



→ **A Proposal on
RFID Data Analytics Methods**

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Outline



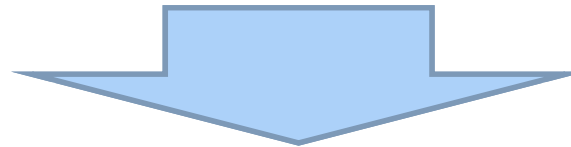
- **Background**
- **Consumer purchase behavior**
- **Hypotheses**
 - Hypothesis 1
 - Hypothesis 2
- **Validation of hypotheses**
- **Summary**



Background



- **Adoption of RFID in retailing**
 - Many experiments
 - Many commercial use applications
- **Insufficiency in RFID-captured data analytics**
 - Possibility of improving corporate business(e.g., product design, pricing, inventory management etc.)



Necessity of RFID data analytics methods



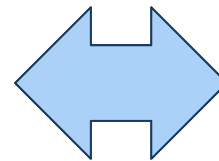
Consumer purchase behavior analysis



- **Definition of “Consumer purchase behavior”**
 - *“A series of interactions between items at a store and a consumer who has an intention to buy something”*
- **Consumer purchase behavior Analysis in this study**
 - Analysis between consumer purchase behavior and purchase behavior



Consumer purchase behavior



Purchase behavior



Our focus



- **General expectation to consumer purchase behavior**
 - Why some items are sold well but others not?
 - Were customers interested in items in a special promotion?
 - Do customers buy items because of company's sales promotion?
 - Do customers really buy items that they are interested in?



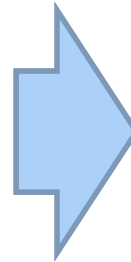
- **Our Focus**
 - Why some items are interested in and sold, but others are interested in but not sold?
 - Are there any items that stimulate sales of other?

→ Hypotheses



Focus 1

Why some items are interested in and sold, but others are interested in but not sold?



Hypothesis 1

Items in the same category are compared, and customer does not take all, only one or two

Focus 2

Are there any items that increase sales of other?



Hypothesis 2

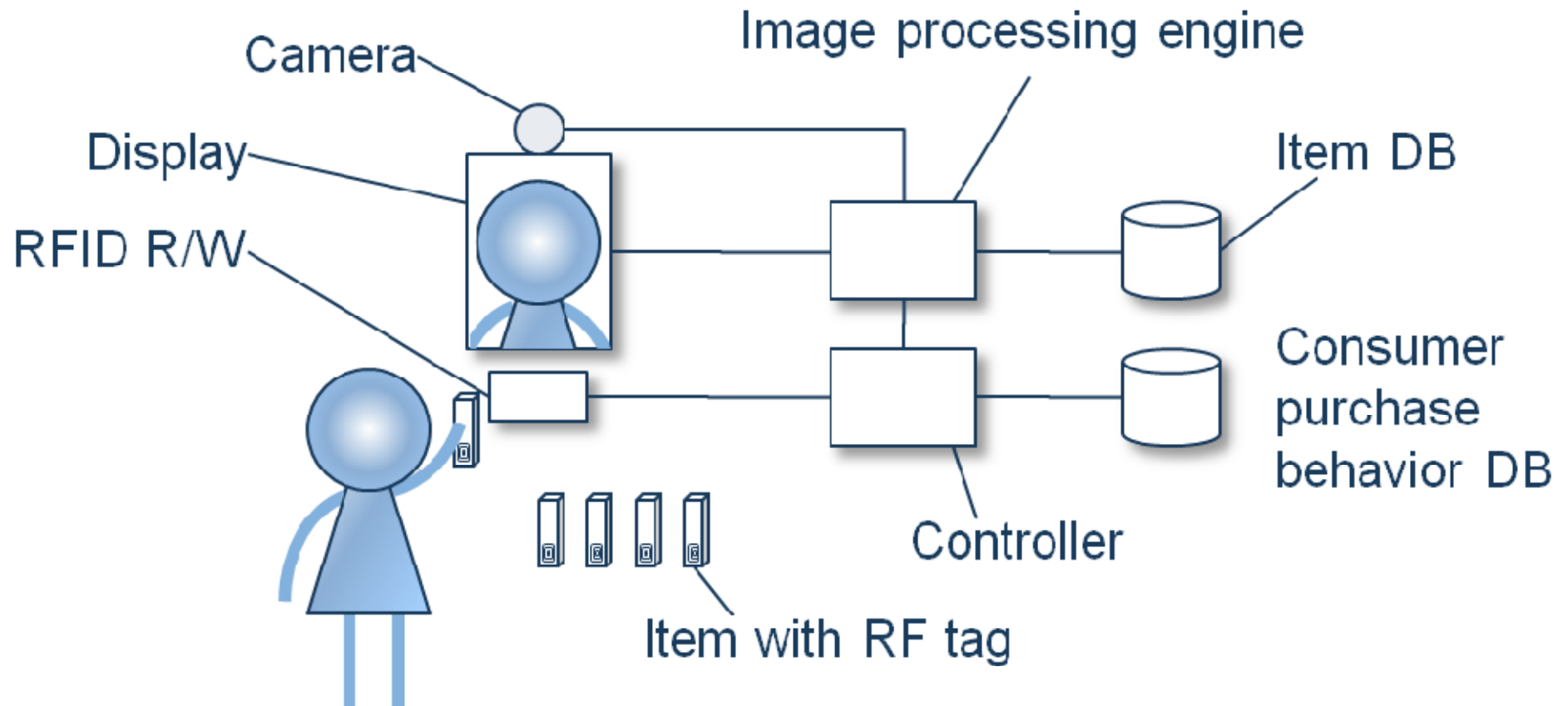
There are good combination of items in different categories, and these items stimulate sales of others each other



