

# Scheduling Family Medicine Residents at the American University of Beirut Medical to Clinics Using Optimization Methods With Multi-Objective Criteria and Priority Rules

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## Problem Statement

### Background

- Family Medicine (FM) is a specialized field of medicine that provides comprehensive care for families and individuals of all ages.
- The FM residency at the American University of Beirut Medical Center (AUMBC) in Lebanon is a 4-year training program in which residents must complete rotations in different departments (Neurology, OBGYN, Mental Health, etc.) in addition to their FM obligations.
- These obligations include clinic hours and night shifts at AUMBC and FM clinics at multiple locations around Beirut.
- Each clinic location provides a unique educational experience — for example, one location is the equivalent of a Veterans Affairs hospital, while another serves patients in a refugee camp.

	Monday	Tuesday	Wednesday	Thursday	Friday
7:30-8:30 AM	Lecture	Lecture	Lecture	Lecture	Lecture
8:30AM- 12:00PM	FM Clinic	Nephrology	Nephrology	Nephrology	Nephrology
12:00-1:00PM	Lecture	Lecture	Lecture	Lecture	Lecture
1:30-5:00PM	Nephrology	FM Clinic	FM Clinic		Nephrology
5:00PM-7:30AM			Duty		

Figure 1: Weekly Schedule of a 2<sup>nd</sup> Year Resident on the Nephrology Rotation. We are responsible for scheduling the time and location of their FM Clinics (highlighted in yellow).

### Traditional Approach

- The chief resident creates a new schedule every month, which is time and labor intensive.

### The Challenge

- Create a schedule every month that ensures each clinic location is adequately staffed by residents according to their level of experience, their responsibilities at AUMBC, and concurrent specialty rotations.
- The schedules should provide a fair, consistent distribution of workload among the residents as well as access to a diverse training experience over the course of the year.

↑ Quality ↓ Time

### Research Goal

- Create a tool that automates the scheduling process and is accessible to users without training in mathematical optimization or special-purpose software.

## Solution Approach

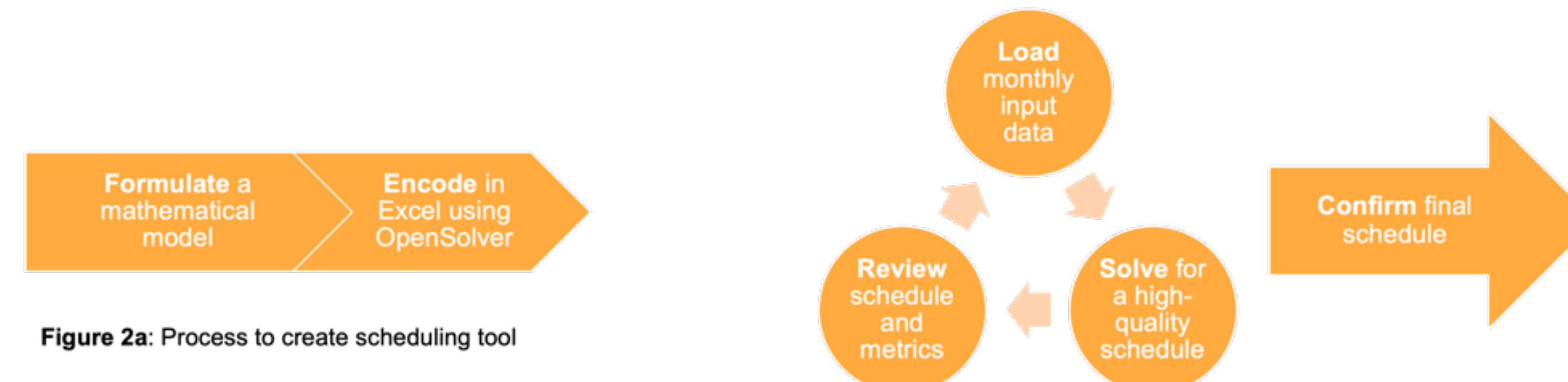


Figure 2a: Process to create scheduling tool

### Decisions

Do we assign a resident  $r$  to shift  $s$  on date  $d$  at location  $k$ ?

$$x_{r,k,d,s} = \begin{cases} 1 & \text{if resident } r \text{ is assigned to location } k, \text{ on date } d, \text{ on shift type } s \\ 0 & \text{otherwise,} \end{cases}$$

### Constraints

All rules must be fulfilled for the schedule to be considered feasible

- Different rotations require different number of residents per shift
- Residents who worked a night shift the night before cannot be assigned to an afternoon shift the next day
- Certain clinic locations can only be staffed by seniors or a certain rotation
- Satisfy work and vacation requests
- And more...

