Advancing Data-Driven Solutions for Improved Healthcare Outcome

Application of Optimisation and Queueing Models in

Healthcare Operations.

Evander Nana Bosomefi Eghan

Supervisor

Prof. Peter Amoako-Yirenkyi

Dr. Reindolf Nartey Bokor

Kwame Nkrumah University of Science and Technology Facilitated by: National Institute for Mathematical Sciences (NIMS), Ghana

March 25,2024

OUTLINE OF PRESENTATION

INTRODUCTION

SOME CONSTRAINTS FROM THE UROLOGY DEPARTMENT-KATH

RESULTS

OPEN FOR DISCUSSIONS



THE HEALTHCARE SCHEDULING PROBLEM



Figure 1: A Nurse Schedule

An Automated Nurse Scheduler With An Auxiliary Schedule To Address Absenteeism And Upsurge in Patient Demand.

CONSTRAINTS CONSIDERED

- Ensures maximum of three consecutive shifts off if the nurse works four consecutive night shifts in his/her individual schedule.
- 2. Requires that each nurse work a minimum number of afternoon shifts.
- 3. Ensures that no weekend shifts are scheduled for head nurses.
- Ensures that the required number of nurses is present in each shift throughout the day.
- Ensures that each nurse is only assigned one shift type (i.e. morning, afternoon, night, day off, auxiliary shift).
- 6. Ensures a night shift does not immediately following a morning shift the next day.

RESULTS

Table 1: PNO_1s' schedule

	Week_one								Week_two								Week_three								Week_four							
	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund				
Morning	М	М	М	М	М	-		М	М	М	М	М	-		М	М	М	М	М			М	М	М	М	М	-					
Afternoon				-		-		-		-		-	-	-	-	-	-					-	-	-		-	-					
Night		-		-		-			-	-	-	-	-			-	-		-							-	-					
Aux-M				-		-	S		-	-	-	-	-			-	-		-		S	-	-			-	-					
Aux-A				-		-		-	-		-	-	-			-	-					-					S					
Aux-N				-		-		-					S			-						-					-					
Day_off				-		-		-	-		-	-	-			-	-					-					-	D				
Day_off				-		-							-			-	-					-		-		-	-					
Day_off				-		D				-			-	D		-	-			D				-			-					



Table 2: SSN_1s' schedule

	Week_one								Week_two								Week_three								Week_four							
	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund				
Morning	М			-	-	М		М	-			-	-			М	-	М	М	М	М	М		М	М	М	-					
Afternoon			A	A	-		A	-				-					-	-		-		-				-	A					
Night				-	-			-	N	N	N	N	-					-		-	-	-				-	-					
Aux-M				-	-			-				-					-	-		-		-				-	-					
Aux-A				-	S			-				-								-		-				-	-					
Aux-N				-	-			-	-			-	-				-	-		-		-	S			-	-					
Day_off				-				-					-				D	-		-		-				-	-					
Day_off				-	-			-	-			-	-				-	-		-		-				-	-					
Day_off		D		-	-		-	-				-	D	D	D			-		-		-				-	-	D				



Table 3: SSN_5s' schedule

	Week_one								Week_two							Week_three								Week_four							
	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund	Mond	Tues	Wedn	Thur	Frid	Satu	Sund			
Morning		М	М	М	-	М	М	-	М		М	М	М	М	М		-	М	M	М	М		М	М	М		М	М			
Afternoon				-	-			-									-			-			-								
Night				-	-	-		-	-			-	-	-	-		-	-		-	-	-	-			-					
Aux-M				-	S			-		S							S			-			-			S					
Aux-A				-		-		-	-			-	-	-			-	-		-		-	-			-					
Aux-N				-	-	-		-	-			-	-				-	-		-			-			-					
Day_off	D			-	-	-		D								D	-			-		D	-								
Day_off				-	-	-		-	-			-	-	-		-	-	-	-	-			-			-					
Day_off				-	-	-		-	-			-	-	-			-	-		-	-	-	-			-					



WHAT NEXT ?



Figure 2: What next ?



HOSPITAL REFERRAL SYSTEM IN LOWER MIDDLE INCOME COUNTRIES (LMIC)



Figure 3: Ghana's Healthcare Referral System





Figure 4: Overcrowded Hospital



Figure 5: Registration Process





Figure 6: Queues to See A Doctor.







Figure 7: Referred Cases







BASIC UNDERSTANDING OF QUEUES



Figure 10: Queue



BASIC UNDERSTANDING OF QUEUES



Figure 10: Queue

• A queuing system can be describe as patients arriving for service, waiting for service if it is not immediate, utilizing the service, and leaving the system after being served.



OPEN FOR DISCUSSIONS

- What are the clinical pathways in the hospital?
- How are multiple treatments handled?
- How do you currently deal with an increase in patient demand?
- How are revisits handled?



References

[]

- Abdalkareem, Z. A., Amir, A., Al-Betar, M. A., Ekhan, P., and Hammouri, A. I. (2021). Healthcare scheduling in optimization context: a review. *Health and Technology*, 11:445–469.
- Agrawal, G. (2010). A queuing model for health centre. In 2010 International Conference on Electronics and Information Engineering, volume 1, pages V1–542. IEEE.
- Al-Mudahka, I. and Alhamad, R. (2022). On a timetabling problem in the health care system. *RAIRO-Operations Research*, 56(6):4347–4362.
- Demeester, P., Souffriau, W., De Causmaecker, P., and Berghe, G. V. (2010). A hybrid tabu search algorithm for automatically assigning patients to beds. Artificial Intelligence in Medicine, 48(1):61–70.
- El Adoly, A. A., Gheith, M., and Fors, M. N. (2018). A new formulation and solution for the nurse scheduling problem: A case study in egypt. Alexandria engineering journal, 57(4):2289–2298.
- Ernst, A. T., Jiang, H., Krishnamoorthy, M., and Sier, D. (2004). Staff scheduling and rostering: A review of applications, methods and models. *European journal of operational research*, 153(1):3–27.
- Haspeslagh, S., De Causmaecker, P., Schaerf, A., and Stølevik, M. (2014). The first international nurse rostering competition 2010. Annals of Operations Research, 218:221–236.
- Legrain, A., Bouarab, H., and Lahrichi, N. (2015). The nurse scheduling problem in real-life. Journal of medical systems, 39:1-1
- Maass, K. L., Liu, B., Daskin, M. S., Duck, M., Wang, Z., Mwenesi, R., and Schapiro, H. (2017). Incorporating nurse absenteeism into staffing with demand uncertainty. *Health care management science*, 20(1):141–155.
- Mtonga, K., Gatera, A., Jayavel, K., Nyirenda, M., and Kumaran, S. (2022). Adaptive staff scheduling at outpatient department of