Illustration of CPB capturing system



- RFID enabled virtual make-up system

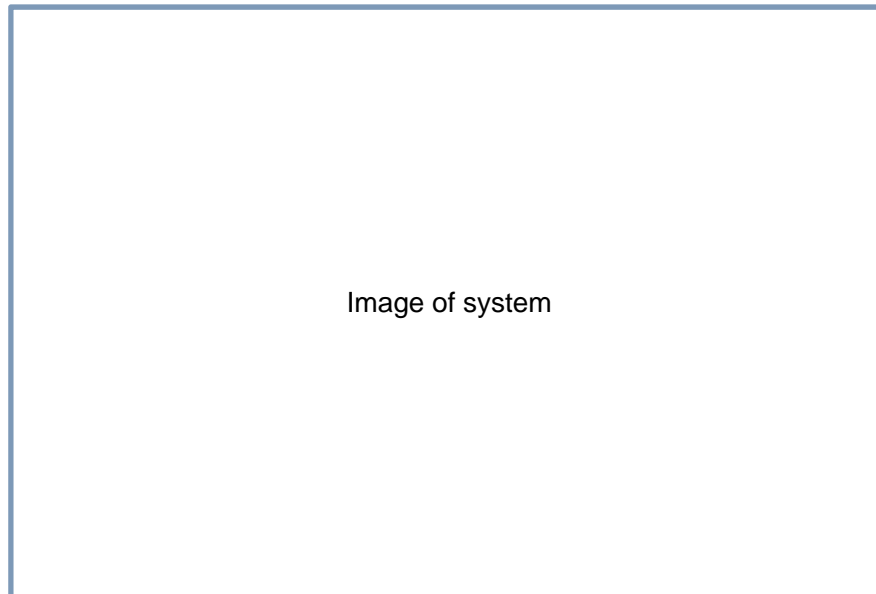




RFID system to capture CPB



RFID enabled virtual make-up system



- **CPB data from RFID system**
 - Item name
 - Time, duration, combination
- **Data**
 - 3 months of data
 - 12 stores inside dept. stores
 - 21 items in 3 categories
 - 9 Lips (Denoted as “L”)
 - 7 Shadows (Denoted as “S”)
 - 5 Cheeks (Denoted as “C”)



Analytics method proposal



- **Inference of compared items**
 - Corresponding to hypothesis 1
 - Consumer Purchase Portfolio
 - Radar chart
 - Domain shift time chart
- **Inference of good combination items**
 - Corresponding to hypothesis 2
 - Association analysis
 - Apriori
 - Comparison of sales according to extracted rules



