

Using Optimization and Simulation to Build Better Block and Monthly Shift Schedules: Pediatric Residency Scheduling

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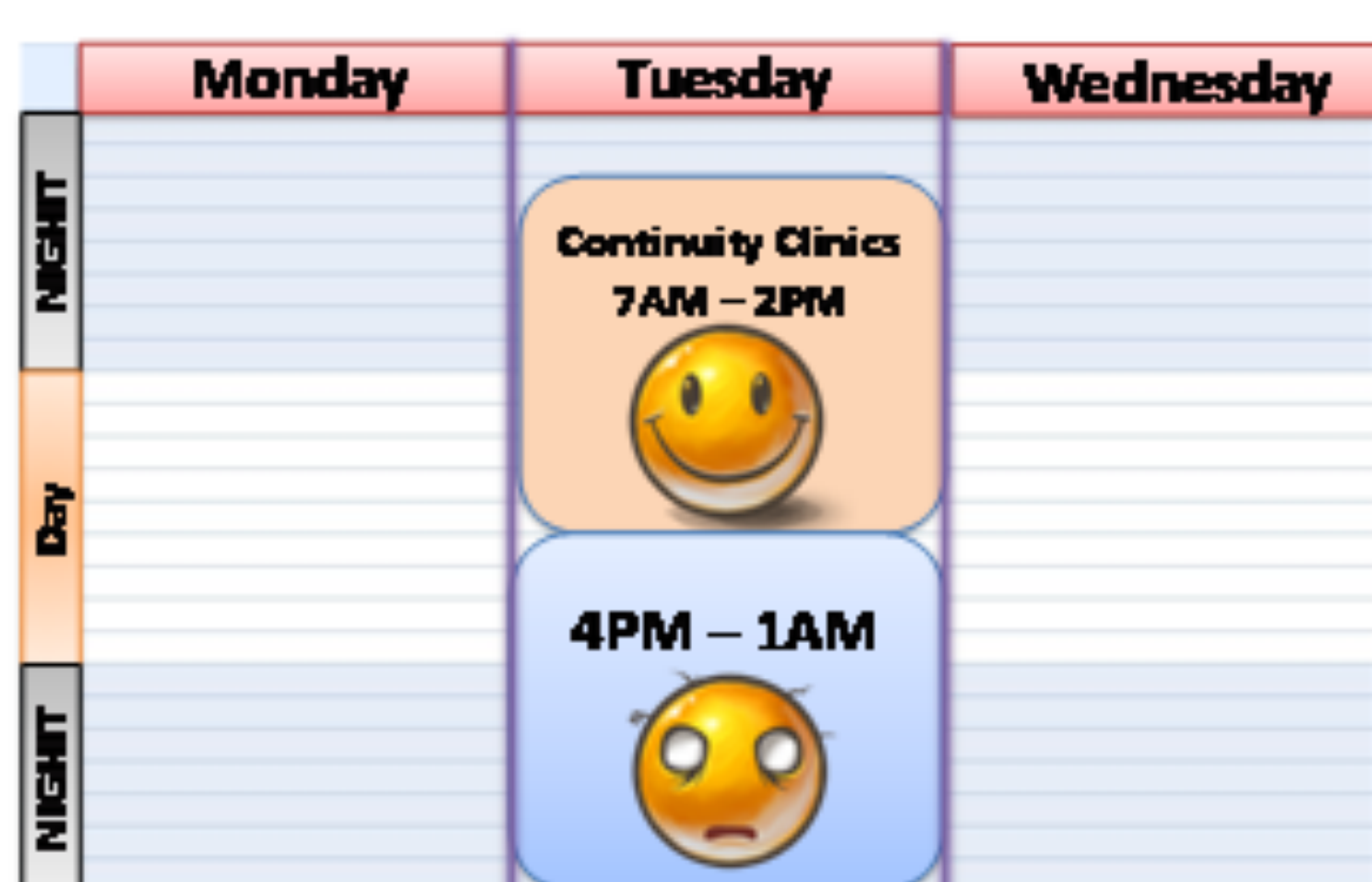
Problem Statement

