Home Healthcare: Integrated Multi-Period Combinatorial Auction and Nurse Routing Problem

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Abstract. We study an integrated Multi-Period Combinatorial Auction (MPCA) and Nurse Routing Problem (NRP) to better support hospital home healthcare decisions in facing overcrowding due to the current COVID-19 pandemic. The MPCA allows the hospital to create a collaborative patients management system where part of the visits can be outsourced. External providers' offers consist in a subset of services and the total cost required to perform them. Instead, for the services directly managed by the hospital, a NRP generates daily routes for each nurse [1]. To guarantee a high QoS, the problem is complicated by consistency constraints [2], which limit the number of nurses assigned to each patient, and by soft time-windows, which highly penalize the visits performed outside the patients' availability range. The hospital goal is to implement an outsourcing policy minimizing both the auction and the travelling costs related to its own nurses. We provide a Mixed-Integer Linear Programming formulation for the integrated problem and an effective heuristic procedure based on decomposition. The approach is tested on realistic instances by varying the number of providers and the required consistency level to assess how different degrees of collaboration affect both the hospital's internal logistics and the QoS.

Keywords: Home Healthcare; Combinatorial Auction; Nurse Routing; Consistency Constraints.

References

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