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

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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

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

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

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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