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Scheduling Elective Surgeries with Sequence-Dependent Setup Times to Multiple Operating Rooms Using Constraint Programming

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Abstract

The problem studied in this paper is to schedule elective surgeries (in contrast to urgent surgeries) to multiple operating rooms (ORs) in ambulatory surgical settings. We focus on three aspects of the daily scheduling decisions, including the number of ORs to open, the allocation of surgery-to-OR, and the sequence of surgeries in each OR. All the surgeries to be scheduled are known in advance, which is a common assumption for elective surgery scheduling problems. The surgeries belong to different types, and each OR can only allow certain types of surgeries to be performed. Before a surgery starts, some setup work needs to be done, such as sterilization and preparing required equipment. The setup times are assumed sequence-dependent, and both setup times and surgery durations are deterministic. The fixed costs of running the ORs are high; while sometimes overtime costs, which are even higher than the fixed costs, may occur when the surgeries cannot be done within the normal operating period of the ORs. We build a Mixed Integer Nonlinear Programming (MINLP) model and a Constraint Programming (CP) model to solve this problem. The performance of these two models is tested on numerical examples, and the results show that the CP model is more efficient than the MINLP model in terms of the computational time and solution quality. We also examine the sensitivity of the solutions to the variation of surgery durations, and the analysis shows that the total costs do not change much when the variations of surgery durations are small.

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