

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 “wobble-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

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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