

MGMTMSA 403: Optimization

Assignment 1: Operating Room Scheduling

Due on CCLE by 11:59pm on November 21st.

Background

A hospital has six departments which require access to surgical facilities: General Surgery, Emergency, Neuro-surgery, Ophthalmology, Oral Surgery, and Otolaryngology. Each department currently shares a set of three operating rooms, and is currently allocated the following amount of total operating room time (in hours per week):

Department	Total hrs/week of OR time	Share of total OR time
General Surgery	92	48.4%
Emergency	8	4.2%
Neuro-surgery	48	25.3%
Ophthalmology	14	7.4%
Oral Surgery	10	5.3%
Otolaryngology	15	7.8%
Total	190	100%

Next year, the hospital will be relocating to a larger hospital with five operating rooms. The new operating rooms will provide a total of 213.5 hours of operating room time per week (an increase from the current 190 hours per week). The availability of each room on each day of the week is given in the table below:

	Main-1	Main-2	Main-3	Main-4	Main-5
Monday	8:00-17:00	8:00-17:00	8:00-17:00	8:00-17:00	8:00-15:30
Tuesday	8:00-17:00	8:00-17:00	8:00-17:00	8:00-17:00	8:00-15:30
Wednesday	8:00-17:00	8:00-17:00	8:00-17:00	8:00-17:00	8:00-15:30
Thursday	8:00-17:00	8:00-17:00	8:00-17:00	8:00-17:00	8:00-15:30
Friday	8:00-17:00	9:00-17:00	9:00-17:00	9:00-17:00	9:00-15:30

Moving to the new, larger hospital with more operating rooms means a new schedule must be devised. As a result, the hospital CEO has hired you to develop a new operating room schedule. The main concern of the CEO is to find a schedule that is *equitable*. Specifically, she wants the new schedule to allocate slots to each department such that each department maintains its current share (on a % basis) of the total operating room time. Additionally, there are a number of policies that are being considered, and you will be required to determine how each policy might potentially affect the fairness of the new schedule.

Questions

For each part below, (1) write the optimization model (you may do this by hand or in a text editor), (2) include your Python code for the model, and (3) report the optimal value obtained at an optimal solution.

- a) First, formulate a schedule that **minimizes the total under-allocation of each department to operating rooms**. For example, General Surgery currently receives 48.4% of the total operating room time, and should therefore receive 48.4% of the total operating room time in the new schedule as well. In particular, the CEO has specified that under-allocation is to be avoided, meaning a penalty should be incurred if a department is allocated **less** than its target %, but there should be no penalty if a department is allocated **more** than its target % of operating room time.

Your model should produce a new schedule that minimizes the total under-allocation (on a percentage basis). The reason for representing allocation on a percentage basis is that using units of time is not equitable: For example, a loss of 1 hour per week is much more disruptive to Oral Surgery (currently 10 hrs/week) than it is for General Surgery (92 hrs/week).

Hint: Index departments using $d = 1, \dots, 6$, operating rooms using $i = 1, \dots, 5$, and days using $k = 1, \dots, 7$.

- b) Operating rooms Main-1, Main-2 will be located on the first floor of the new hospital, Main-3 and Main-4 will be on the second floor, and Main-5 will be located on the third floor. To improve communication and mobility among department staff, the CEO has inquired whether it is possible to devise the schedule so that no department is split between two or more floors on the same day. For example, it is acceptable if a department is exclusively assigned to Main-1 on Monday and then Main-3 on Tuesday, but not acceptable if a department is assigned to Main-1 and Main-5 on the same day.

Incorporate constraints into your base model from part a) to ensure that no department is allocated rooms on two different floors on the same day.

Hint: Index floors of the hospital using $l = 1, 2, 3$.