Association rule analysis and Recommendation system using Instacart's transactions data

Brightics Ambassador
Final Project
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Agenda

1. Project Overview & Goals

2. Data Used & Analysis Process

3. Association Rules

4. ALS Recommend

5. Conclusion

1. Project Overview & Goals

Analysis of Grocery Transactions Data

- Instacart sells groceries and other goods from ~500 brick-and-mortar retail stores in the US. through an online platform
- The project aims to implement a association rule analysis and recommendation system using Instacart's sales data.
- This analysis allows the brick-and-mortar retail stores to closely position products that are purchased together
- Instacart can personalize recommendations to users using the recommendation algorithm.

Overview & Goals

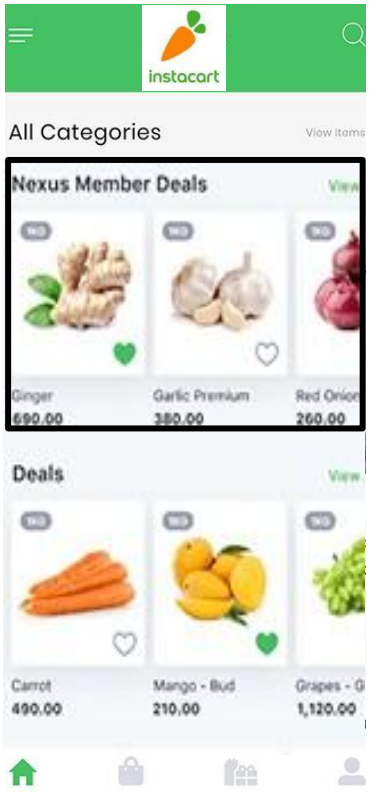
Association Rules Analysis

Analytical Technique:

- Find out the **relevance** between products purchased in the same shopping cart and predict which product a customer will buy.

Effects:

- Product placement and configuration **optimization**
- **Increase sales** by finding relevant products, optimizing product placement in offline stores / apps, and organizing free gifts or package products.



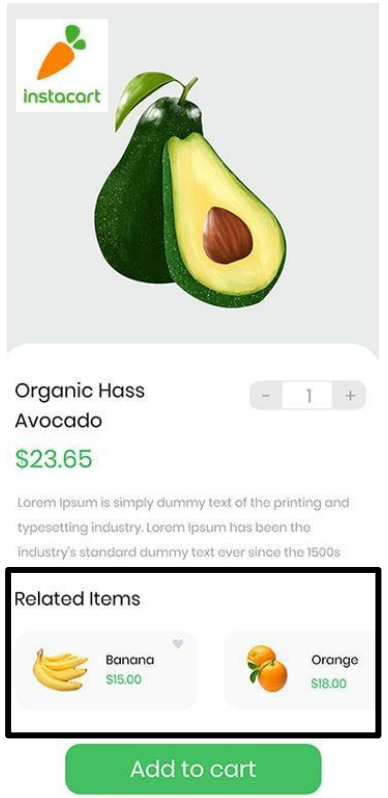
ALS Recommend

Analytical Technique:

- Implement customer-specific **customization** through product rating data goods

Effects:

- Increase in customer **satisfaction**
- Through a personalized recommendation system in the 'Related items' section of the Instacart app, customers can be encouraged to **purchase more products**.



2. Data Used & Analysis Process

Data Used

	user_id	order_id	product_id	department	aisle	product_name	add_to_cart_order	order_dow	order_hour_of_day
1	8382	317499	4	frozen	frozen m…	Smart Ones Cl…	13	2	19
2	102491	459014	4	frozen	frozen m…	Smart Ones Cl…	6	1	16
3	145313	508627	4	frozen	frozen m…	Smart Ones Cl…	13	1	17
4	167145	732095	4	frozen	frozen m…	Smart Ones Cl…	8	0	16
5	92944	770868	4	frozen	frozen m…	Smart Ones Cl…	6	0	15
6	21668	837726	4	frozen	frozen m…	Smart Ones Cl…	10	6	18
7	85136	864245	4	frozen	frozen m…	Smart Ones Cl…	3	6	13
8	109342	918568	4	frozen	frozen m…	Smart Ones Cl…	12	5	23
9	58746	934893	4	frozen	frozen m…	Smart Ones Cl…	6	3	16
10	177860	1083228	4	frozen	frozen m…	Smart Ones Cl…	1	3	14
11	38808	1418300	4	frozen	frozen m…	Smart Ones Cl…	5	4	13
12	160185	1633856	4	frozen	frozen m…	Smart Ones Cl…	8	6	18
13	44072	1815999	4	frozen	frozen m…	Smart Ones Cl…	10	3	14
14	200689	1941618	4	frozen	frozen m…	Smart Ones Cl…	21	2	17
15	150300	2153170	4	frozen	frozen m…	Smart Ones Cl…	4	2	11
16	29756	2179434	4	frozen	frozen m…	Smart Ones Cl…	14	0	14
17	67711	2372790	4	frozen	frozen m…	Smart Ones Cl…	2	2	19
18	91550	2439653	4	frozen	frozen m…	Smart Ones Cl…	16	0	15
19	47296	2472936	4	frozen	frozen m…	Smart Ones Cl…	9	6	12
20	167	2742787	4	frozen	frozen m…	Smart Ones Cl…	7	0	11
21	30889	2891043	4	frozen	frozen m…	Smart Ones Cl…	21	2	7
22	119229	3156707	4	frozen	frozen m…	Smart Ones Cl…	2	6	18
23	8382	317499	30	frozen	frozen m…	Three Cheese …	12	2	19
24	146034	941240	30	frozen	frozen m…	Three Cheese …	19	2	14
25	145522	1397014	30	frozen	frozen m…	Three Cheese …	6	1	10
26	38808	1418300	30	frozen	frozen m…	Three Cheese …	4	4	13
27	99996	1649913	30	frozen	frozen m…	Three Cheese …	12	4	11
28	7543	1711258	30	frozen	frozen m…	Three Cheese …	14	2	12
29	203269	1842155	30	frozen	frozen m…	Three Cheese …	15	0	13
30	45069	2237919	30	frozen	frozen m…	Three Cheese …	9	6	8
31	158212	2473363	30	frozen	frozen m…	Three Cheese …	3	4	9
32	65956	3344598	30	frozen	frozen m…	Three Cheese …	4	3	12

