Introduction to REVENUE MANAGEMENT

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References

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- S. Pölt, Revenue Management Tutorial (slides of a seminar with notes, available on moodle)
- A.R. Goetz, T.M. Vowles, The good, the bad, and the ugly: 30 years of US airline deregulation, *Journal of Transport Geography*, vol 17 (2009) 251-263 (paper on the US airline deregulation: story and consequences, available on moodle)

History (1)

- Prior to 1978 in USA: CAB (Civil Aeronautics Board) controls schedules and fares.
- Airline Deregulation Act (1978): removal of fare regulation. Carries are now free to change prices, schedules, and service without CAB approval.
- 1981: PeopleExpress (and other low-cost and charter airlines) enters the market.
- 1984: PeopleExpress profit = $60 million
  American Airlines (AA) (and other major companies) looses many price-sensitive clients.

History (2)

- 1984: AA proposes Super-Saver Fares:
  - purchased at least 30 days in advance
  - nonrefundable
  - requiring a seven-day minimum stay.

  Purchase restrictions + capacity controlled fares.

- 1985: AA implements DINAMO (Dynamic Inventory Allocation and Maintenance Optimizer) to control the capacity (seats) reserved to discount fares on each individual flight (importance of information technology!).

- 1986: PeopleExpress goes bankrupt, sold to Continental Airlines.

Revenue Management companies

Passenger airlines, hotels, car rental companies, freight transportation, cruise lines, passenger trains, theaters and sporting events…

Features:

- Customer heterogeneity (leisure, business, corporate…)
- Demand variability and uncertainty
- Production inflexibility
- Data and information systems infrastructure
- Management culture

RM: definition and conditions

Definition: Strategy and tactics used by some companies to manage the allocation of their capacity to different fare classes over time in order to maximize revenue.

Conditions:

- The seller is selling a fixed stock of capacity.
- Customers book capacity in advance.
- The seller manages a set of fare classes, each having a fixed price (at least in the short run).
- The seller can change the availability of fare classes over time.

Levels of RM

Level	Description	Frequency
Strategic	Segment market and differentiate prices	Quarterly or annually
Tactical	Calculate and update booking limits	Daily or weekly
Booking Control	Determine which bookings to accept and which to reject	Real time

RM - Booking Control level

Function of the Computerized Reservation System

Possible ways to manage bookings:

- Allotments (=quote assegnate)
- Nesting classes and *nested booking limits*
- Dynamic Nested Booking Control:
  - ✓ irreversible approach
  - ✓ reversible approach

Allotments (or partitioned booking limit)

Example:

- In a 100 seats aircraft,
  - 30 seats reserved for deep discount (B-Class) with $125 fare
  - 45 seats to full fare (M-Class) $200
  - 25 seats to business class (Y-Class) $560

Allotments (or partitioned booking limit)

Example:

- In a 100 seats aircraft,
  - 30 seats reserved for deep discount (B-Class) with $125 fare
  - 45 seats to full fare (M-Class) $200
  - 25 seats to business class (Y-Class) $560
- Two weeks before departure 25 B, 45 M and 10 Y have been accepted
- Remaining allotments: 5 B, 0 M and 15 Y

What if a request of an M class pops up?

High-fare customers may be rejected while lower fare customers are still being accepted

Nested booking limit

- Classes (1, 2, …, n) are ordered from the most important (highest fare) to the least important.
- b_j = *(nested) booking limit for class j = maximum number of acceptable bookings for class j and lower fare classes:*

  $b_1 \geq b_2 \geq b_3 \geq \ldots \geq b_n$
- Every fare class has access to all of the inventory available to lower fare classes.
- Protection level for class j = total number of seats protected for sale only to class j and higher fare classes =

  $y_j = b_1 - b_{j+1}$ for $j=1,\ldots,n-1$, $y_n = b_1$.
- $b_1 \geq C$ capacity of the flight

Example

5 fare classes

Current booking limits are

$(b_1, b_2, b_3, b_4, b_5) = (100, 73, 12, 4, 0)$.

Class 5 is closed.

$y_j = b_1 - b_{j+1}$ for $j=1,\ldots,n-1$, $y_n = b_1$

Corresponding protection levels are

$(y_1, y_2, y_3, y_4, y_5) = (27, 88, 96, 100, 100)$.

