new infrastructure to more efficiently handle clinic shutdowns and other unforeseen requirements

Working with residency program and clinics to achieve more consistency in staffing needs
Acknowledgements

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- [Seth Bonder Foundation](#)
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Thank you

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