*Kaggle's Data
As of 2017

Customer Data

- User id
- Order id

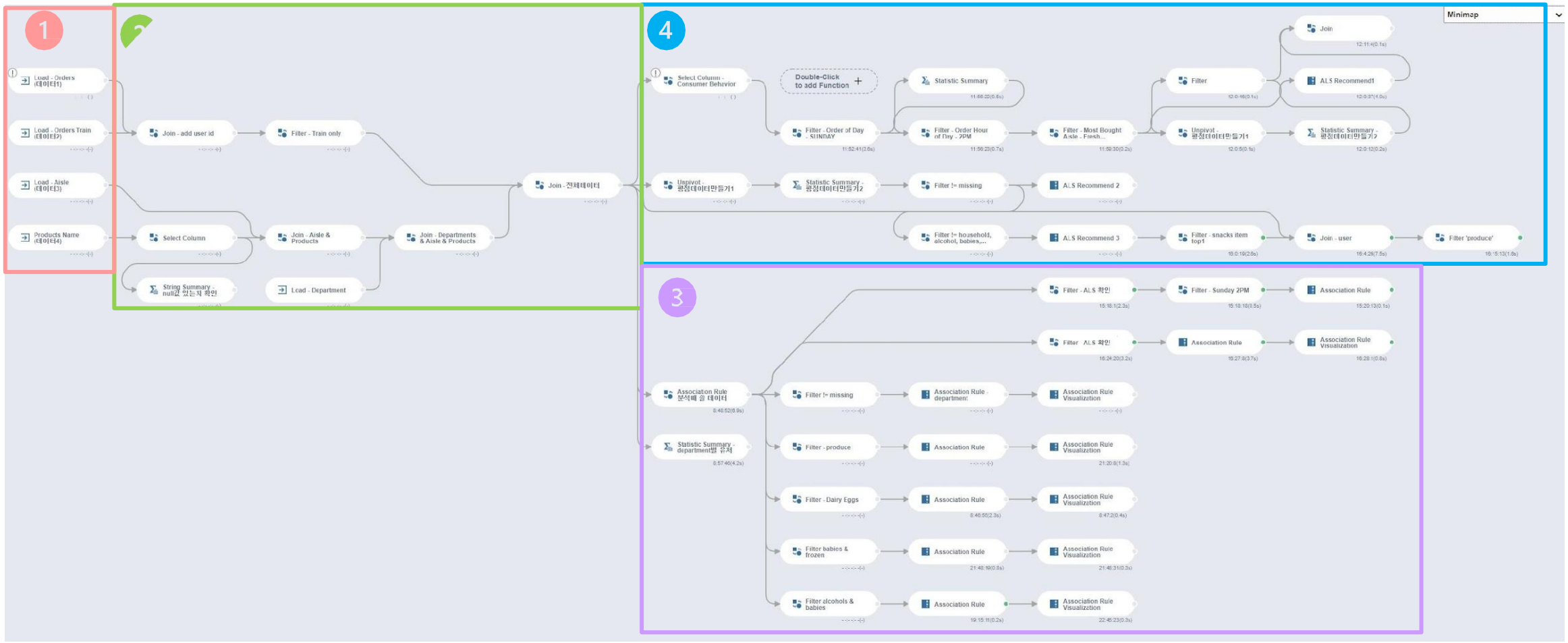
Product Data

- Product id
- Department: main category where a product is classified
- Aisle: sub-category of a product
- Product name

Other Useful Data

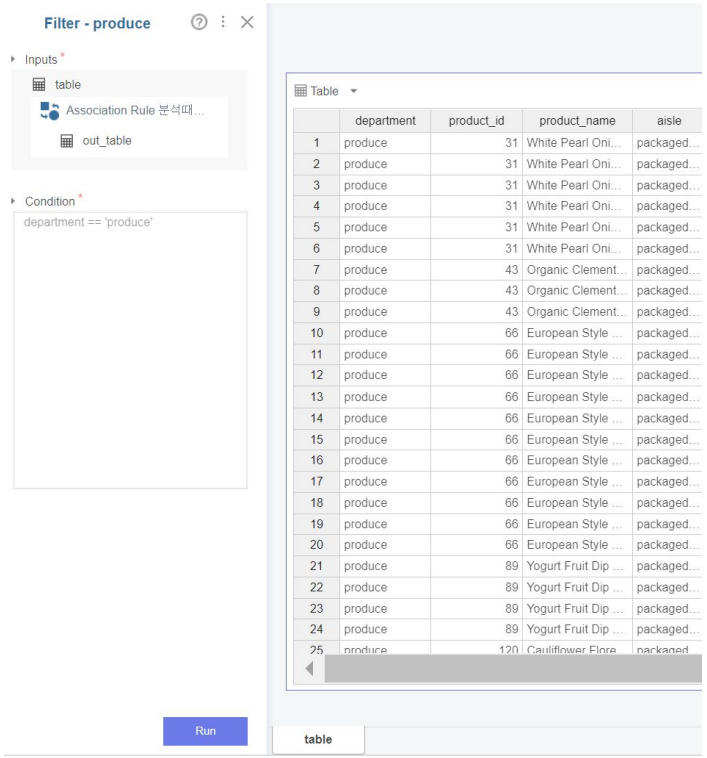
- Add to cart order
- Order dow (day of week)
- Order hour of day