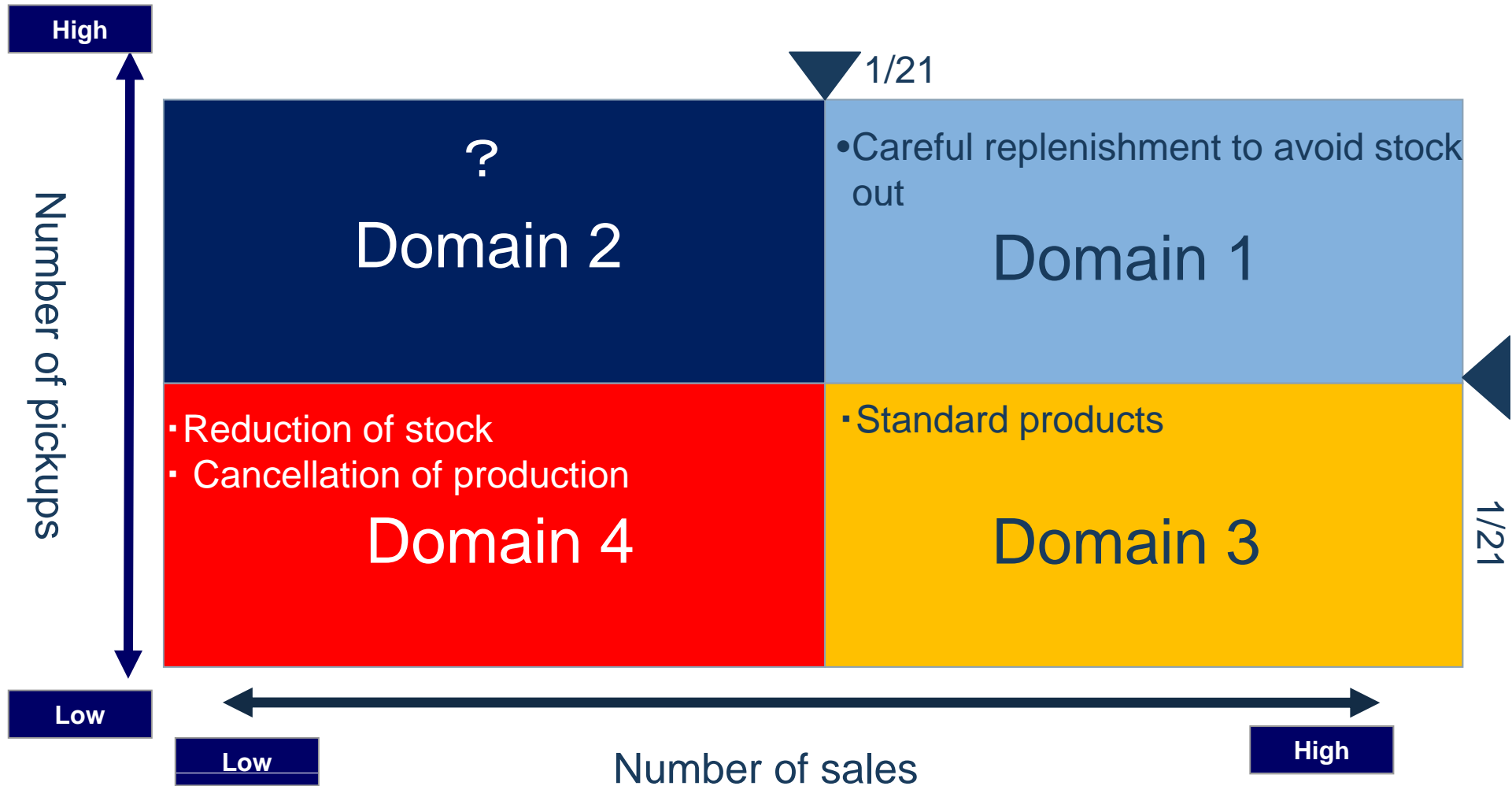
Approach to hypothesis 1



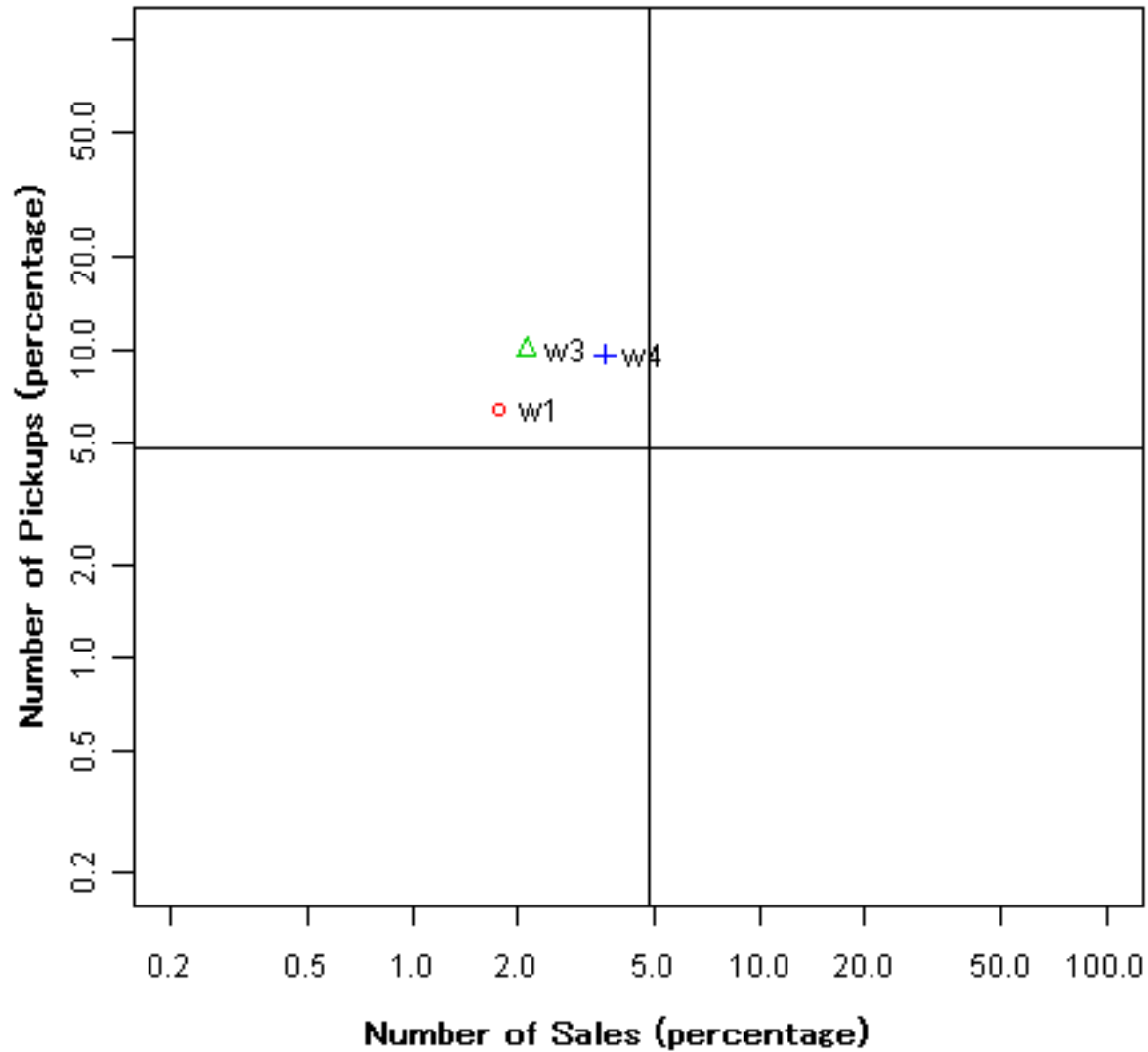
- **[Step 1] To find items that are picked up well but not sold well**
 - Use Consumer Purchase Portfolio (CPP) and search items in domain 2
- **[Step 2] To find items that are compared with the item in the domain 2**
 - Use Radar Chart and find compared items
 - Use Domain Shift Time Chart and see the relation between domain 2 items and compared items



