

## **Problem Statement**

The University of Michigan Medical School (UMMS) offers comprehensive training programs across many disciplines



Coordinating the long- and short-term schedules for all these trainees is a complex challenge

### **Traditional Approach:**

Hand-made schedules built by the Chief Resident or some other administrator

### Benefits

- 1) Intimate knowledge of problem
- 2) Administrative consolidation
- 3) Streamlined approval process

### Drawbacks

- 1) Time-consuming construction
- 2) High cognitive demand
- 3) Limited tradeoff consideration

### **Importance of Schedule Quality:**

Schedule quality impacts

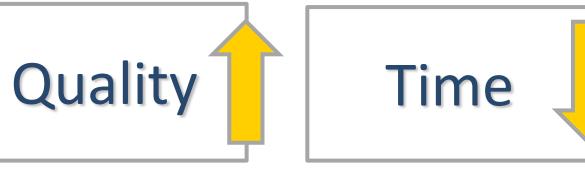
- Patient access, care quality, safety, and satisfaction
- Training quality and burnout rates
- Clinical/administrative workflow

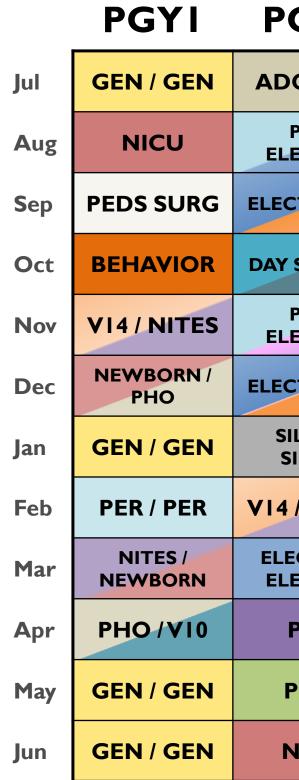
### The Problem:

The construction process is resource-intensive yet often fails to satisfy the individual & collective needs of stakeholders for long- and short-term schedules

### **Objective:**

Develop decision support systems (DSS) to enable fast construction of high-quality rotation & monthly schedules while improving measures of quality.





Sample rotation for Pediatrics 24 residents per level per year

# **Scheduling Healthcare Providers Using Optimization**

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1: Industrial & Operations Engineering 2: Center for Healthcare Engineering & Patient Safety 3: Pediatric Resident Program 4: Department of Surgery

GY2	PGY3
OLESC	ELECTIVE / V7
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РСН	GEN / GEN
PICU	NITES / PER
NICU	РСН

# **Annual Blocks: Solution Approach**

Sets	Decision Variables	
R: residents C: resident categories S: services	$x_{rsm} \in \{0, 1\}$ : whether resident $r$ is assigned to service $s$ in month $m$ $\forall r \in R, s \in S, m \in M$	1. Formulate
M: months Parameters	<b>Objective Function</b>	Two models, each customized to
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<sub>s</sub> , μ <sub>rs</sub> : lower, upper bounds on mon resident r must spend on servic	ths	
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### Solve 4.

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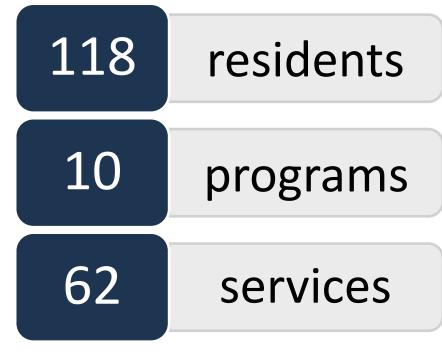
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# **Annual Block: Impact/Results**

The Surgical Block Scheduling DSS aided schedule construction for:



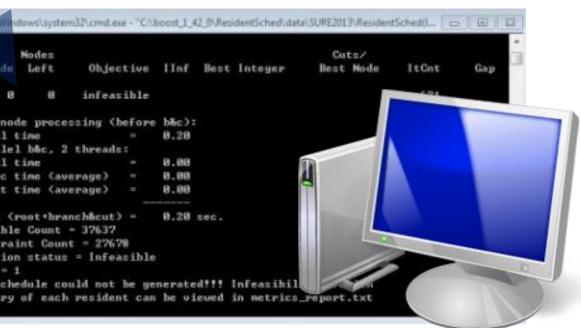
Solve time per iteration:

217

5 min



of UMMS '199 residents



### eview

le and metric reports ted for presentation to strators

### The Pediatrics Block Scheduling DSS aided schedule

construction for:

Solve time per iteration:





# **Monthly Schedules: Solution Approach**

### **Metrics**:

- Total Shift Equity (1)
- Night Shift Equity (

Prefere

### **Feasibility Optimization Problem:**

- × Quantifying object
- $(w_i)$  is difficult due
- Non-linearity
- Subjectivity

Min <del>w<sub>1</sub>(</del>	TSE)
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### **Iterative Improvement:**

Resident Name	Number of Shifts	Number of Night Shifts	Number of Post-CC Shifts	Number of Bad Sleep Patterns
Stumpos	8 (7,9)	2 (2,3)	0 (0,1)	0 (0,0)
Schwein	8 (7,10)	2 (2,3)	0 (0,1)	0 (0,0)
Grum	8 (7,9)	2 (2,3)	1 (0,1)	0 (0,0)

# **Monthly Schedules: Impact/Results**

### **Implementation Results:**

- Reduced schedule creation time

20 hrs / month

### **Next Steps:**

This work was generously supported by:

- UMHS Department of Pediatrics & Communicable Diseases
- UMHS Department of Surgery
- The Doctors Company Foundation
- Seth Bonder Foundation

students who have contributed to these projects.

TSE) (NSE)	<ul> <li>Bad-Sleep Patterns (BSP)</li> <li>Post-Continuity Clinic Shifts (PCC)</li> </ul>
nces? W	eights? Trade-off?

ctive weights Je to	<ul> <li>Feasibility with metric bounds offers</li> </ul>
	<ul> <li>Flexibility</li> </ul>
	– Speed

 $() + w_2(NSE) + w_3(BSP) + w_4(PCC)$ "rules/requirements"  $x_{rsd} \in \{0,1\}$  $b_{TSE} \leq (TSE) \leq ub_{TSE}$  $\mathfrak{b}_{NSE} \leq (NSE) \leq ub_{NSE}$  $b_{BSP} \leq (BSP) \leq ub_{BSP}$  $b_{PCC} \leq (PCC) \leq ub_{PCC}$ 

Engage Chief Resident to review, revise and finalize the schedule

• Statistically significant improvement in 3 of 4 metrics l hr / month

• Generalize models into universal formulation

• Extend models to address other residency programs' needs • Apply algorithm to apply maximally feasible sets of requests

### Acknowledgements

We also express our gratitude to the former chief residents and many