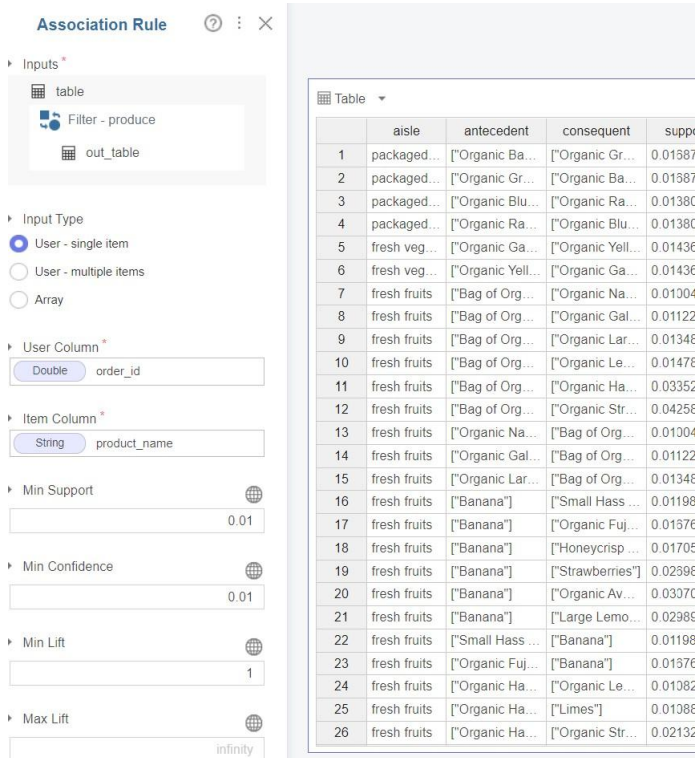
Analysis Process

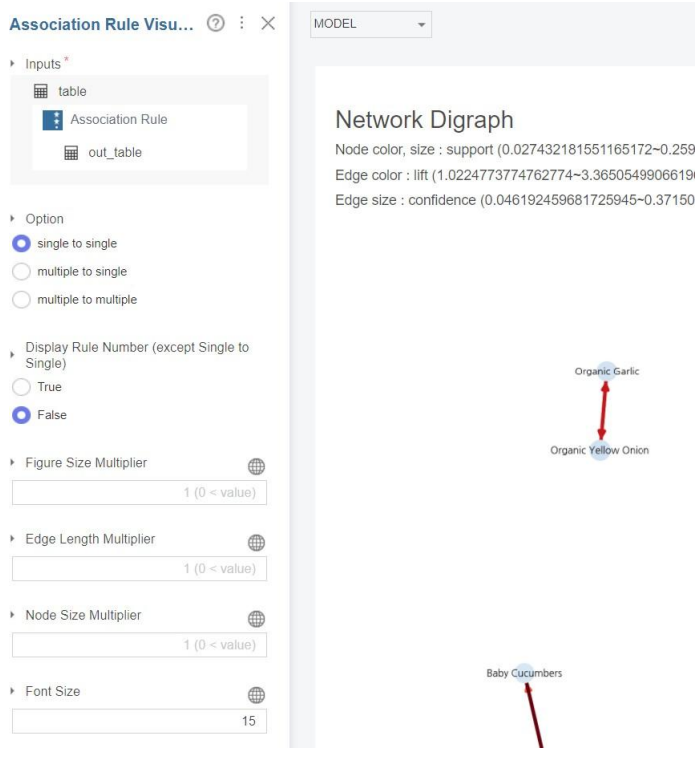


1) Data Upload | 2) EDA | 3) Modeling & Visualization | 4) Create Rating Data and build Recommendation System

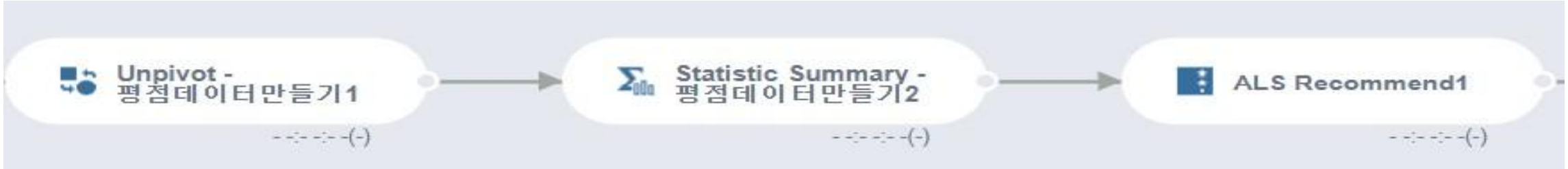
Analysis Process - Association Rule Analysis

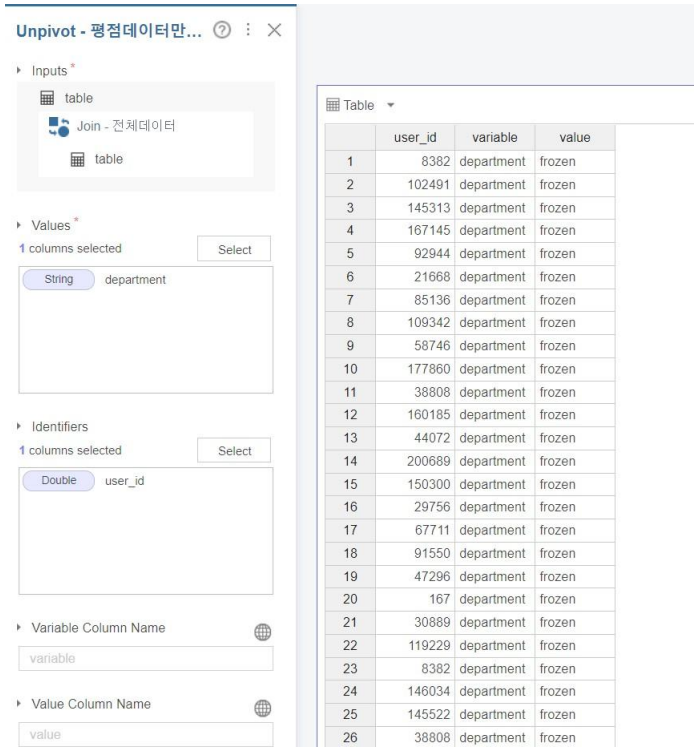






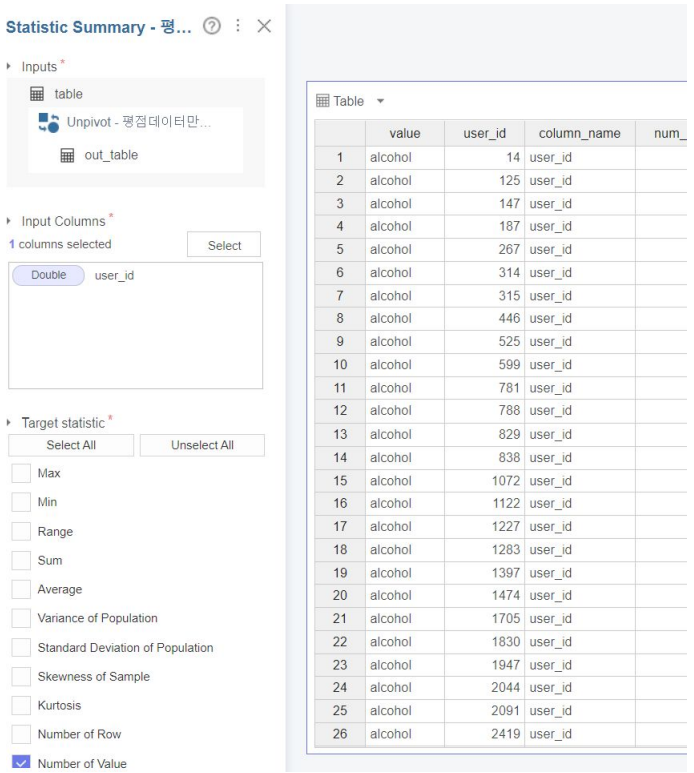
Analysis Process - Recommendation System