Consumer Purchase Portfolio (CPP)



→ CPP of Store 2 Item S5

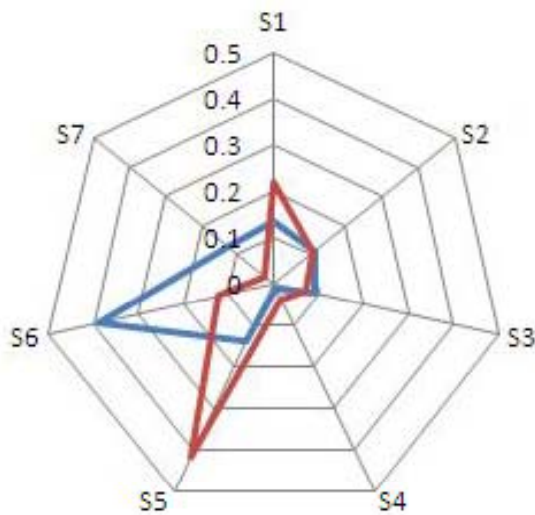




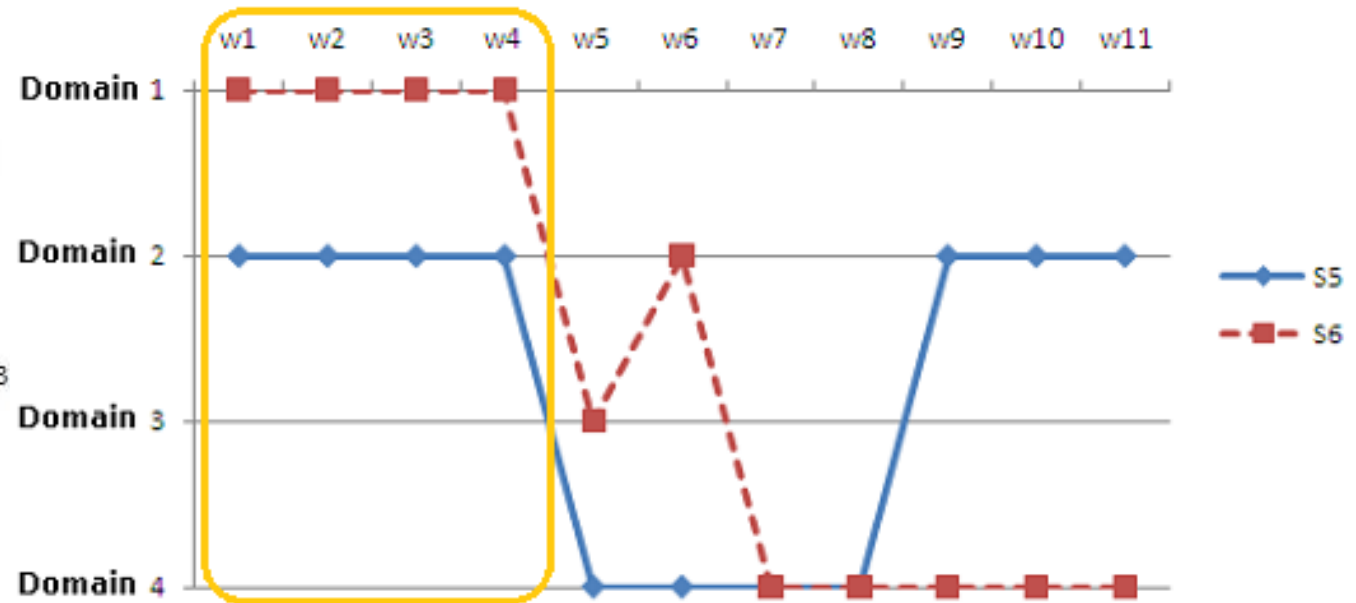
Inference of compared items



Radar Chart



Domain Shift Time Chart



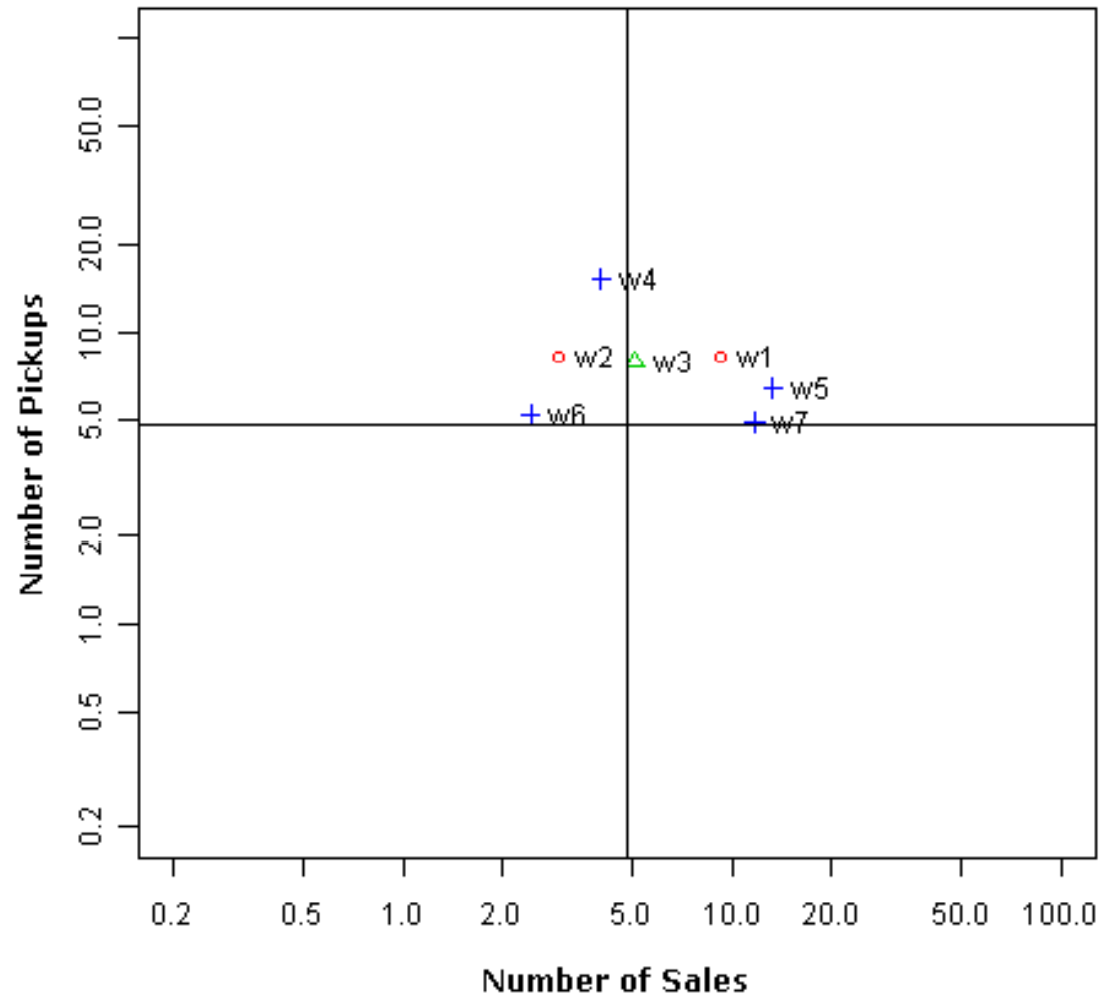
