

# Dynamic pricing in the ferry industry

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In this paper we present a dynamic pricing model on the ferry industry in which efficient packing algorithms are used to fit more vehicles in the ferry, leading to better expected revenues.

The origins of the revenue management (RM) lie in the airline industry. In 1997 it was shown the potential of this market when RM were introduced with a profit of 60\$ millions in the year 1984. RM practices generated 1,4 billion in additional revenues at American Airlines in the three year period starting from 1988. One of the consequences of such potential is that most of the world's major air carriers and many smaller airlines have some level of revenue management capability. The main issue when applying the dynamic programming models used in the airline industry and in the ferry industry is how to measure the space left in the ferry, whilst avoiding overbooking. In the airline industry the number of sales is determined by the number of seats, however, in the ferry industry the number of vehicles which could fit in the ferry depends on the layout used in the ferry. Furthermore, a better placement of the vehicles allows either more vehicles or bigger vehicles to be placed and, therefore, there is a higher chance to increase the expected revenues.

In order to solve the pricing problem, in which the expected revenues are maximized, we solve a dynamic programming formulation in which the number of states (layouts), i.e. the number of vehicle mixes that can be accommodated at each time period in the selling season is calculated from packing algorithms.

We propose two different approaches to place the vehicles in the ferry. In a first approach the decks are divided into lanes, and each lane has a known length, width and height, leading to a one dimensional heterogeneous bin packing problem. In the second approach the number of lanes and their widths are not given, so they should be decided by the packing algorithms, leading to a two dimensional rectangular packing problem.

In order to solve the pricing model more efficiently we need to find all the solutions in the Pareto frontier, where the number of vehicles placed in the ferry of each type is a single objective. We use an iterative procedure to find all the solutions. In order to decide whether a set of vehicles fits on the ferry or do not fit, we explore fast constructive heuristics like the minimum length placement heuristic (bottom left heuristic) and first fit decreasing algorithms. In addition, we propose an IP model to solve the packing problem to optimality, which is capable of finding all of the feasible solutions with a reasonable computational effort. We extend this IP model to case where the lane dimensions are real variables.

We present some computational results on instances generated based on real data. The results shows that the expected revenues increases when the packing is solved more efficiently, and the exact algorithm is capable to solve instances with up to 5 vehicles types, 4x50 meter lanes and a 100 price types.

**Keywords:** *Dynamic Pricing, 1D multiple bin size bin packing, 2D rectangular bin packing.*