Background

- We have developed optimization-based software to help the Pediatrics Chief Resident build monthly shift schedules for residents in the Pediatric Emergency Department (ED)
- Resources available for these schedules depend on decisions made at a higher level when block scheduling the entire Peds residency program
- We use simulation along with this optimization tool to show how integrated decision making can lead to easier monthly scheduling

Block Scheduling

- Made once a year, assigns residents to services in the hospital for every month.
- Assigns residents their continuity clinic day



- Throughout residency, residents work continuity clinics
- Clinics are a day when residents are outside of the hospital and are restricted from working certain shifts
- If everyone has the same continuity clinic, no one will be able to work that day

Shift Scheduling

- Shift schedules are built each month for the Peds ED.
- Each month has a different mix of interns and senior residents from the block schedule
- Many ACGME and Hospital rules need to be satisfied
 - No interns can work the first or last shift
 - Interns begin on the 27th of the previous month. We leave some shifts at the end of the month open for interns to fill the next month.

Motivation

- Some months we struggle to generate a feasible schedule
- Two main issues we see
 - Not enough residents on Wednesdays due to too many residents have Continuity Clinics scheduled for Wednesday
 - Some months we do not have enough interns to cover the end of the previous month

Methods

Shift Scheduling Tool

Have a tool in C++/Cplex which takes all ACGME and hospital rules, vacation requests, resident types, continuity clinics, ect and creates a feasible schedule

- Interactive approach engaging chief resident
- Quickly build high quality schedule

Simulation

Goal is to determine the odds of generating a feasible schedule with a given number of senior and intern residents

- For each senior/intern pair run 500 simulations
- Generate random continuity clinics for each resident
- Test for a feasible schedule.

```
How many repetitions do you want to run? 100
How many seniors do you have? 7
How many interns do you have? 5
Do the residents have continuity clinic? Y/N y
Are clinics fixed (enter '1') or randomized (enter '2')? 2
Rep 1: Feasible
Rep 2: Feasible
Rep 3: Infeasible
Rep 4: Feasible
Rep 5: Infeasible
Rep 6: Feasible
Rep 7: Feasible
Rep 8: Infeasible
```

Percentage of Reps Feasible (N = 500)

	Interns													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0														
1														
2														
3														
4								53.60%	74.20%	70.40%	77.60%	76.80%	82.00%	74.80%
5							64.40%	82.80%	88.60%	91.00%	90.00%	91.40%		
6						67.80%	88.20%	92.80%	97.00%					
7					71.60%	87.80%	95.80%							
8				71.00%	87.80%	96.00%								
9			70.20%	90.20%	96.40%									
10		71.20%	87.20%	95.80%										
11	71.20%	92.20%	94.80%											
12	89.60%	95.00%												
13	96.00%													

Impact/Results

Why do we Care?

Generating an optimal shift schedule depends on the mix of residents in the ED for a month. Interns have more restrictions on shifts they can work and they begin on the 27th of the previous month.

- If we have too few interns, we cannot fill all the shifts at the beginning of the horizon
- If we have too few seniors, we cannot fill the first or last shifts

Interns and Seniors do not have a 1-1 trade off

- Replacing one senior with an intern reduces the feasibility of the generated schedules

There is a number of total residents that virtually guarantee feasible schedule

- In this case 13 total residents, results in 90% feasible schedules

Consistent numbers lead to better schedules

- By keeping the number of interns every month consistent, the change of getting a feasible schedule increases
- Average 12 residents per month in the ED. If 1/3 are consistently interns, then 87.80% of schedules are feasible

Scheduling of Continuity Clinics is important

- Need to factor in the continuity clinics when generating the Block Schedule
- Multiple people having continuity clinic in the same day will make it difficult to generate feasible schedule
- If you know the continuity clinics before the block schedule, you can schedule residents by clinic day
 - Spread out residents with same clinics

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