Scheduling Colonoscopy Patients in an Outpatient Endoscopy Clinic

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Problem Statement

Background

- Colorectal Cancer Cancer (CRC)
  - Second leading cause of cancer related deaths in the U.S
- Colonoscopy
  - CRC screening test
  - Spot existing cancers, so treatment can be started, and prevent future cancers, through the detection and removal of polyps

Colonoscopy Appointment problem (CAp)

- A unique bimodal duration structure with high unpredictability

Duration	Prep Quality	Health Conditions	No. of Polyps	Type of Sedation
Short	Adequate	Good	Low	Conscious
Long	Poor	Poor	High	Anesthesia

- Risk of CRC and patient outcomes
- Patient absenteeism, unpunctuality and cancellations
- Multiple and conflicting criteria that affect the quality of the schedule
  - Patient access to screening and preferences
  - Patients Delays on the day of the procedure
  - Provider preferences, overtime and idling

Key Goals

- Reduce the barriers to efficient and timely CRC screening
- Appointment schedules that are better tailored toward patient outcomes with fewer scheduling outliers and uniform flow throughout the day
- Develop a decision support tool to decide the order (sequence) and the appointment time for a set of patients while considering
  - The unique and bimodal duration structure
  - Patient outcomes, absenteeism and un-punctuality

Framework

- Simulation and mathematical programming techniques to analyze and improve the scheduling of colonoscopy patients
- Within a Monte Carlo optimization framework, we approximated the duration structure based on the likelihood of the duration type
- Properties of the optimal schedule under different scenarios with respect to a weighted combination of the performance metrics

Scheduling Model

Objective

Optimal patients order and appointment times that minimizes total expected waiting, idling and overtime

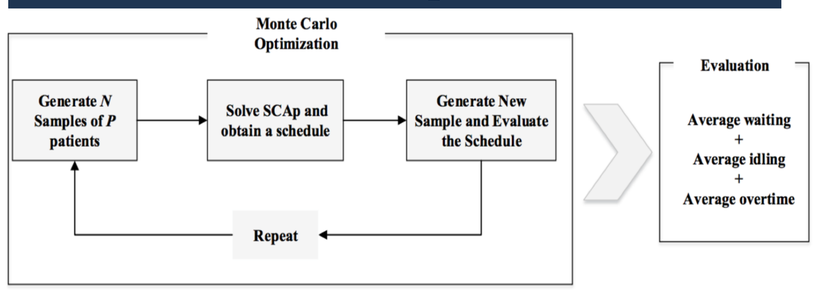
First stage decisions (generate a schedule)

Patient order
Appointment times

Second stage decisions (actual schedule)

Arrival time and actual start time
Waiting, idling and overtime (metrics)

Monte Carlo Optimization



- How the performance of optimal schedule changes as a function of variation in the prep?
- How the performance of optimal schedule changes as a function of absenteeism?
- How the performance of optimal schedule changes as a function of arrival uncertainty?

Results

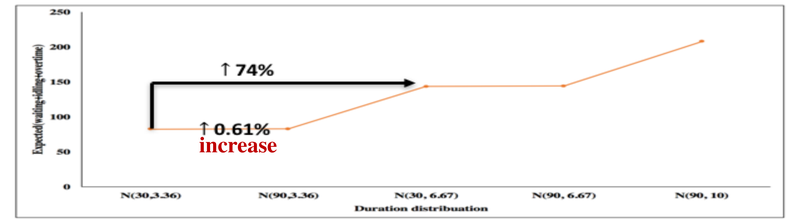


Figure 2: Effect of duration uncertainty on schedule performance

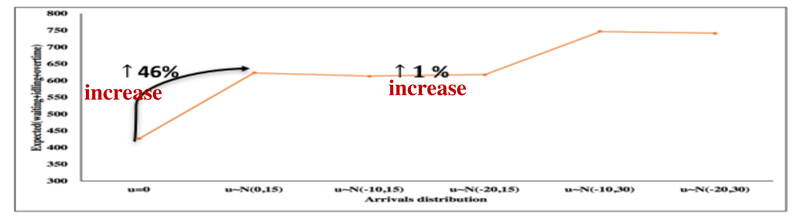


Figure 3: Effect of arrivals uncertainty on schedule performance

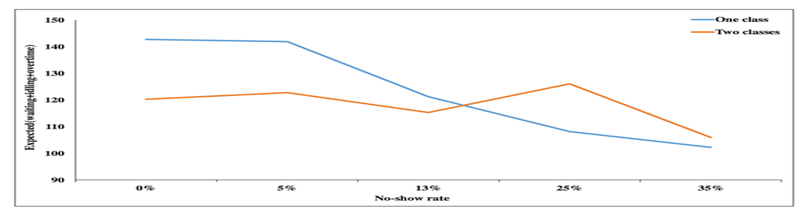


Figure 4: Changes in schedule performance for one classes of no-show (blue) as the rate changes from 0 to 0.35 and for two patient classes (red) where the rate is 0.18 for one class and ranges from 0 to 0.35 for the other class

Future Directions

- Continue observation at the University of Michigan Medical Procedure Unit
- Models for patients outcomes and preferences to include them in the scheduling decisions
- Statistical models for the unique colonoscopy duration, absenteeism and arrival distributions and include them in the scheduling decision.
- Design practical scheduling template and use simulation and UMHS-MPU historical data to validate it and identify areas for improvement

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