

Creating a Computerized Tool to Schedule Dermatology Residents Each Month

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Presentation Outline

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

Michigan Medicine



Dermatology Residency Program

- ❖ 3-year program (after PGY I transitional year)
- ❖ 8 residents per class



Chief residents must create monthly schedule staffing all residents

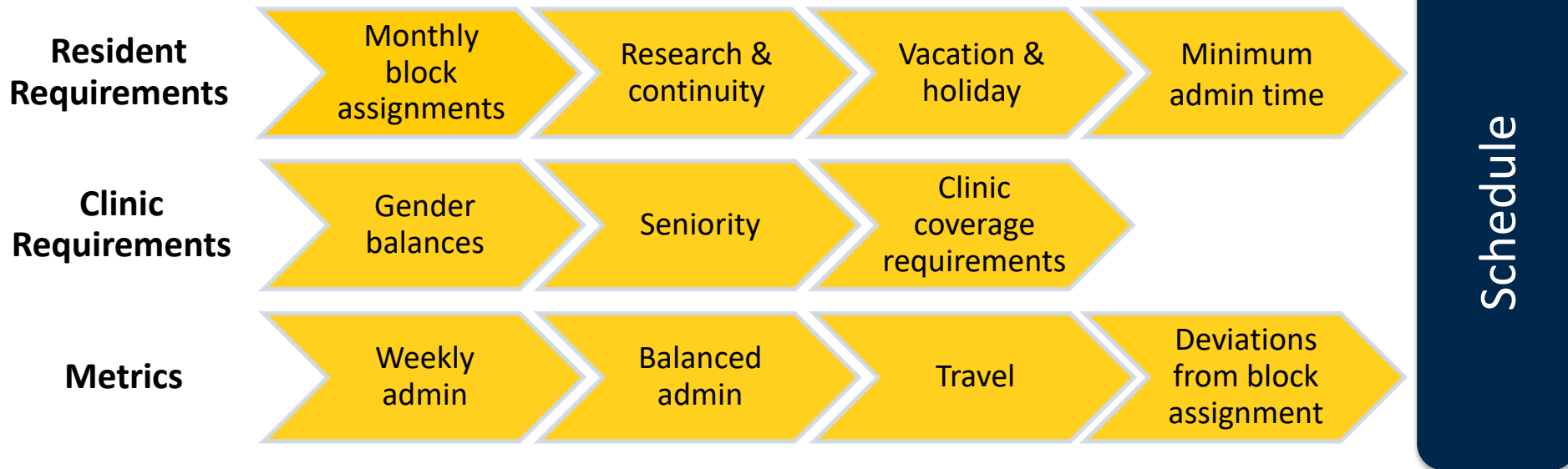
Residents must be assigned into clinical activities for the morning and afternoon of every weekday

Must meet:

- ❖ Resident educational requirements
- ❖ Activity coverage demands

Problem Statement cont.

Chief residents must also consider these types of requirements simultaneously when creating a monthly schedule.



Residents often have **conflicting requirements:**

- ❖ Block assignment
- ❖ Ad hoc assignments
- ❖ Research
- ❖ Continuity clinic
- ❖ Vacation

Dermatology **clinics frequently change:**

- ❖ Openings and closures
- ❖ Staffing level changes

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

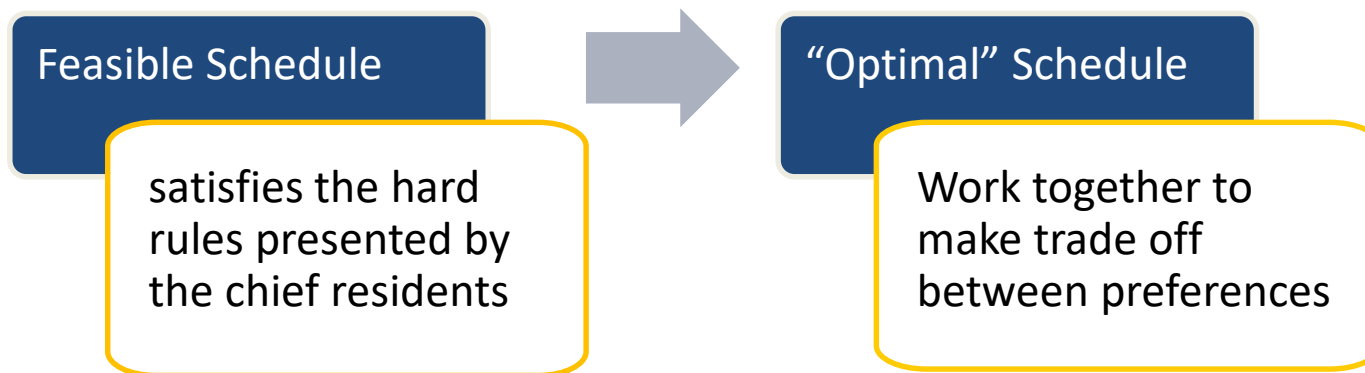
Creating a monthly schedule requires **multiple days**