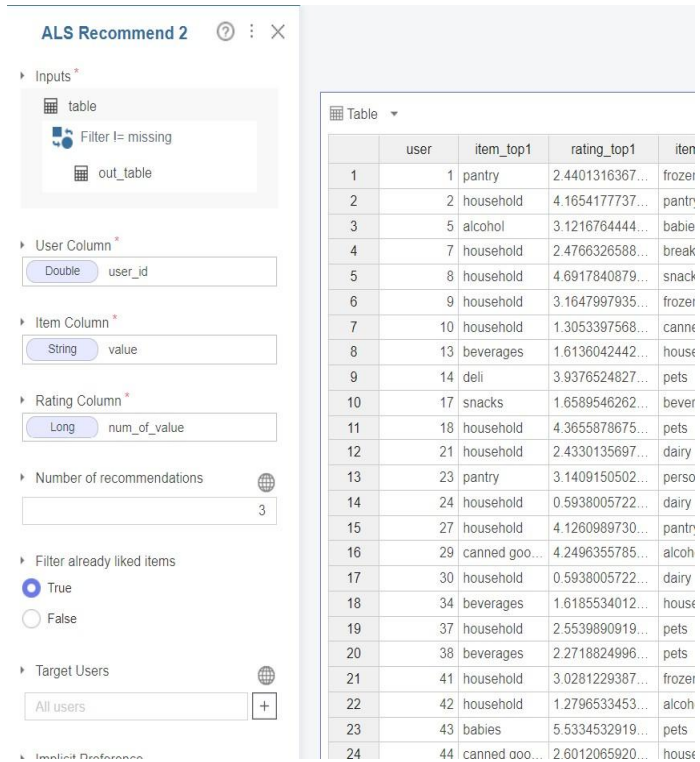
Table

	user_id	variable	value
1	8382	department	frozen
2	102491	department	frozen
3	145313	department	frozen
4	167145	department	frozen
5	92944	department	frozen
6	21668	department	frozen
7	85136	department	frozen
8	109342	department	frozen
9	58746	department	frozen
10	177860	department	frozen
11	38808	department	frozen
12	160185	department	frozen
13	44072	department	frozen
14	200689	department	frozen
15	150300	department	frozen
16	29756	department	frozen
17	67711	department	frozen
18	91550	department	frozen
19	47296	department	frozen
20	167	department	frozen
21	30889	department	frozen
22	119229	department	frozen
23	8382	department	frozen
24	146034	department	frozen
25	145522	department	frozen
26	38808	department	frozen



Table

	value	user_id	column_name	num_
1	alcohol	14	user_id	
2	alcohol	125	user_id	
3	alcohol	147	user_id	
4	alcohol	187	user_id	
5	alcohol	267	user_id	
6	alcohol	314	user_id	
7	alcohol	315	user_id	
8	alcohol	446	user_id	
9	alcohol	525	user_id	
10	alcohol	599	user_id	
11	alcohol	781	user_id	
12	alcohol	788	user_id	
13	alcohol	829	user_id	
14	alcohol	838	user_id	
15	alcohol	1072	user_id	
16	alcohol	1122	user_id	
17	alcohol	1227	user_id	
18	alcohol	1283	user_id	
19	alcohol	1397	user_id	
20	alcohol	1474	user_id	
21	alcohol	1705	user_id	
22	alcohol	1830	user_id	
23	alcohol	1947	user_id	
24	alcohol	2044	user_id	
25	alcohol	2091	user_id	
26	alcohol	2419	user_id	



Table

	user	item_top1	rating_top1	item
1	1	pantry	2.4401316367...	frozer
2	2	household	4.1654177737...	pantry
3	5	alcohol	3.1216764444...	babie
4	7	household	2.4766326588...	break
5	8	household	4.6917840879...	snack
6	9	household	3.1647997935...	frozer
7	10	household	1.3053397568...	canne
8	13	beverages	1.6136042442...	house
9	14	deli	3.9376524827...	pets
10	17	snacks	1.6589546262...	bever
11	18	household	4.3655878675...	pets
12	21	household	2.4330135697...	dairy
13	23	pantry	3.1409150502...	perso
14	24	household	0.5938005722...	dairy
15	27	household	4.1260989730...	pantry
16	29	canned goo...	4.2496355785...	alcoh
17	30	household	0.5938005722...	dairy
18	34	beverages	1.6185534012...	house
19	37	household	2.5539890919...	pets
20	38	beverages	2.2718824996...	pets
21	41	household	3.0281229387...	frozer
22	42	household	1.2796533453...	alcoh
23	43	babies	5.5334532919...	pets
24	44	canned goo...	2.6012065920...	house

3. Association Rules

Association Rules Analysis Overview

Association between products from same department

Goal:

- Optimize product placement by finding the relevance of products belonging to the same department.

Method:

- Filter only one department out of the entire data and use Brightics' Association Rule function.

Data:

- Analyze the relationship between "Produce" and "Dairy & Eggs", which are the categories with the highest customer purchase frequency.

Association between products from a different department

Goal:

- Organize a gift or promotion by finding the relevance of products belonging to different departments.

Method:

- Filter several Departments of interest among the entire data and use the Association Rule function.

Data:

- Analyze the relationship between the most interesting categories: "Pantry" and "Frozen", and "Babies and Alcohol".

