

# Dynamic pricing for upselling based on customer choice behavior

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Selling upgrades has become a widespread practice in revenue management industries (e.g., hotel sector, transportation services) over the past decade. This technique is also known as upselling and can occur immediately after the purchase or shortly before the service is provided (e.g. one day before departure, or at check-in). In this talk, we focus on the second case and on examples from the airline industry. Accordingly, upselling means that customers who have booked a ticket in a lower compartment (economy or business class) are offered to upgrade to a higher one (business or first class) for an additional fee (upselling price) some hours before departure.

We assume that customer decisions follow a multinomial logit model in the booking horizon where the initial purchases occur. What is special about our upselling approach is that the airline uses disaggregated customer data from the booking horizon to set upselling prices. This data can be, for example, the set of products (offer set) that a customer has seen during his/her purchase, and the initial purchase decision. The connection of these properties is made in the upselling process: the customer's response probability to an upselling offer is represented as a conditional probability that depends on the upselling price, and is formally consistent with the multinomial logit model in the booking horizon. [1]

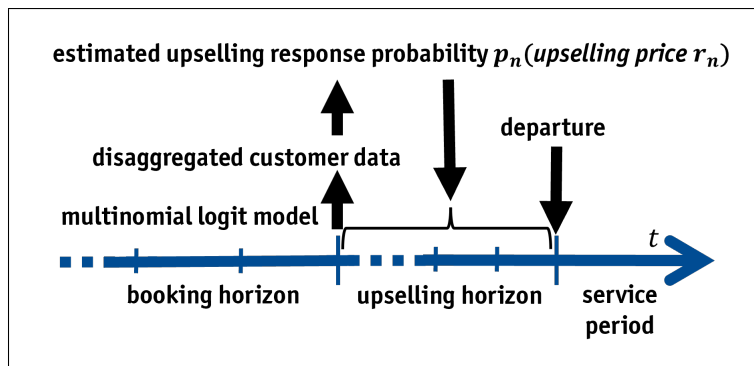


Figure 1: Upselling Model Timeline

We present a dynamic program formulation for the upselling pricing decision problem in the upselling horizon. As the upselling horizon is considered a very short period of time compared to the length of the booking horizon, we assume that no new customers arrive during the upselling offers. To solve the dynamic program efficiently with large numbers of customers, we suggest three solution methods that consider customer groups instead of individual customers as well as price points instead of continuous upselling prices: a dynamic program, an integer linear program, and an approximate dynamic programming approach. This effects our models as follows: considering customer groups leads to including the binomial distribution, and price points has to be chosen wisely to not impede optimality.

Our numerical study shows that using customer data in the upselling price decision problem can increase revenues significantly compared to a simple setting in which the airline gives a static discount of, e.g., ten percent of all higher class ticket prices. Furthermore, computation time is drastically reduced by the presented simplifications, although revenues only decrease slightly.

[1] D. Hartmann, J. Gönsch, and C. Steinhardt, “On the value of booking data for upselling decision-making in airline revenue management,” *Submitted Manuscript*, 2023.