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The value of baggage: dynamic pricing methods for ancillaries

One of the current hot topics in airline revenue management and distribution is dynamic pricing. However, most endeavors focus on dynamic prices for the seat, while little effort thus far has been spent on dynamic pricing of ancillaries. We want to change this by looking into dynamic pricing for the first bag ancillary.

→ **Lufthansa Systems Blog (/blogs)**

This post was written in collaboration with Janek Reichardt, work student at Lufthansa Systems. Several colleagues from Berlin and Budapest participate in this project.

Ancillaries are services which are sold by the airline as add-ons to a flight ticket. Examples for ancillaries are extra baggage, additional leg room, or priority boarding. Some ancillaries are already included in the ticket price itself such as the free cancellation you can get with more flexible tickets. Other ancillaries can be ordered “à la carte”.

What does Dynamic Pricing mean in this context?

Dynamic means here that the prices for a booking request are calculated in real time by the system. In principle, they can differ for each request. Hence, the passenger does not pay the same, fixed amount for extra baggage as is the case at most airlines at present. Instead, the extra baggage item sometimes costs a little less and at other times a little more.

At Lufthansa Systems, we run these calculations on a powerful computation platform from the project PROCESS. The EU project PROCESS (https://www.process-project.eu/) (PROviding Computing solutions for ExaScale challengeS) aims to deliver a hard-, and software environment specially developed to enable exascale data processing in both scientific research and advanced industry settings. It is part of the EU research program Horizon 2020 (https://ec.europa.eu/programmes/horizon2020/en).

Which prices are the best dynamic prices?

It is our task to determine revenue-optimal ancillary prices, that is, individual prices for every booking request such that the total revenue is maximized. This task will be completed in two steps. First, we use machine learning algorithms to understand how the decision for buying extra baggage depends on the parameters of the request. Based on this information, we solve a nonlinear optimization problem in the second step to determine the revenue-optimal prices.

We employ machine learning algorithms provided by the open source project H2O.ai (https://www.h2o.ai/). H2O implements many machine learning algorithms. We call H2O from within the Statistics platform R (https://www.r-project.org/) to train both a Distributed Random Forest (https://docs.h2o.ai/h2o/latest-stable/h2o-docs/data-science/drf.html) model as well as a Deep Neural Network (https://docs.h2o.ai/h2o/latest-stable/h2o-docs/data-science/deep-learning.html) model and use the better one for the actual calculation.

Machine Learning methods are powerful tools. They are able to detect complex interrelations within a data set. In our case, we would like to find out how likely it is that a customer will purchase extra baggage. The customer’s decision to purchase extra baggage depends on a number of factors, for example on the date of departure or on the ticket price, but most importantly, on the price of the ancillary itself. The likelihood that a customer will purchase an ancillary also changes during the time interval between the ticket sale and the departure. Therefore, our model also contains a time component over the booking horizon.

The system uses this new knowledge to determine optimal pricing strategies. For example, if a customer is not likely to be interested in additional baggage, the model might propose a slightly lower price as an incentive for purchase. In addition, it might lower the prices on the first few days after the sale of the ticket as a “reward” for passengers who decide early on to book extra baggage. On the other hand, prices for extra baggage may increase as the day of departure approaches. The determination of the price strategy is formulated as nonlinear optimization problem which is solved with standard methods.

How is the model used?

Given sufficient computation power – as provided by cloud solutions – airlines are able to compute these ancillary prices in real time as new flights are booked. At each booking request, our models estimate the willingness to pay of that particular customer for each day between the date of booking and the date of departure. Afterwards we solve the nonlinear optimization problem using these estimations to generate a price for each of these days.

In our tests we trained the models on a sample size of up to 350 million bookings. This took overall around 75 minutes in the PROCESS environment. The training process is repeated once a month. Calculating the optimal pricing strategy is executed in the millisecond range. Therefore it can easily be used to offer prices in a web service in real time. Our simulation shows a revenue increase by dynamic pricing of extra baggage revenue of up to 6%.

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Franziska Berger (https://www.lhsystems.com/users/franziska-berger)
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About the author

For the past few years, I have been working in different roles in the Revenue Management and Pricing Team. Current research topics include dynamic offer creation (dynamic pricing, dynamic bundling).

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