Association between products from same department

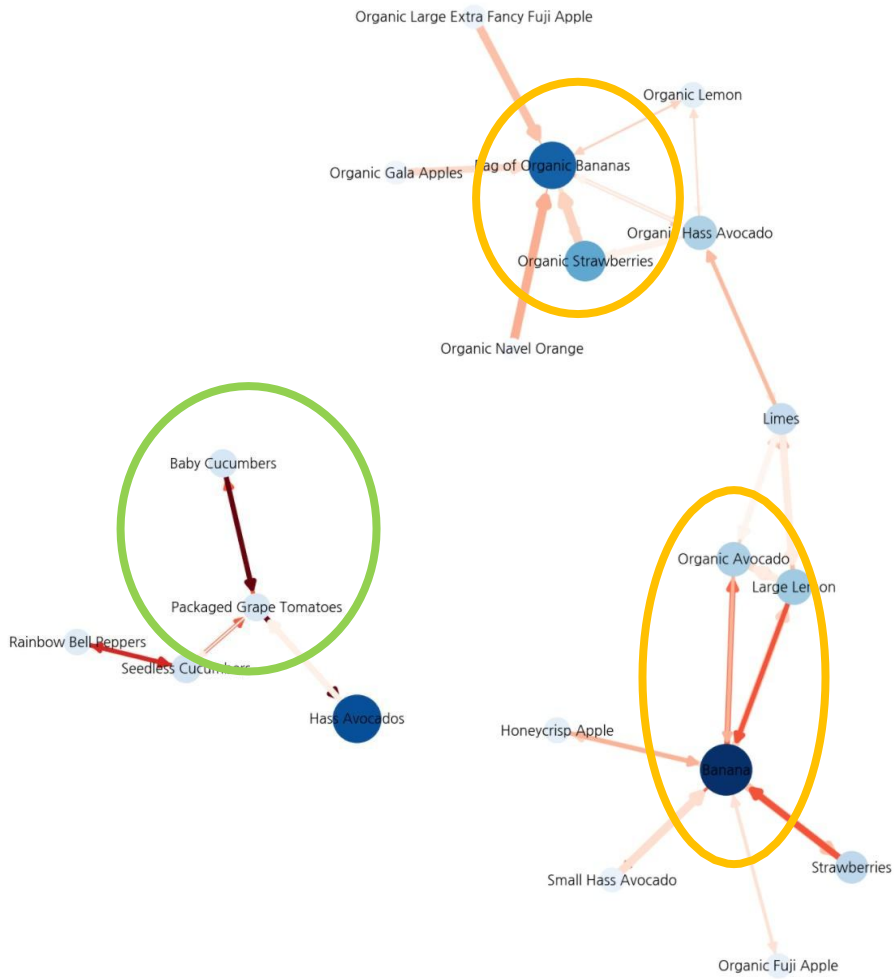
A. Products from “Produces” Department

Tomatoes, Cucumbers

- When purchasing ‘Baby Cucumbers’, the probability of purchasing ‘Packaged Grape Tomatoes’ is **3.4 times (lift)** greater than the probability of purchasing ‘Packaged Grape Tomatoes’.
- Since the color of the arrow leading from cucumber to cherry tomato is the darkest, **placing** the two products **next to each other** will encourage more customers to purchase these products together.

Banana, Strawberry, Avocado

- Of the entire purchase “Produce” history, transactions that include 'Bag of Organic Bananas' and 'Organic Strawberries' are **4.2% (support)**, and if 'Organic Strawberries' are purchased, the probability that 'Bag of Organic Bananas' will be purchased is **28% (confidence)**.
- Of the entire purchase “Produce” history, the transaction that includes ‘Bananas’ and ‘Organic Avocado’ is **3% (support)**, and if ‘Organic Avocado’ is purchased, the probability that ‘Bananas’ will be purchased is **30% (confidence).**
- Banana is a popular product that is included in many rules with high support or confidence. Placing it on the front page of the Instacart app will increase customer satisfaction, but even if not bananas will still be bought.
- Because the lift of bananas, strawberries, and avocados is smaller than that of cucumbers and cherry tomatoes, the effect of banana purchases on strawberry and avocado purchases is relatively small. After all, **placing cucumbers and cherry tomatoes next to each other** is more important than placing bananas, avocados, and strawberries next to each other.

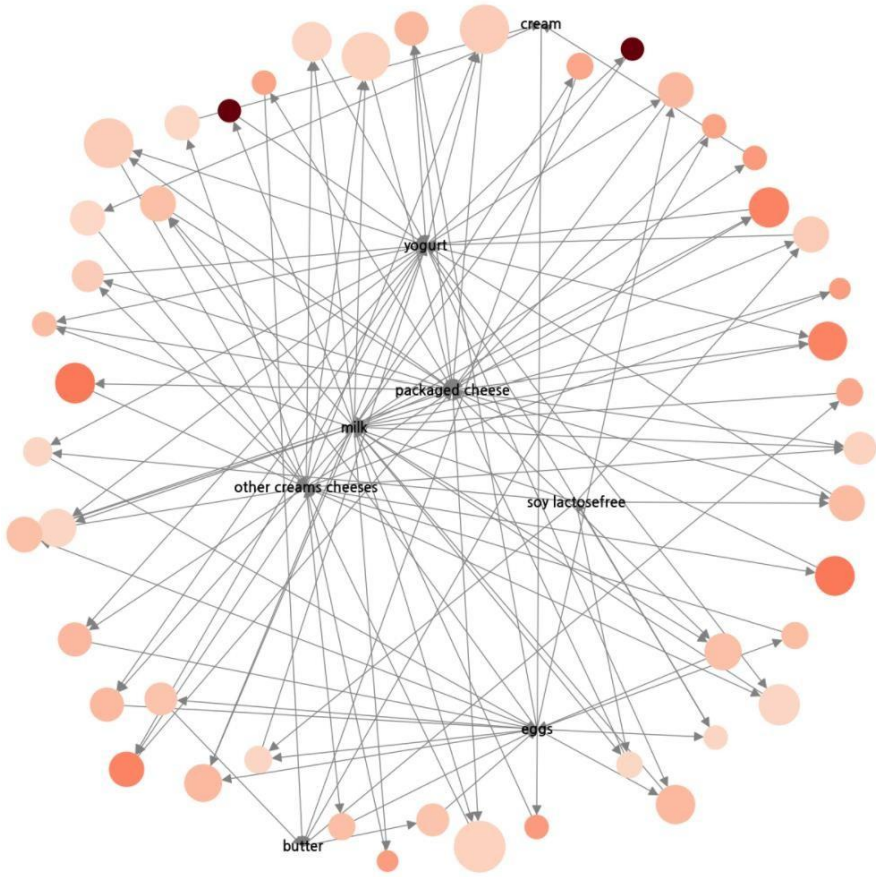


Association between products from same department

B. Products from “Dairy&Eggs” Department

Yogurt, Milk, Cream

- Of the total purchase history of “Dairy & Eggs”, transactions that include ‘milk’ and ‘yogurt’ are **13% (support)**, and if ‘milk’ is purchased, the probability that ‘yogurt’ will be purchased is **34% (confidence).** When purchasing ‘milk’, the probability of purchasing ‘yogurt’ is **1.02 times** greater than that of ‘yogurt’.
- Of the total purchase history of “Dairy & Eggs”, transactions that include ‘milk’ and ‘cream’ are **4.5% (support)**, and if ‘milk’ is purchased, the probability that ‘cream’ will be purchased is **13% (confidence)**. When purchasing ‘milk’, the probability of purchasing ‘cream’ is **1.03 times (lift)** greater than that of ‘cream’.
- Milk is the most popular product among “Dairy & Eggs” because it is included in many rules with great support and confidence. On the other hand, since the lift of the rule that includes milk is almost 1, it can be seen that the purchase of milk has nothing to do with the purchase of yogurt or cream. After all, milk, yogurt, and cream **don't have to be placed next to each other.**



