An integrated nurse rerostering and routing problem in hospital-at-home

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Hospital-at-home provides short-term acute care at the patient's home for conditions that would otherwise necessitate in-patient hospitalization. Several benefits of this service are the following: increased capacity of the institutional health care system, improved patient quality of life, and reduced length of stay (Shepperd & Iliffe, 2005). The problem addressed in this presentation focuses on operational scheduling decisions for hospital-at-home systems. When having an acute illness, a patient needs care for a limited period. As a result, the patient mix fluctuates. Moreover, the availability of nurses also varies over time. Therefore, a precise scheduling plan is required to better match available resources with patient needs.

Given the baseline nurse roster and patient requirements, several operational decisions are taken simultaneously over the planning horizon: (i) select patients to be admitted and their admission dates, (ii) assign nurses to the admitted patients and schedule the care visits, and (iii) decide whether and how the nurse roster should be updated. The studied problem is a combination of task scheduling, nurse routing, and nurse rerostering problems. Generally, the underlying subproblems are solved independently in the literature, as this approach is less complex and thus more computationally practical. However, this sequential decision-making process may lead to inefficient or even infeasible solutions, since the subproblems are strongly intertwined.

The objective of this work is first to maximize the number of patients treated at home, and second to minimize the total working duration of the nurses. A variety of complex real-world characteristics are considered, yielding a rich integrated problem. In particular, to schedule the patient visits of the routing subproblem, we consider the temporal dependencies between the treatments associated with each patient, as well as the periodicity of those treatments. Such routing problems are classified as the home health care routing and scheduling problem in the literature (Fikar & Hirsch, 2017). Another important aspect of the problem we studied are the rerostering decisions (Maenhout & Vanhoucke, 2018). When rerostering is necessary, several classical rostering constraints must be respected, such as the minimum rest time and the maximum number of shift

assignments.

The resulting mixed-integer program is modelled using a stepping horizon approach (Salassa & Vanden Berghe, 2012) in order to properly address the connections between consecutive scheduling periods. The model was validated using toy instances. The presentation will discuss several challenges encountered due to the integration of scheduling, routing, and rerostering decisions. Our next step is to develop solution methods to tackle realistic instances.

Keywords: nurse rerostering, home health care routing and scheduling, integrated combinatorial optimization, hospital-at-home

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