Coordinated Scheduling of Operating Room and Clinic Time Blocks for Surgical Attendings

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7-31-2015

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Outline

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

• Colorado Health System
  – Pilot 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)
Decisions

• **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
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
Results

• Monthly schedule with reduced room overutilization is quickly generated

• Reports on room over/underutilization

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