BRANCH AND BOUND ALGORITHM FOR SCHEDULING SURGICAL UNITS

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1 Introduction

Scheduling in health-care institutions is a critical component for the management of these institutions. When we speak about the surgical units, it is clear that we are considering the most important and delicate part of a health-care institution. In this paper, we are interested in this problem as it has been studied in van Essen *et al.* [1] and Ayachi *et al.* [2]. More precisely, we propose and implement a branch-and-bound algorithm to solve this scheduling problem in surgical units. The obtained results are satisfactory.

2 Problem formulation

We start with a list of interventions, which were already assigned to each room but not yet sequenced. The problem is to sequence elective operations already assigned to their room so that the waiting time of the emergency interventions is reduced as much as possible. The aim is to minimize the length of the largest interval (δ) or (BII), which separates two consecutive completion or starting times (these times represent the completion and/or the starting of one or several elective operations and they are consequently possible times when an urgent intervention can start). All these times (T_i) or (BIM) are represented in a list called total sequence, which includes all the generated values after the sequencing of all the interventions in the rooms where they were assigned. Our objective is to minimize the length of the greatest interval $\delta=\max\{\delta_i\}$. In Figure 1, we can see an illustrative example.

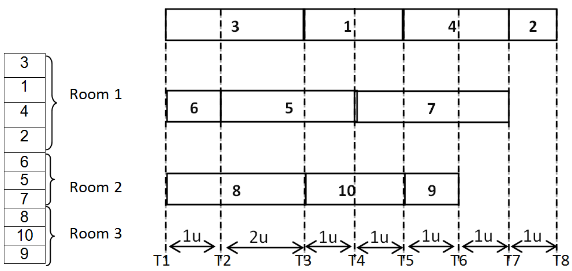

Figure 1: An illustrative example

3 Branch-and-bound algorithm

The method used is based on a lower bound, which is initially defined by the smallest operation's duration and an upper bound obtained by the application of a genetic algorithm [2]. Each node of the tree presents an operation scheduled in the room where it is assigned. Each branch of the tree (since the first node until the last one) presents a possible solution of the problem. Each level of the tree is devoted for one and only one of the operational rooms. We keep the initial lower bound to the M first levels (with M the number of operational rooms). Starting from the M+1 level, we calculate the lower bound (the lower bound is calculated as: Max(BII).) for each node and we compare it to the upper bound:

- If the new lower bound is greater or equal to the upper bound, then we remove this node and we do not explore it.
- Else, we keep the node and we pass at the next level.

The exploration of the tree has been done in-depth and the upper bound has been calculated from a metaheuristic method [2].

4 Results and conclusions

The proposed algorithm has been coded and tested. We were based on a standard benchmark (see Fei *et al.* [3]).The operating times of the interventions were selected randomly between 30 and 150 minutes with 6 operating rooms and the number of operations to be tested belongs to {20, 30, 40, 50, 75, 100}. The branch-and-bound has been compared to heuristics used by Van Essen *et al.* [1], as well as those in Ayachi *et al.* [2]. The computation time of the branch-and-bound algorithm is limited but largely the greatest one. Nevertheless, the results show that the branch-and-bound algorithm with a limited number of nodes are the best results obtained for this problem until now. Moreover, the truncated version of the exact algorithm does not always improve the results in [2], but it improves the results of the four heuristics in [1] (for a large percentage of instances).

The study of the approximation techniques for this problem can be an interesting topic to construct a more complete picture of the topic at the methodological level.

5 REFERENCES

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