Association between products from a different department

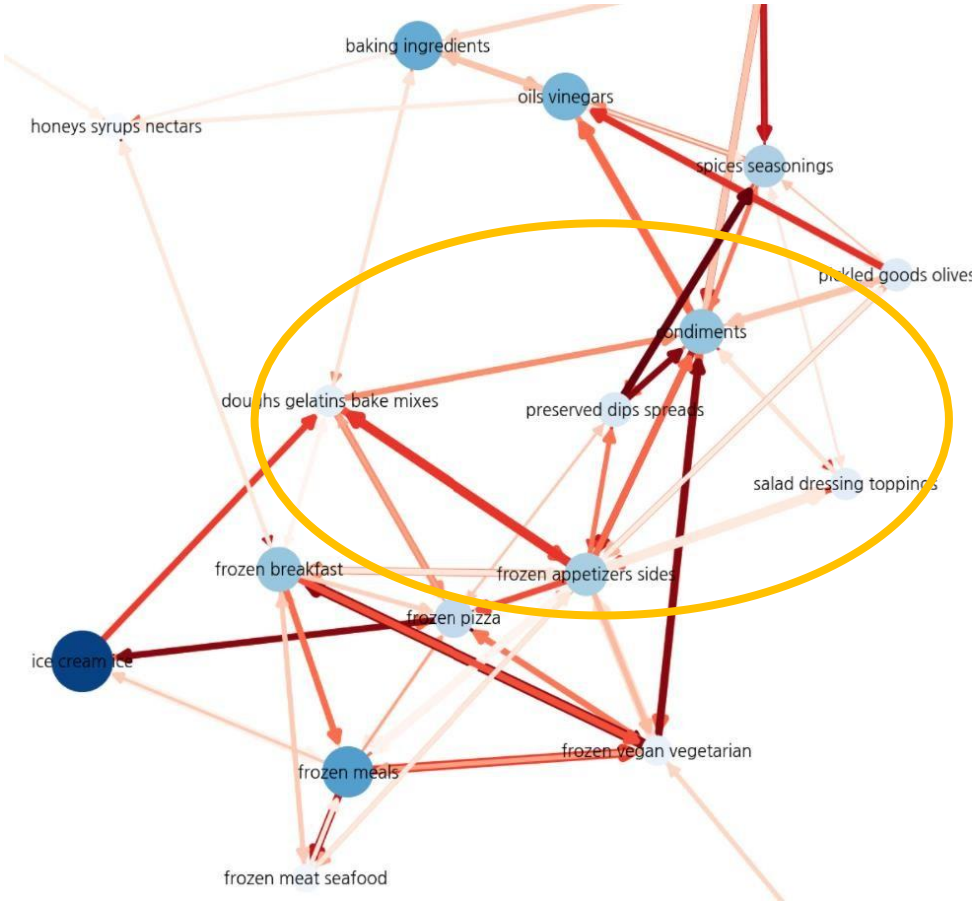
A. Products from “Frozen” and “Pantry” Department

Condiments, Frozen Breakfast, Syrups

- Among the entire purchase history of “Frozen” and “Pantry”, if 'honey syrups nectars' are purchased, the probability of 'frozen breakfast' being purchased is **14.2% (confidence)**, and 'frozen breakfast' is purchased when 'honey syrups nectars' is purchased. The probability of purchasing a 'frozen breakfast' is **1.3 times** greater than that of a 'frozen breakfast'.

- Among the total purchase history of “Frozen” and “Pantry”, the probability of purchasing 'condiments' when 'frozen vegan vegetarian' is purchased is **12% (confidence),** and the probability of purchasing 'condiments' when 'frozen vegan vegetarian' is purchased is **1.1** times greater than that of ‘condiments’.

- Recommendation: When customers buy frozen food, they buy sauce, and vice versa. It would be nice to have a promotion where they can buy sauce at a discounted price if they purchase frozen food over a certain price.