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

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



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Sets



R: set of residents



A: set of activities



D: set of days in a
given month

Decision variables

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

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

Basic Assignment:
(afternoon)

$$\sum_{a \in A} x_{rad} = w_d$$

$$\forall r \in R, d \in D$$

Coverage:
(afternoon)

$$lb_{adc}^P \leq \sum_{r \in R_c} x_{rad} \leq ub_{adc}^P$$

$$\forall a \in A, d \in D, c \in C$$

AM/PM Prohibitions:

$$x_{r_n a_n d_n} + y_{r_n a_n d_n} \leq 1$$

$$\forall n \in N$$

AM/PM Requirements:

$$x_{r_c a_c d_c} - y_{r_c a_c d_c} = 0$$

$$\forall c \in C$$

Resident Prohibitions:
(afternoon)

$$x_{r_p a_p d_p} = 0$$

$$\forall p \in P^x$$

Preassignments:
(afternoon)

$$x_{r_h a_h d_h} = 1$$

$$\forall h \in H^x$$

Consider **numerous metrics**

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

Work with chief residents to determine **satisfactory balance**

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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

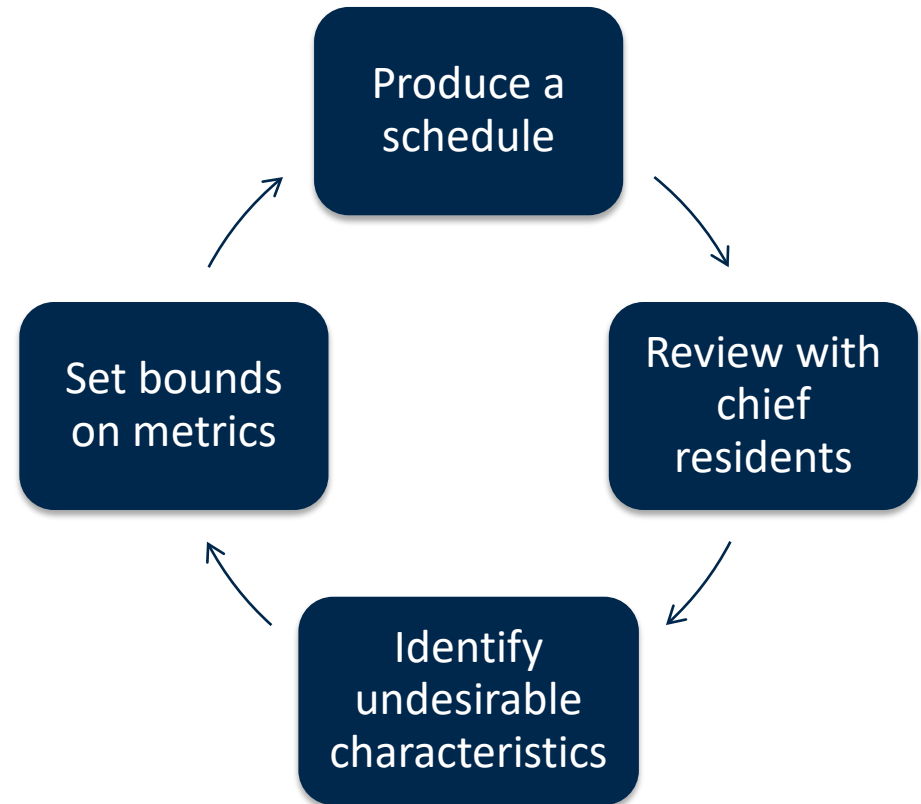
- Software generates an feasible solution

Review

- Schedule and metrics reported for review by chief residents

Researchers and the chief residents iteratively revise the schedule

Improving one metric may worsen another



Problem Size

| | Oct 2017 | Nov 2017 | Dec 2017 | Jan 2018 | Feb 2018 | Mar 2018 |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Residents | 24 | 24 | 24 | 24 | 24 | 24 |
| Dates | 31 | 30 | 31 | 31 | 28 | 31 |
| Activities | 29 | 30 | 31 | 31 | 31 | 31 |

Scheduled monthly assignments from April 2017 – June 2018

| Name | Time | 1-Mar Thu | 2-Mar Fri | 5-Mar Mon | 6-Mar Tue | 7-Mar Wed |
|-------------------|------|--------------|--------------|--------------|--------------|--------------|
| Resident 1 | AM | SRPC | Admin-Gen | Admin-Gen | TC | Melanoma |
| <i>MEL2/MEL2</i> | PM | Admin-Gen | UHS | TC | Merkel | Melanoma |
| Resident 2 | AM | Admin-ThuAM | Admin-Gen | VA-Path | VA-Path | VA-Path |
| <i>VAI/VAI</i> | PM | VA-PM | DF | VA-PM | VA-PM | VA-ENT |
| Resident 3 | AM | Mohs | Mohs | Mohs | Mohs | Mohs |
| <i>VAST/VAST</i> | PM | Mohs | Mohs | Mohs | Mohs | TC-CC |

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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



Rapidly-
Generated,
High-Quality
Schedules

Less Review
Time Required
By Chief
Residents

Improved
Patient
Experience

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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Thank you

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