Dynamic Nested Booking Control

(as in Phillips)

Rules:

- every time a seat is booked, decrement all nonzero booking limits by 1
- once a booking limit for a class reaches zero, it remains there

(see next table) or DNBC.xlsx file

DYNAMICS OF BOOKING LIMITS AND PROTECTION LEVELS

	Booking limits					Protection levels					Request	Action
	1	2	3	4	5	1	2	3	4	5		
1	100	73	12	4	0	27	88	96	100	100	2 seats in class 5	reject
2	100	73	12	4	0	27	88	96	100	100	5 seats in class 2	accept
3	95	68	7	0	0	27	88	95	95	95	1 seat in class 2	accept
4	94	67	6	0	0	27	88	94	94	94	1 seat in class 4	reject
5	94	67	6	0	0	27	88	94	94	94	3 seats in class 3	accept
6	91	64	3	0	0	27	88	91	91	91	4 seats in class 3	reject
7	91	64	3	0	0	27	88	91	91	91	2 seats in class 3	accept
8	89	62	1	0	0	27	88	89	89	89	4 seats in class 3	reject
9	89	62	1	0	0	27	88	89	89	89	1 seat in class 3	accept
10	88	61	0	0	0	27	88	88	88	88	2 seats in class 2	accept
11	86	59	0	0	0	27	86	86	86	86	2 seats in class 3	reject

How to manage cancellations

Notice:

- fare classes close in order, from lowest to highest
- protection levels for higher classes are preserved while bookings are being accepted for lower classes
- a class can be closed as a result of accepting bookings for a higher class

In case of cancellations:

When 1 cancellation occurs, increase all positive booking limits by 1

Irreversible process: a booking request, accepted and immediately cancelled, changes the booking limits

IRREVERSIBLE PROCESS						
	Booking limits					
	1	**2**	**3**	**4**	**Event**	**Action**
1	73	12	4	0	Request 2 seats in Class 3	Accept
2	71	10	2	0	Request 2 seats in Class 3	Accept
3	69	8	0	0	2 bookings cancel	
4	71	10	0	0	Request 5 seats in Class 3	Reject
5	71	10	0	0	Request 3 seats in Class 2	Accept
6	68	7	0	0	Request 2 seats in Class 3	Reject
7	68	7	0	0	3 bookings cancel	
8	71	10	0	0	Request 2 seats in Class 3	Reject
9	71	10	0	0	Request 2 seats in Class 3	Reject
10	71	10	0	0	2 booking cancel	
11	73	12	0	0	Request 1 seat in Class 2	Accept
12	72	11	0	0	Request 1 seat in Class 3	Reject
FINAL STATE	**72**	**11**	**0**	**0**		

Variation of Dynamic Nested Booking Control

Rules:

- When accepting a request, decrease all booking limits (they may become negative)
- If a booking limit is negative, the corresponding class is temporarily closed
- When 1 cancellation occurs, increase all booking limits by 1

Reversible process: a booking request, accepted and immediately cancelled, does not change the booking limits

(see next tables for a comparison) or file Cancellations.xlsx

REVERSIBLE PROCESS

	Booking limits					
	1	**2**	**3**	**4**	**Event**	**Action**
1	73	12	4	0	Request 2 seats in Class 3	Accept
2	71	10	2	-2	Request 2 seats in Class 3	Accept
3	69	8	0	-4	2 bookings cancel	
4	71	10	2	-2	Request 5 seats in Class 3	Reject
5	71	10	2	-2	Request 3 seats in Class 2	Accept
6	68	7	-1	-5	Request 2 seats in Class 3	Reject
7	68	7	-1	-5	3 bookings cancel	
8	71	10	2	-2	Request 2 seats in Class 3	Accept
9	69	8	0	-4	Request 2 seats in Class 3	Reject
10	69	8	0	-4	2 booking cancel	
11	71	10	2	-2	Request 1 seat in Class 2	Accept
12	70	9	1	-3	Request 1 seat in Class 3	Accept
FINAL STATE	**69**	**8**	**0**	**-4**		

ACTION DIFFERENCES		IRREVERSIBLE PROCESS	REVERSIBLE PROCESS
	Event	**Action**	**Action**
1	Request 2 seats in Class 3	Accept	Accept
2	Request 2 seats in Class 3	Accept	Accept
3	2 bookings cancel		
4	Request 5 seats in Class 3	Reject	Reject
5	Request 3 seats in Class 2	Accept	Accept
6	Request 2 seats in Class 3	Reject	Reject
7	3 bookings cancel		
8	Request 2 seats in Class 3	Reject	Accept
9	Request 2 seats in Class 3	Reject	Reject
10	2 booking cancel		
11	Request 1 seat in Class 2	Accept	Accept
12	Request 1 seat in Class 3	Reject	Accept

Comparison

- The reversible approach sometimes opens previously closed classes: it accepts more low-fare bookings than the irreversible approach.
- The irreversible approach saves more seats for later high-fare bookings.
- Generally, it is felt that the reversible approach provides higher revenue.

Which approach is used (irreversible vs reversible) is often determined by the capabilities of the reservation system rather than by considerations of relative benefit.

Components of Tactical RM

Calculate and update booking limits in order to maximize revenue.

1. Capacity allocation: calculate booking limits
2. Overbooking: manage resources when bookings are allowed to cancel or not show with little or no penalty
3. Network management: manage products consisting of combination of resources

See

R.L. Phillips

Pricing and Revenue Management

Stanford University Press, 2005 [Chapter 6]