Advanced Online Algorithms for Real-world Elevator Control

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Abstract: The control of passenger elevators in a building is one of the prime examples of an online optimization problem. A suitable control should achieve small waiting and travel times for the passengers. The waiting time and the travel time of a passenger is the time span between the release of the call and the arrival of the serving elevator at the start floor and destination floor, respectively.

In a conventional 2-button system, a passenger enters his desired travel direction using up/down buttons. In such a system, there is not only uncertainty about future passengers (the online aspect), but also uncertainty about the destination floors of the passengers waiting at a floor. This additional lack of information severely limits the optimization that can be performed. Some elevator companies therefore introduced *destination (hall) call systems*, where a passenger enters the destination floor. Such a destination call system provides more information earlier, which should allow to improve the performance of the system.

We propose an exact reoptimization algorithm for scheduling a group of elevators controlled by a destination call system. The algorithm is based on a set partitioning model, which is solved via column generation techniques. We solve the pricing problem using a Branch & Bound algorithm that computes lower bounds on the waiting and travel times and thus on the reduced cost of a schedule. The lower bound computation takes into account stops that may be necessary to avoid reversing the direction while passengers are loaded. Once our pricing algorithm does not find improving schedules, we solve the Integer Program consisting of the schedules found during pricing to optimality to compute a schedule for the whole elevator group. This reoptimization is invoked each time some new information becomes known. We will also discuss special features of the algorithm aimed to improve its online performance as well as to obtain real-time running times on practically relevant problem sizes.

Using extensive simulations, we compare the elevator group performance of conventionally controlled systems to ones controlled by our sophisticated algorithm. We find that it may substantially increase the number of passengers (i. e. system load) for which an acceptable service level can be provided.

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