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Rolling Horizon Network Revenue Management Using Decomposition

Special case of hotel

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***Abstract*— In this paper, we develop an approach in network revenue management problem, focused on hotel industry. The objective is to determine the booking price for the next 350 dates (one year) in advance, as well as to update them periodically. The main difficulty with determining the optimal solution of multiple-night stay is caused by the huge number of products. Each product (customer request for booking) depends on many factors such as duration of stay, arrival and departure dates, day of week and season. The key idea in this approach is to decompose the multiple-night stay problem into single-night ones. To do so, we need to estimate the effective arrival rate for each individual date by considering the effects of other dates. In fact, "customer loss" of a specified date may be due to the features of other dates. Therefore first we calculate the probability of customer loss, which can be categorized into two groups: (a) because of room shortage of at least one date of customer request; and (b) because of high price. By calculating the probability of these events and their effect on the potential customer appearance rates, we estimate the effective arrival rate of each date individually. We develop an algorithm to estimate the effective arrival rate of each individual date based on historical data base. At last, we develop a single leg rolling horizon model to obtain the suitable booking price in a timely manner, within the framework of dynamic programming. By sequentially solving the developed models, an appropriate booking price of different dates are obtained.**

Keywords-revenue management; dynamic pricing;network management; hotel industry

I. INTRODUCTION

The majority of published papers focusing on the application of revenue management in hotel industry are developed based on the possibility of single night stay. According to Weatherford [1], taking the length of stay into account in hotel revenue management, can increase revenue by as much as 2.94% which results in huge saving. There exists a very rich "network revenue management" literature, especially in the airline industry. However, according to Talluri and Van Ryzin [2] not necessarily exact optimization methods can be found for practical purposes. In fact, many optimization methods use various categories of approximations. Achieving a good balance between the quality of approximation and efficiency is the key for a method to be successful.

The idea of this paper is to decompose the multiple-night stay problem into single night ones to be able to make pricing decisions for the next 350 days using rolling horizon. Therefore we apply dynamic programming approach to obtain a solution with a high quality approximation in a timely manner. Since the price and number of available rooms in different days affect the booking request of other dates, it is necessary to consider the problem of multiple-product book. However, due to complexity of multiple product approach, in this paper we use decomposition method. In fact, the main contribution of this paper is to identify the relation between different products (dates) and figure out the effect of this relationship on the effective arrival rate of customers for a specific date. By estimating this effective arrival rate of customers we are able to decompose the model.

Although there are some other dynamic programming decomposition approaches in the literature, they are mostly focused on the airline industry and most of them use capacity control policies, whereas our focus is on pricing and in the hotel industry. Liu and Van Ryzin [3] model customer choice behavior using dynamic programming decomposition approach. In their model the customers select among the available itineraries. According to Erdelyi