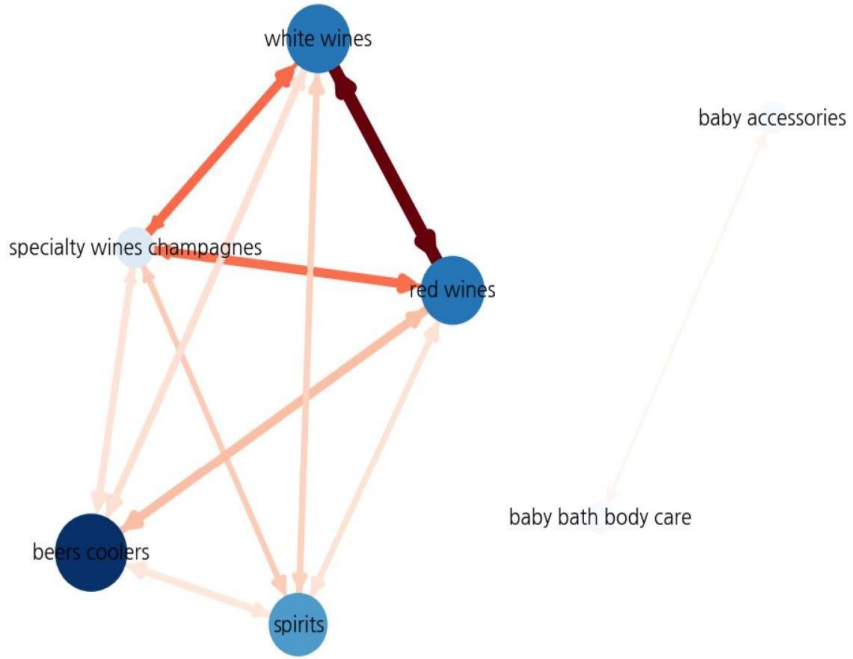


Association between products from a different department

A. Products from “Alcohol” and “Babies” Department

Alcohol, Babies

- The most representative example of a correlation analysis discovered by Walmart in the 1990s is beer and diapers. The husband, who wants to drink beer on Friday evening, claims that he also buys beer with the excuse that he is going to buy diapers.
- The Association Rule function was used by filtering only the “Babies” and “Alcohol” departments to see if the data of 2017 customers shopping with the Instacart app would show the same pattern.
- As shown in the Network Digraph on the right, as a result of setting the minimum support to 0.001, there were **no rules for alcohol and baby products.**
- However, this association is limited to Instacart's data; the main customer for diapers at Walmart is male, and the gender of the user of the Instacart app is unknown.
- It is possible to find a correlation with a lower minimum support, but if so, it is not meaningful to proceed further with the analysis because the transaction that includes alcohol and baby products is less than 0.1% of the total purchase history of “Alcohol” and “Babies”.



4. ALS Recommend

ALS Recommend Overview

Recommend products belonging to the same department as the purchased product

Goal:

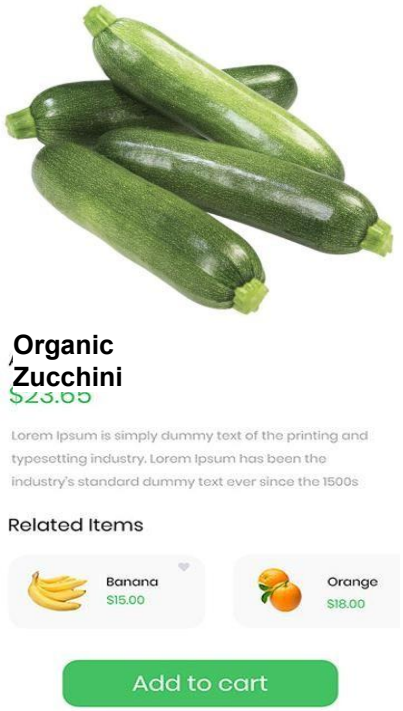
- In the ‘Related Items’ section, products from the same department as the product purchased by the customer are recommended.

Method:

- Gather customer and product related data to create rating data.
- Filter only one department out of the entire data and use the ALS Recommend function as the customer's product rating data.

Data:

- Pick one specific product of interest and recommend a personalized product.



Recommend products belonging to a different department as the purchased product

Goal:

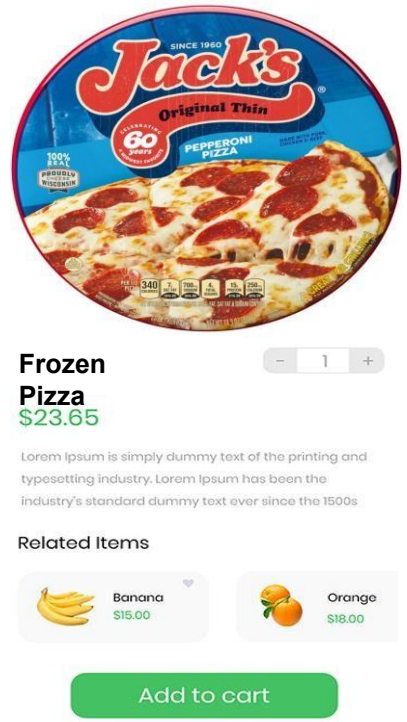
- In the ‘Related Items’ section, recommend products from a different department than the one the customer purchased.

Method:

- Gather customer and product related data to create rating data.
- After excluding a few departments from the entire data, the ALS Recommend function is used with the customer's product rating data.

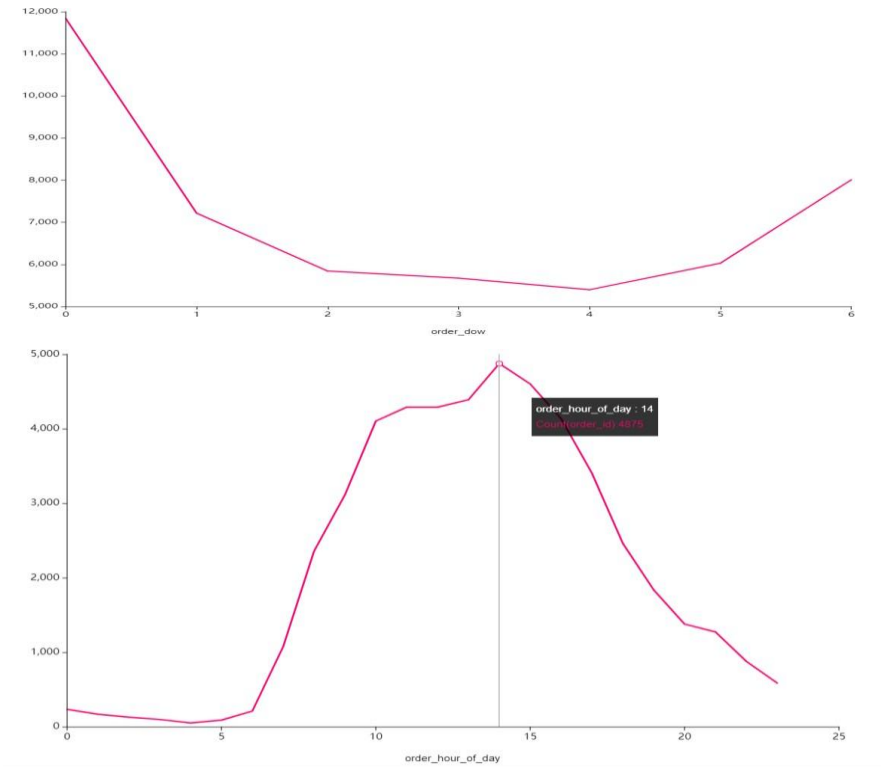
Data:

- Pick two departments and make a little more detailed recommendation.

