Customer Loyalty Based Dynamic Pricing by Using RFID-enabled Floor Level Sales Information

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Agenda

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- Supporting Practices
  - Frequent Shoppers Program (FSP)
  - Dynamic Pricing (DP)
- System Overview and Flow
- Proposed Algorithms
- Evaluation
- Conclusion, Limitation and Future Possibilities
Summary

Propose an application and algorithms to achieve two goals together:

- Target inventory turnover rate to increase profit of retailers that have physical stores
- Rewarding Frequent Shoppers Program members based on their loyalty status
Introduction: Background

- Physical store retailers’ situation
  - Space constraint (of course this is a strong point as well)
  - Difficult forecasting because of shorter product lifecycle

- Retailers’ strategies
  - Improve inventory turnover rate to make the most use of the store floor space (SCM)
  - Build good relationship with loyal customers (CRM)
Introduction: Challenges & Role of RFID

- **Combining SCM with CRM!**
  - Challenge for retailers for long time
  - Differentiate members through FSP, but not loyalty basis
  - Critical issue: Customers do not identify themselves

- **RFID fills the gap**
  - FSP members card with RFID and readers at the store floor connects SCM and CRM
RFID reader with display
- Customers scan loyalty card with RF tags
- Reader displays information only to the customers

Photo courtesy of Dai Nippon Printing and Sears
Supporting Practices

- **Frequent Shoppers Program (FSP)**
  - Practice to build strong customer relationship
  - Rewarding customers based on customers’ loyalty level
  - Popular in airline industry and retail industry

- **Dynamic Pricing (DP)**
  - Optimize revenue out of given resources
  - Manipulating price to meet customer demand

\[
\max \sum_{t=1}^{T} r(t, d(t)) \quad \text{s.t.} \quad \sum_{t=1}^{T} d(t) \leq C \quad d(t) \geq 0
\]

\(r(t,d):\text{ revenue, } d(t):\text{ demand, } C: \text{ constraint}\)
System Overview and Flow

Dynamic Pricing Engine (DPE)

Customer DB

Inventory Management System (IMS)

RFID reader with display

Loyalty Card w/RFID tag
Proposed Algorithms: BTDP Algorithm

Base Target Discount Price (BTDP) Calculation
- Compute a price to achieve inventory turnover rate goal
- Difference in loyalty status is not taken into account

Start

Get data for sales forecasting and price – demand relation

Get current inventory level, price, and date in sales period

Forecast sales amount of the rest of the sales period

Compute inventory level at the end of sales period

Excess

Compute base target discount price to make the inventory level of end of sales period zero

Not Excess

End
Proposed Algorithms: MTDP Algorithm

**Member type Target Discount Price (MTDP) Calculation**

- Compute prices appropriate for each member status
- Use a price computed through BTDP algorithm

\[
P_{BTDP} = cust\_class(0)\square P_{LIST} + \sum_{k=1}^{n} cust\_class(k)(1 - disc)^{k-1}\square P_{MTDP}(1)
\]

\[
P_{MTDP}(i) = (1 - disc)^{i-1}\square P_{MTDP}(1), \ i = 2, \ldots, n
\]

- \(P_{BTDP}\): Price from BTDP
- \(P_{MTDP}(i)\): Price from MTDP
- \(P_{List}\): List Price
- \(cust\_class()\): % of each group
- \(disc\): Discount rate difference
Evaluation

- **Demo system development**
  - Demo system spec.
    - Hardware
      - PC: Panasonic CF-W4 (Mobile Pentium 1.2GHz)
      - Reader/Writer: Omron V720S-HME01
    - Software
      - Windows XP Professional Version 2002 SP2
      - DB: MySQL 4.0.20a

- **Numerical study**
  A) Increase retailer’s profit or not
  B) Reward customers based on loyalty status
  C) Control inventory turn over rate
Build demo system
  - Work fine but may need improvements (e.g., performance)

Dear Mary Johnson (Cust. No. 10)
Your member type is Gold.
100GB HDD Recorder is $1012.
16% Discount! (You save $188.)
(This price is only on 2006-10-25.)

Dear Richard Smith (Cust. No. 1)
Your member type is Silver.
100GB HDD Recorder is $1054.
12% Discount! (You save $146.)
(This price is only on 2006-10-25.)

Screen shot of demo system
Evaluation: Numerical Study

- Three points for evaluation
  A) Increase retailer’s profit or not
  B) Reward customers based on loyalty status or not
  C) Control inventory turn over rate successfully or not

- Show effectiveness of the algorithms through comparison
  i. Without Dynamic Pricing
  ii. With Dynamic Pricing. Without loyalty status differentiation (only difference in FSP member and non-member)
  iii. With Dynamic Pricing. With loyalty status differentiation (three statuses: Platinum, Gold, and Silver; and non-member)

- Common settings
  - Poisson distribution, 3 months, 5 days/week, \( P_{List} = ¥1,200, \) Disc: 4%
  - Demand-price curve: \( \text{demand} = 600 - 0.4 \times \text{price} \)
  - Actual demand: 120 [items/wk], Forecast range: 100 – 150 [items/wk]
Result of Numerical Study (A)

- Algorithms increase the profit

![Graph showing profit differences]

- Demand Forecasting at the beginning of sales period [Items]
- Profit differences

- (I) w/o Dynamic pricing
- (II) w Dynamic pricing, w/o FSP difference
- (III) w Dynamic pricing, w FSP difference

- [Yen]
- Algorithms appropriately reward customers

**Result of Numerical Study (B)**

Offer low price to loyal customers
Algorithms successfully control inventory level

Algorithms reduce the inventory level at the end
# Conclusion, Limitations & Future Possibilities

## Conclusion
- Propose an application and algorithms to achieve two goals together:
  - Target inventory turnover rate to increase profit
  - Rewarding FSP members based on loyalty status
- Connect the gap between SCM and CRM

## Limitations
- Privacy
- Legality of the practice

## Future Possibilities
- More information for consumers
  - Not only discount but also recommendation
- More information for retailers and manufacturers
  - Behavior information (Promotion, List price decision)
References

- Dainippon Printing : http://www.dnp.co.jp/
Thank you!