- S5 and S6 are compared each other from Radar Chart
- S6 is in the domain 1 while S5 is in the domain 2



CPP for Store 5 Item L1



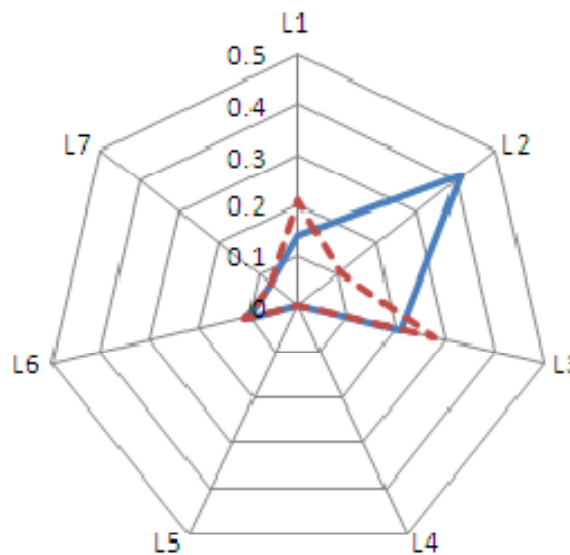
Store5 ItemL1



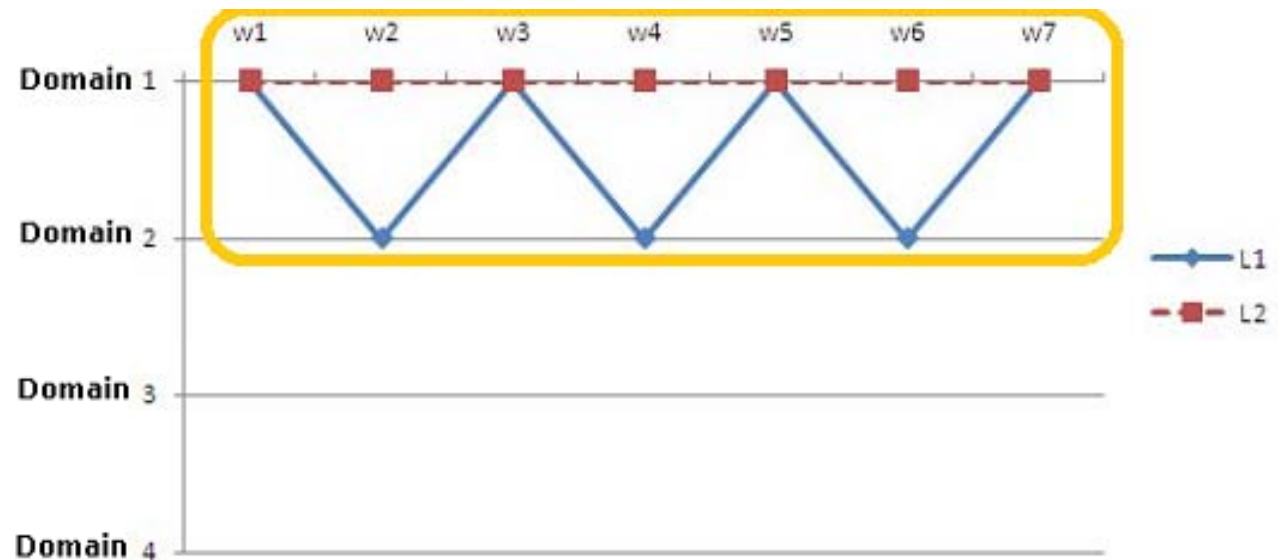
→ Validation for hypothesis 1 (2)



