Coordination of Surgical Blocks and Ambulatory Clinics at a Large Teaching Hospital

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Outline

• Motivation and Background
• Goals
• Inputs
• Decisions and Objective
• Initial Results
• Feasibility Challenges
• Conclusions/Future Work
Motivation
Background

• Colorado Health System
  – Piloting project for Orthopedics
  – Numerous locations and specialties

• Providers
  – Require both Operating Room (OR) and Clinic Room time
  – Must satisfy numerous individualized requirements

• Current Schedule
  – Pieced together over time
  – Minimal “wiggle-room”
  – Providers want more rooms
Goals

• Develop a **mathematically-based decision support tool** that **efficiently schedules** health care providers into **operating and clinical rooms** over a monthly horizon.

• **Enable what-if analyses** for incorporating new providers, adding new rooms, addressing bottlenecks, and improving existing schedules.
Inputs

• Types of rooms
• Room locations
• Room availabilities
• Provider availabilities
• Allowable daily schedules
• Provider room requirements (work packages)
• Scheduling considerations
  – Continuity across weeks
  – Specialty Coverages
Decisions

• **Approach 1:** Assign providers to rooms during each shift
  
  – $X_{pnrhdw}$: Does physician $p$ get $n$ rooms of type $r$ during shift $h$ on day $d$ of week $w$?
  
  – **Challenge:** Rules relating AM shifts and PM shifts

• **Sequence:** a combination of room types and how many rooms of each type that make up a single, feasible day of work
  
  – (e.g. 2 Denver ORs in the AM and 4 Denver Clinic rooms in the PM)
• **Approach 2:** Assign providers to sequences for each day of the month
  – $X_{psdw}$: Does physician $p$ get sequence $s$ on day $d$ of week $w$?
  – **Challenge:** Rules relating sequences across weeks

• **Weekly Template:** a combination of weeks
  – (e.g. $\{1,2,3,4,5\}$, $\{1,3,5\}$, $\{2,4,5\}$, $\{1\}$, $\{2\}$, ...)

Decisions
• **Approach 3:** Assign providers to sequences and weekly templates for each day of the week
  
  – $X_{psdt}$: Does provider $p$ get sequence $s$ on day $d$ for the weeks in weekly template $t$?

**Alternative decision variable definitions can reduce the number and complexity of constraints**
Objective Function Criteria

• **Provider Considerations:**
  – Weekly continuity
  – Required travel (daily/weekly)
  – Changes to current schedule
  – Number of rooms per shift
  – Full-days vs. half-days

• **Schedule Considerations:**
  – Leveling of specialty coverage
  – Amount of overbooking in clinics
Objective Function

- Determining weights for metrics is challenging
- Multi-criteria objectives take longer to solve
- Non-linear relationships
- Decision makers are better at comparing schedules to one another

Using an iterative solving approach involving bounds on each metric has advantages over using weighted objective functions
Initial Results

• Monthly schedule with reduced room overutilization is quickly generated

• Report is generated on room utilization which enables identification of room over/underutilization

• Capable of what-if analyses:
  – Hiring a new providers
  – Adding new rooms
  – Modifying current work packages
Feasibility Challenges

- Unrealistic expectations combined with complex scheduling rules can result in infeasibilities
- Must differentiate “needs” from desires
- When needs can’t be satisfied, we may not know why
- Need to make compromises in order to find an implementable schedule
Feasibility Challenges

• Example: 3 providers each “need” 4 rooms of clinic, but only 10 rooms are available
  – Reduce rooms required for one provider to 2
  – Reduce rooms required for two providers to 3
  – Increase rooms available to 12
  – Increase rooms available to 11 and reduce rooms required for one provider to 3

• 10 efficient options to choose from

Identifying sources of infeasibility is difficult
Future Work

• Develop algorithms for identifying sources of infeasibility and the potential fixes

• Identify the types of decisions that are best to “bundle” into single decisions

• Refine objective function approach of using bounds instead of weights on metrics
Thank You!

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