Revenue Management for Small Hotels[I]

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Small Independent Hotels vs. Big Chain Hotels

- Less rooms (25-50)
- No (centralised) revenue management system
- Small management team (typically of size 1)

Our Research

- Collaboration with 5 small independent hotels in the Netherlands
- Research motivated by real hotel data

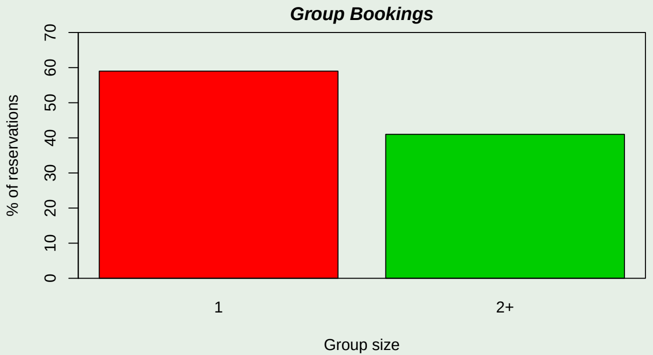
Important Properties of Revenue Management System

- Group bookings
- Networks (multiple night stays)
- Cancellations

Example: Data from One Small Dutch Hotel

- The hotel has **34 hotel rooms** with **5 room types**
- Located in the **countryside**
- Attracts **business** as well as **leisure** clients
- **Competition** mainly consists of a big chain hotel

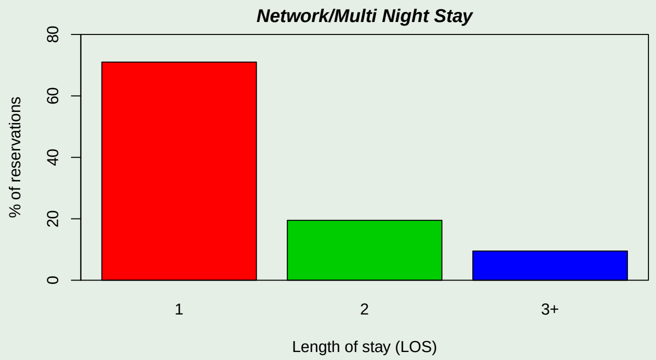
Group Bookings



Observation

Large part (41%) of all bookings are group bookings

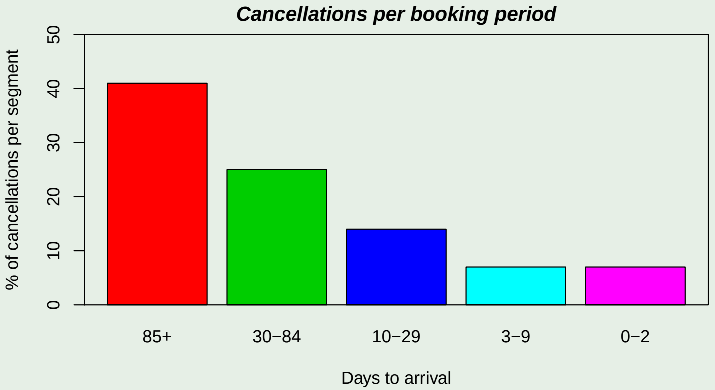
Networks/Multiple Night Stays



Observation

Big part (29%) stays more than one night

Cancellations



Observations

- 22% of all bookings are cancelled
- Early booking $\Longrightarrow$ high cancellation probability

Customer Choice Cancellation Model

Properties:

- Customer choice behaviour
- Cancellation
- Overbooking

Related work:

- Subramanian et alii (1999): Overbooking and cancellations
- Talluri and Van Ryzin (2004): Customer choice behaviour
- Ge and Pan (2010): Customer choice behaviour and overbooking

Example (Talluri & van Ryzin, 2004)

Hotel with

- $C = 20$ rooms
- $n = 3$ products with prices

$$r_1 = 800 \qquad r_2 = 500 \qquad r_3 = 450$$

- T days before arrival
- $\lambda = 1/4$ probability that a customer arrives
- x_j number of reservations for product j ($x = (x_1, x_2, x_3)$)
- $\gamma(x_j) = x_j/100$ probability that product j is cancelled
- $L_j = r_j$ loss if product j is cancelled

Example (continued)

- $P(S, j)$ probability that customer buys product j if $S \subset \{1, 2, 3\}$ is offered
- $P(S, 0) = 0$ probability that customer buys nothing
- E.g. $S = \{1, 2\}$ and

$$
\begin{aligned}
P(S, 1) &= 0.1 \\
P(S, 2) &= 0.6 \\
P(S, 3) &= 0 \\
P(S, 0) &= 0.3
\end{aligned}
$$

Objective

Which products $S \subset \{1, 2, 3\}$ do we offer t days before arrival in state x

Solution

Model as Markov decision process and solve with dynamic programming

Problems with exact model

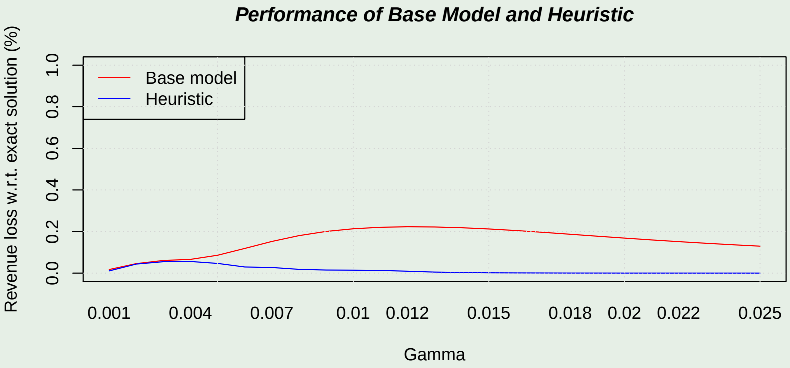
- State space too large to solve ($x = (x_1, \dots, x_n)$)
- Action space too large ($|\mathcal{P}(\{1, \dots, n\})| = 2^n$)

Solution: heuristic

Outline algorithm:

- One-dimensional state space ($x \in \mathbb{N}$ number of reservations)
- Procedure:
  1. Fix strategy and approximate loss L_j
  2. Solve one-dimensional problem to find next strategy
  3. Use strategy to approximate loss L_j and go to step 2
- *Upside:*
  1. Smaller state space (one-dimensional)
  2. Smaller action space (most sets S can be ruled out)
- *Downside:* Not always convergent

Numerical Results



Observations

- Base model performs bad
- Heuristic performs well

Conclusions

- Cancellations have a big impact on revenue
- The heuristic approximates solution well

Further Research

- Bounds solution of heuristic
- Apply cancellation model to real data
- Group bookings and networks