Radar Chart



Domain Shift Time Chart



- L1 and L2 are compared each other from Radar Chart
- L2 is in the domain 1 while L1 is in the domain 2/1



Approach to hypothesis 2



- **[Step 1] To find items in different categories that are well combined**
 - Use association analysis (Apriori) and identify the popular rules
 - Select commonly observed rules in different environment
- **[Step 2] To examine the relation between item and sales**
 - Check the sales of consequent items in the different sales environment
 - If sales of the consequent items is high the antecedent items are sales stimulation items



Example of Apriori analysis



No.188: 6.67% of customers try both C1 and L2 as a combination, and 73.26% of them also try S1.

No.	Rules {Antecedent}⇒{Consequent}	Support	Confidence
277	{S2,S3} ⇒ {S1}	8.04 %	75.81 %
183	{S2,S4} ⇒ {S1}	6.99 %	78.81 %
188	{C1,L2} ⇒ {S6}	6.67 %	73.26 %
165	{S3,S4} ⇒ {S1}	6.14 %	75.08 %
108	{C1,L1} ⇒ {S6}	5.13 %	70.55 %
153	{S1,S3,S4} ⇒ {S2}	5.09 %	82.86 %
138	{L2,S4} ⇒ {S1}	3.02 %	73.55 %



Commonly observed rules



- Extracted rules of other stores

Store	Rule{Antecedent }⇒{Consequent}	Support	Confidence
5	{C1,L8} ⇒ {S6}	6.0 %	100.0 %
6	{C1,L8} ⇒ {S6}	5.4 %	53.3 %
11	{C1,L8} ⇒ {S6}	5.5 %	72.7 %

This rule is not extracted from other stores



Sales analysis



- Sales of Item S6 in all the stores

Stores WITH the rule

Store	Sales percentage
11	15.0 %
5	12.2 %
6	11.6 %

Stores WITHOUT the rule

Store	Sales percentage
8	9.7 %
1	8.5 %
3	6.6 %
9	6.5 %
7	2.9 %
2	1.6 %
4	0.0 %
10	0.0 %
12	0.0 %

- S6 sales in stores with the rule are relatively higher than those of the other stores.
- This implies that combination of C1 and L8 stimulates sales of S6

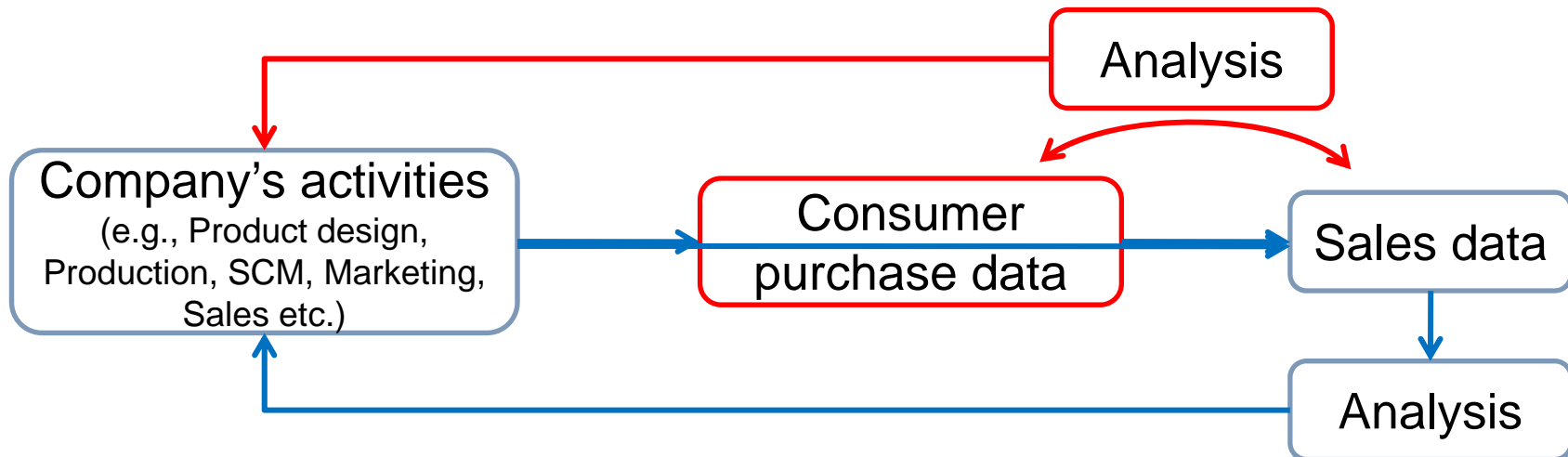
→ Implication



Only sales data



Consumer purchase data + sales data





Summary (1)



- **Proposal on a framework for consumer purchase behavior analysis**
- **Validation of two hypotheses**
 - Items that are picked up well but not sold well is compared with other items in the same category
 - There are items that stimulate sales of items in other categories



Summary (2)



