SINERGiES
Soins Intégrés, Nanomédecine, IA & Ingénierie pour la Santé

Thesis proposal

Title	:	Optimization of Caregiver Assignment in Rehabilitation Hospitals: An Integrated Approach Using Operational Research and Artificial Intelligence
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Context and Problem Statement

Rehabilitation hospitals, such as the Strasbourg University Hospital (CHU) in France or Rehabilitation Hospital No. 3 in Shanghai, China, play a crucial role in providing functional recovery care for patients after illness, injury, or surgery. These institutions must manage hundreds or even thousands of patients while ensuring the optimal assignment of caregivers (doctors and nurses) based on their skills, work schedules, patient priorities, required care time, and other factors. Currently, this assignment is often performed manually or semi-automatically, leading to inefficiencies, staff overload, and prolonged patient waiting times.

The aging population exacerbates this issue. With increasing life expectancy and the growing prevalence of chronic diseases, rehabilitation hospitals face a rising demand for specialized care. This situation highlights the need to develop innovative solutions to optimize human resource management in these facilities.

Operational research and artificial intelligence offer powerful tools to address these challenges. However, their application in the specific context of rehabilitation hospitals remains limited. This thesis aims to bridge this gap by developing an integrated approach for the optimal assignment of caregivers while considering the complex constraints and specificities of these institutions.

Objectives

The primary objective of this thesis is to design, implement, and validate an optimization system for caregiver assignment in rehabilitation hospitals. Specific objectives include modeling the assignment problem, designing efficient optimization algorithms, integrating artificial intelligence techniques for real-time adaptation, and validating the system using real-world data from institutions such as the Strasbourg University Hospital and Rehabilitation Hospital No. 3 in Shanghai.

Key Challenges

The complexity of the caregiver assignment problem lies in the multitude of constraints that must be considered: specific skills of doctors and nurses, work schedules, patient priorities, required care time, etc. Additionally, patient and caregiver data are often heterogeneous and require rigorous integration. Another major challenge is the system's real-time adaptability, as patient needs and caregiver availability can change rapidly. Finally, the system must be user-friendly and easily interpretable for hospital administrators and caregivers while providing reliable and actionable results.

Expected Improvements Over Existing Practices

Several improvements over current practices are expected. First, optimal caregiver assignment will reduce patient waiting times, thereby enhancing their experience and satisfaction. Second, better workload distribution among caregivers will reduce fatigue and the risk of burnout, fostering a healthier work environment. Furthermore, by accounting for caregivers' specific skills and patients' needs, the system will enable a more efficient use of human resources. Lastly, the system will be capable of real-time adaptation to changes in patient needs and caregiver availability, ensuring continuous and effective care delivery.

Methodology

This thesis follows a structured methodology consisting of several key steps. The first step is to define a mathematical model to formalize the assignment problem, considering factors such as skills, schedules, priorities, and required care time. Optimization algorithms will then be designed and implemented, leveraging techniques such as linear programming, integer programming, and metaheuristics. Artificial intelligence methods will be integrated to predict patient needs and adjust assignments in real-time. The system will be validated using real-world data from institutions such as the Strasbourg University Hospital and Rehabilitation Hospital No. 3 in Shanghai, and it will be compared to existing practices to assess its effectiveness.

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