Patient Scheduling

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Patient Scheduling

• Examples
  – surgery scheduling, doctor appointments, diagnostic, treatment therapy bookings, CAT scans, colonoscopy bookings

• Sources of randomness
  – arrivals and multiple priority levels
  – processing durations
  – no-shows and emergencies

• Types
  – advance scheduling
  – appointment scheduling (scheduling within a day)
Challenges

• Mismatch between capacity and demand

• Uncertainties
  – demand uncertainty (type and arrivals of patients)
  – service duration uncertainty

• Booking of multiple classes of patients

• No-shows

• Emergencies

• .....
Main Concepts

• Matching demand with capacity
  ▪ capacity < demand ➔ backlog and waiting time ↑
  ▪ capacity > demand ➔ backlog and waiting time ↓ (but maybe slow)
  ▪ capacity = demand ➔ backlog and waiting time ?

• Reducing uncertainties / variability: process redesign, optimization and standardization
  – patient arrivals, patient types, no-shows
  – process durations
  – other aspects of operations such as late starts

• Effective scheduling
  – wait target time achievement
  – less waiting within a day: less idle time, less overtime, less wait time
  – less backlog in the queues
How to Reduce Wait Time/Queue Size?

• More efficient processing
  – decrease setups and idle times
  – specialization (e.g., all same/similar type of scans on a machine/day)

• More efficient scheduling
  – smoothing demand when possible, e.g., using lower priority patients to infill after higher priority patients are scheduled
  – determine appropriate service durations
  – overbooking, standby lists and other

• When possible,
  – capacity increase
  – demand decrease
How to Reduce Wait Time/Queue Size?

• Reduce uncertainty
  – standard exams and patient type definitions
  – best practices, process redesign and optimization

• Decrease no-shows
  – investigate why
  – reminders and confirmations, e.g., 1 week and 2 days before. If a patient did not confirm their appointment 2 days in advance, book someone else
  – let patients know that spots are scarce and precious resource, and they should inform in advance if they cannot make their appointment
  – let patients choose their own appointment time
How to Reduce Wait Time/Queue Size?

• **Decrease no-shows**
  – **open access** (same day appointment) concept (may not be suitable for certain exams and patient types)
  – if a no show (without a valid reason), book them at the latest possible time
  – book in the order of decreasing likelihood of no-show
  – **overbook patients**, have **standby patients**
How to Reduce Wait Time/Queue Size?

• Track patients with $> \text{target time}$ and act upon, increase their priority or schedule them first in their priority

• Rebooked ones are more likely to show up

• Be flexible and do overtime when necessary

• Start on time, i.e., do not start late

• Book more complicated (e.g., longer) and variable cases later in the day rather than earlier in the day
How to Reduce Wait Time/Queue Size?

• Optimal appointment durations can be found to minimize total idle and over time mathematically, e.g., dome shape for identical appointments

• A central wait list or allowing patients to go from one place to another can help to achieve uniform wait times across the system

• Schedule high priority patients first and then start booking lower priority patients to the latest date allowed and move closer

• Use overtime judiciously to ease the load on the system from time to time
Overbooking (if medically allowed)

• Example: 10% no-show rate, 10 spots available, book 11 patients, i.e., 1 extra
  – if a patient fails to show up, you still have 10 patients for 10 spots
  – need overtime if all 11 shows up and some patients waiting time (during the day) may increase

• Bailey's rule: book 2 patients to the first sport at the beginning of the day to reduce idle time
Standby List

• Some patients may be
  – willing to be listed on a standby list with no specific appointment day for a shorter waiting time, and be available for an appointment with a short notice

• Inform them as soon as there is a spot available in the schedule. If no availability for a certain period of time (e.g., 2 weeks), overbook them (if medically allowed)

• Standby patients would be more likely to show up
Lessons from applied projects I

• Define an acceptable and achievable service criteria

• Be proactive rather than reactive when dealing with uncertain arrivals

• Try to set Capacity > Demand

• Know what is sensitive/critical for your system

• Improve and optimize processes/operations constantly
Lessons from applied projects II

• **Process redesign** and optimization
  – e.g., efficient set up and recovery, hire staff when needed

• **Identify true bottlenecks**

• Think of doing things to utilize the expensive resources more

• Try to set **Capacity > Demand**

• **Collect operational data**, analyze data, use data, **report performance across different units and compare**

• Consider **temporary solutions** to clear backlogs

• **Scheduling policy matters**
Lessons from applied projects III

• Smooth your demand when/if possible

• Use of sophisticated mathematical models to solve complex problems

• Better scheduling can lead to more efficient outcomes

• Savings are more if overall system can be considered together
What is Management Science / Operations Research?

• Different names but similar concept: Analytics, Quantitative Decision Making, Industrial Engineering, Process optimization

• A collection of scientific methods of providing decision-makers (e.g., operational, financial) a quantitative basis for their decision making at strategic, tactical and operational levels.

• Data → information → knowledge → understanding → better outcomes/policies
  • evidence based decision making in going from data to policy

• Mathematical modeling, optimization, simulation, decision analysis, queuing theory, probability, forecasting, statistics, game theory
Examples of Questions OR/MS can Help

• **Capacity expansion** at a hospital / health authority
  – alternative and scenario planning and analysis
  – projection, forecasting, prediction of future demand
  – taking into account uncertainties
• **Scheduling** (e.g., patients, appointments, surgeries, staff)
• **Process redesign and optimization** (e.g., porter operations, radiation therapy)
• **Waitlist management**
• **Medical decision making** (e.g., beam optimization, initiation of drug therapy)
• **Sample projects**
  – Patient CT waiting time reduction study for an hospital
  – Improving patient throughput at a Children's Hospital
  – Managing surgical waitlists for an Health Authority
Some References


• For more references and information on projects visit http://www.ivey.uwo.ca/faculty/mbegen/