- **Future study**
 - Assessment of applicability of this method
 - Characteristics of cosmetics: high involvement in selection
 - low price elasticity
 - Improvement of the methods
 - Divider of CPP: a reciprocal of number of items after normalization
 - Number of extracted rules: 10 rules



Acknowledgement



- **We would like to thank to the research partner company for providing data for evaluation and suggestions to our research.**
- **We also would like to thank reviewers for constructive comments and suggestions, and Mr. Stephan Karpiscek for shepherding this paper.**



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9. F. Thiesse, J. Al-Kassab, and E. Fleisch, “Understanding the value of integrated RFID systems: A case study from apparel retail,” *European Journal of Information Systems*, vol. 18, pp. 592–614, 2009.
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Q & A





Backups



→ Related works (1)



- **CPB analysis in book selection**
 - Analyze book title and selection

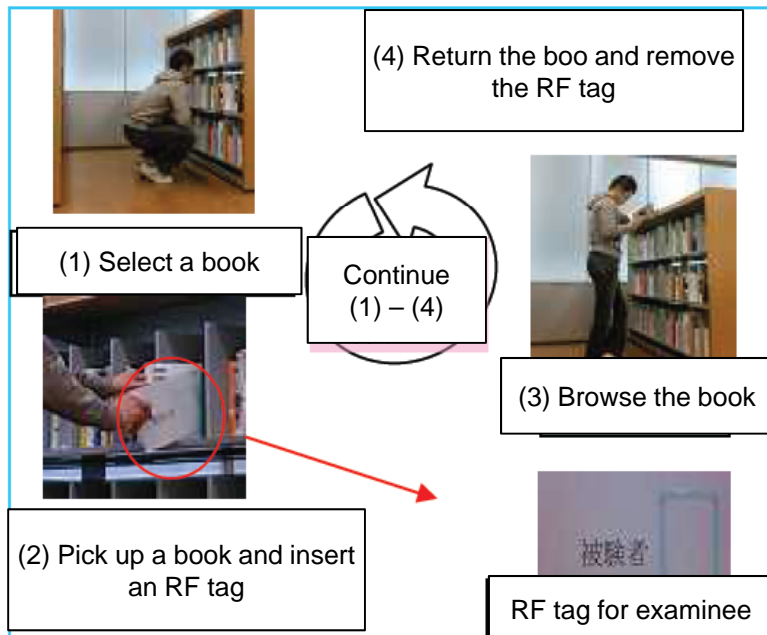


Fig5. Flow of book browsing

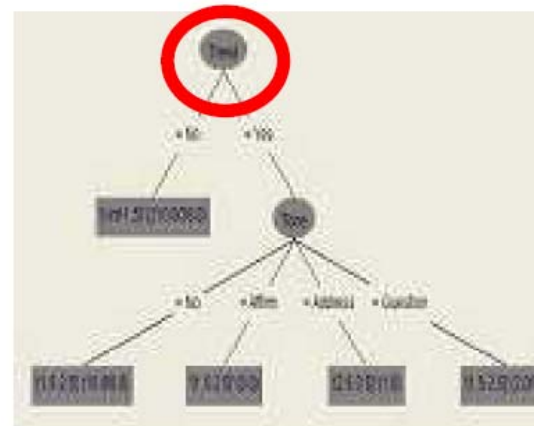


Fig10. Decision tree and Bayesian NW model

Ken Hasegawa, "Extracting reader's thought while browsing books using RFID," Master's Thesis of University of Tokyo, 2008



Related works (2)



