CENTER FOR
HEALTHCARE ENGINEERING & PATIENT SAFETY
UNIVERSITY OF MICHIGAN

Annual Rotation Scheduling for Medical Residents Through Optimization

William Pozehl
Amy Cohn
University of Michigan
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The Team…The Team…The Team

- 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

What are residents?

- 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

JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE
BLUE	MAIZE	PLA	SVA	SICU	BLUE	WHITE	PLA	STX	VA G&V	VA CT	DSP
VA G&V	PLA	MAIZE	WHITE	ACS	BLUE	SICU	BLUE	PLA	STX	STX	VA CT
VA CT	PLA	BLUE	DSP	VA G&V	ACS	SICU	BLUE	MAIZE	WHITE	SVA	SVA
MAIZE	VA CT	VA G&V	BLUE	SVA	WHITE	ACS	SICU	BLUE	STX	PLA	DSP

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

- TK description of the block scheduling problem in general

Pediatric Block Scheduling at UM

- TK specific details about our peds problem, i.e. size, types of residents, list of general rules

Peds Block Scheduling: Approach One

- x_{rsm} = 1 if resident r is assigned to service for month m, else 0
- Problem: In rare cases, months can be split between services
  - TK Examples

Peds Block Scheduling: Approach Two

- x_{rsh} = 1 if resident r is assigned to service for half-month h (e.g. h = July 1 – 15), else 0
- TK explain constraints to enforce valid half-month combinations
- Problem: TK discuss number of constraints needed

Peds Block Scheduling: Approach Three

- 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

Peds Block Scheduling: Approach Three

- 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

- Internal Medicine Residency Program
  - 3-year program
  - 44 residents per year
- Medicine-Pediatrics Residency Program
  - 4-year program
  - 8 residents per year
- TK how they connect to Peds
- TK Goals for this year
  - Solve IM and FM with the same approach
  - Integrate all three if possible

IM/FM Block Scheduling

- TK experience: 1) Size of integrated model; 2) run times (feasibility, optimality); experience in building

Block Scheduling: Lessons Learned

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

Next Steps

- New modeling approaches to better accommodate all three programs (TK Let's not say what it is!)
- Better tools for collecting data, interacting with the Chiefs and Program Directors
- Tools for modifying schedules throughout the year

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Questions and Discussion