### Example: Home Base Rule

Each resident must complete at least one shift at the FMPC location each week.

$$\sum_{d \in D^{\text{dw}}: w(d)=w} \sum_{s \in \{AM, PM\}} x_{r, FMPC, d, s} \geq 1 \quad r \in R_{FM}(w), w \in W.$$

### Metrics

Additional priority rules improve the quality of the overall schedule and for individual residents. These rules are sometimes in conflict with each other and must be balanced to determine the best possible schedule. For these priority rules, lower numbers are preferred.

- Number of residents that work more than one night shift a week
- Number of residents assigned to locations that do not match their difficulty level
- Number of residents assigned to "mis-matched" locations based on their rotation
- Location diversity of assigned shifts
- Number of excess shifts assigned to each resident
- Maintaining a uniform schedule for residents across a monthly period
- Maintain equity amongst weekday and weekend night shifts

Weights for Priorities		
Priority	Weight	Value
Weekly night shift	1	0
Clinic difficulty	1	0
Rotation specialty	1	12
Location diversity	1	19
"Excess" shifts	1	10
Schedule uniformity	1	6
Night shift points	1	0

Figure 3: Weights and Values for Priorities

The Chief Resident has the ability to adjust the weighting of the objective function metrics to impact the final schedule.

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## Impact/Results

	FMPC		Badaro		Tahadi		K
	AM	PM	AM	PM	AM	PM	AM
Mondays	Mohammad-Ali Jardaly (24,31,7,14) Amir El Sehmawy (24,31,7,14)	Rita El Tawil (24,31,7,14) Jad El Khoury (24,31,7,14) Mohammad-Ali Jardaly (24,31,7,14)	Elie Toni Korbani (24,31,7,14)		Lea Feghali (,7,14) Maria Tanielian (24,31,7,14) Michel Ibrahim (24,31,,)		Rana El Jarrah
Tuesdays	Ghassan Khairallah (25,1,8,15) Rana El Jarrah (25,1,8,15)	Lea Feghali (,8,15) Michel Ibrahim (25,,) M. Ramadan M (25,1,8,15)	Elie Toni Korbani (25,1,8,15)				Amir El Se (25,1,8)
Wednesdays	Mohammad Srour (26,2,9,16) Rana El Jarrah (26,2,9,16)	Roxane Assaf (26,2,9,16) M. Ramadan M (26,2,9,16)	Nadim-Nicolas Ghanem (26,2,9,16)		Maria Tanielian (26,2,9,16) Ghassan Khairallah (26,2,9,16)		
Thursdays	Marwan Azzam (27,3,10,17) Amir El Sehmawy (27,3,10,17)	Chloe Saade (27,3,10,17) M. Ramadan M (27,3,10,17)	Elie Toni Korbani (,10,17) Michel Ibrahim (27,,)		Ghassan Khairallah (27,3,10,17) Chloe Saade (27,3,10,17)		Mohammad- (27,3,10,17)
Fridays	Lewaa Shujaa (28,4,11,18) Nadim-Nicolas Ghanem (28,4,11,18) Elie Toni Korbani (28,4,11,18)	Maria Tanielian (28,4,11,18) Chloe Saade (28,4,11,18) M. Ramadan M (28,4,11,18) Rana El Jarrah (28,4,11,18)	Roxane Assaf (28,4,11,18)		Jad El Khoury (28,4,11,18)		Amir El Se (28,4,11,18)

Above: A snippet of a generated day shift schedule. The numbers in the parentheses correspond to the days of the month that the resident will work that month.  
**Note:** The snippet omits three additional clinics that receive resident assignments.

Night Shift Calendar		
Day	Date	Resident
Monday	24-Aug	Chloe Saade
Tuesday	25-Aug	Jad El Khoury
Wednesday	26-Aug	Elie Toni Korbani
Thursday	27-Aug	Ghassan Khairallah
Friday	28-Aug	Mohammad-Ali Jardaly
Saturday	29-Aug	Rana El Jarrah
Sunday	30-Aug	Maria Tanielian
Monday	31-Aug	Ghassan Khairallah
Tuesday	1-Sep	Amir El Sehmawy
Wednesday	2-Sep	Rana El Jarrah
Thursday	3-Sep	Nadim-Nicolas Ghanem
Friday	4-Sep	Jad El Khoury
Saturday	5-Sep	Roxane Assaf
Sunday	6-Sep	M. Ramadan M
Monday	7-Sep	Ghassan Khairallah
Tuesday	8-Sep	Jad El Khoury
Wednesday	9-Sep	Rana El Jarrah
Thursday	10-Sep	Amir El Sehmawy
Friday	11-Sep	Nadim-Nicolas Ghanem
Saturday	12-Sep	Elie Toni Korbani
Sunday	13-Sep	Maria Tanielian

Left: An example of the night schedule.

**Note:** The night schedule minimizes the number of residents who work more than one night shift in a week AND tries to provide equity to weekday night shift assignments.

## Future Work

Modify the tool to include dynamic ranges that accommodates for a larger number of residents, clinic locations, and rotations in case the AUBMC residency program expands in the future.

## Acknowledgements

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