- **CPB analysis in apparel shopping**
 - Comparison between CPB and sales data

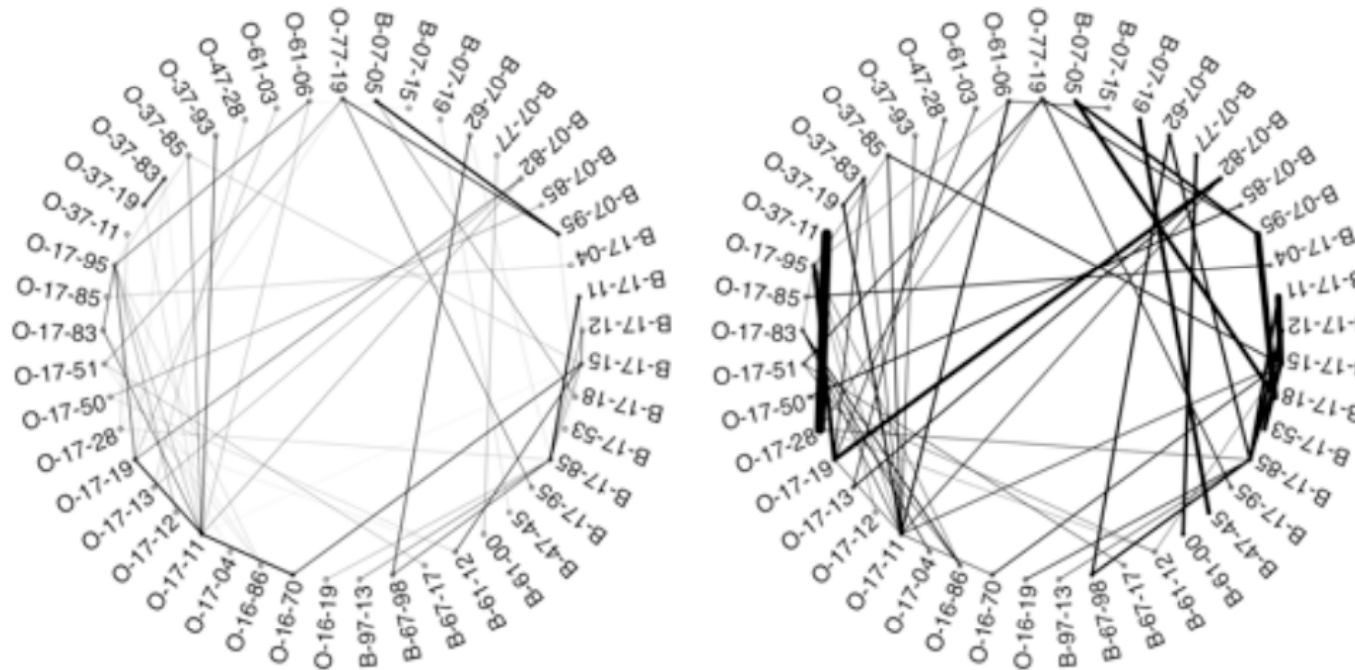


Fig1. Co-occurrence comparison between pickups and sales

H. Kimura, Y. Osawa, T. Ui, "Consumer behavior analysis by combining RFID and POS data in apparel stores, in proceedings of IEICE general conference 2008

→ Related works (3)



- **CPB analysis in apparel industry**
 - Time series analysis between sales and try-ons

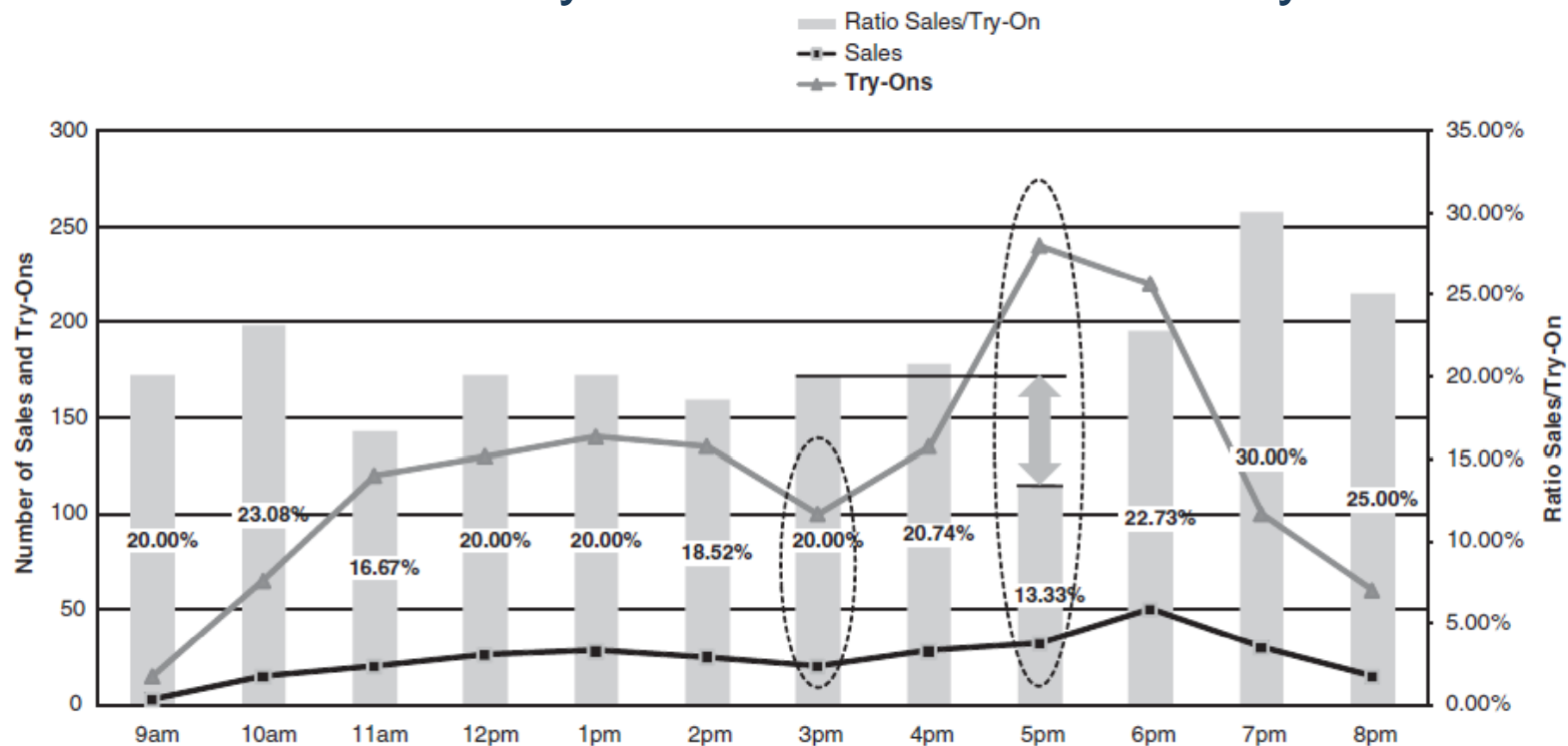


Figure 5 Analysis of sales/try-on ratios over time (Example).

F. Thiesse, J. Al-Kassab, E. Fleisch, "Understanding the value of integrated RFID systems: a case study from apparel retail," European Journal of Information Systems (2009) 18, 592.614