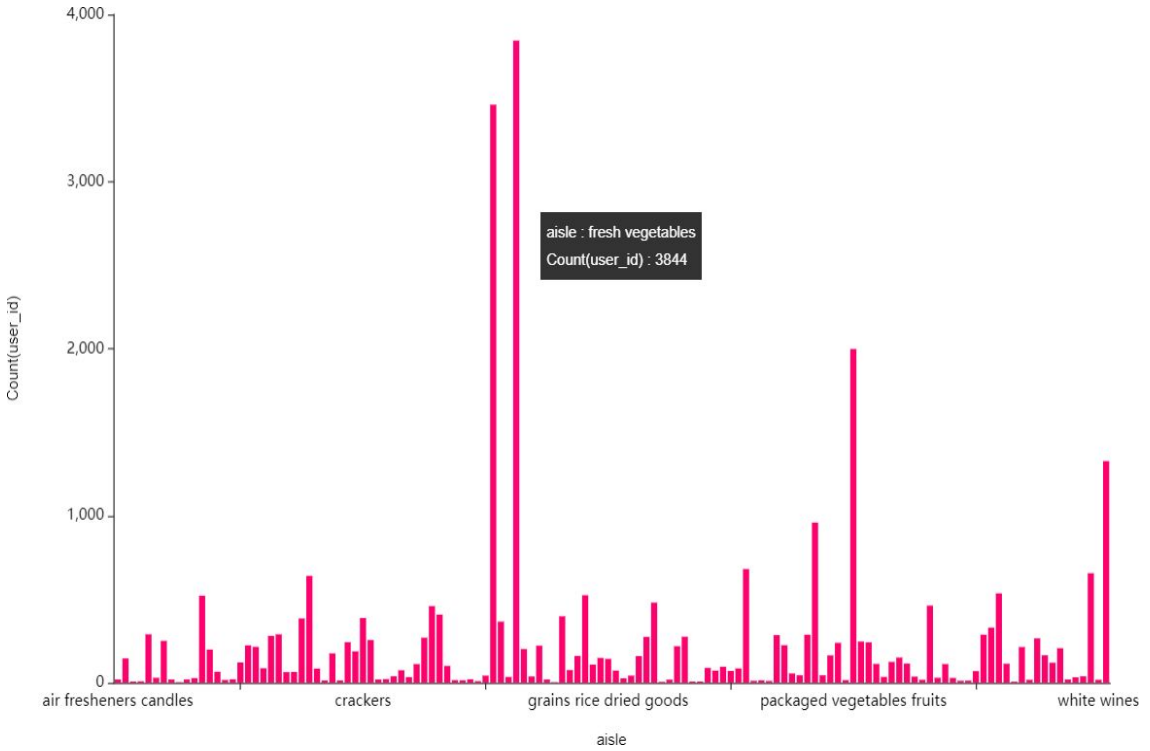


Recommending products from the same department as purchased products

Customer who bought Organic Zucchini



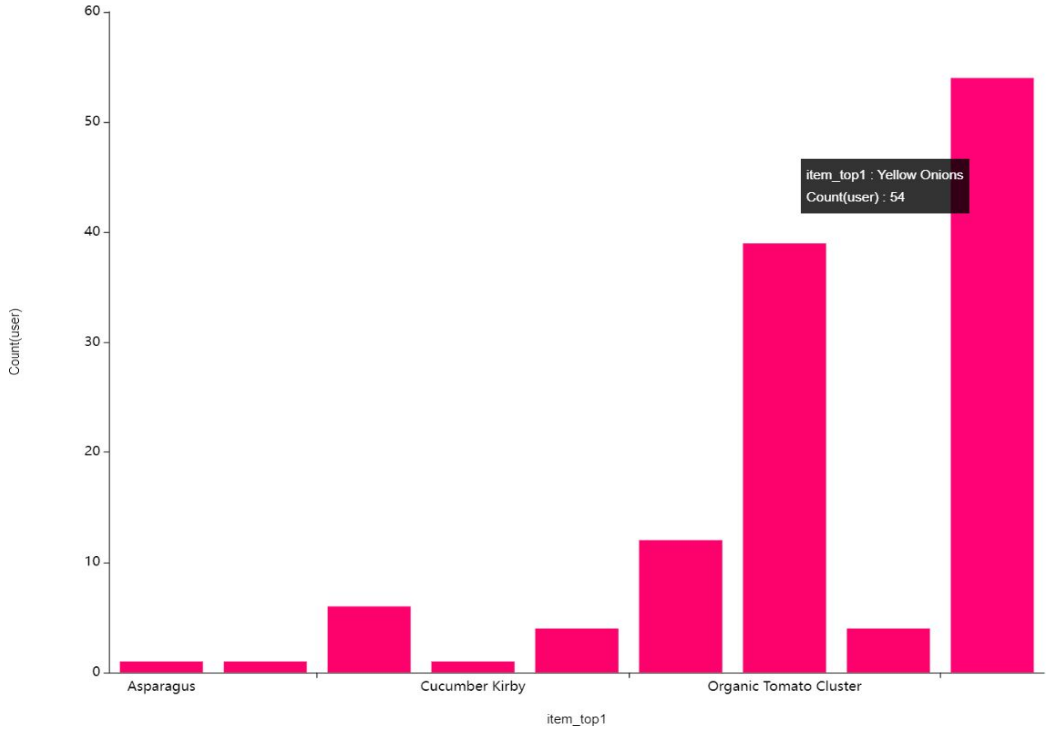
- With Order day of Week and Order hour of day data, I found a time zone where the most customers ordered and selected the most sold products.



- The department that sold the most at 2:00pm on Sunday is “Produce”, Aisle is “fresh vegetables”, and the product is Organic Zucchini.

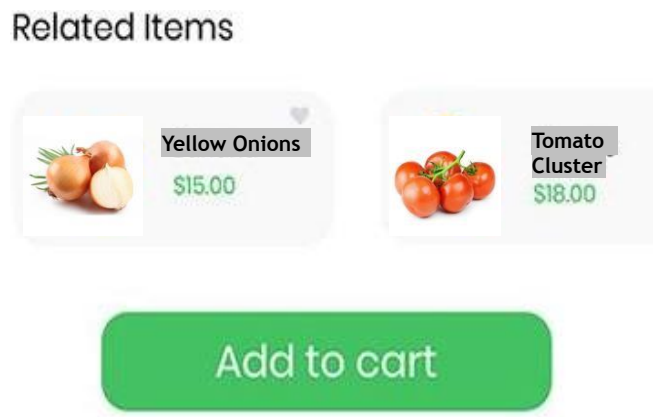
Recommending products from the same department as purchased products

Recommend Yellow Onion, Tomato Cluster, Red Bell Pepper to customers who bought Organic Zucchini



- Yellow Onions and Organic Tomato Cluster are the most recommended products for customers who have purchased Organic Zucchini.

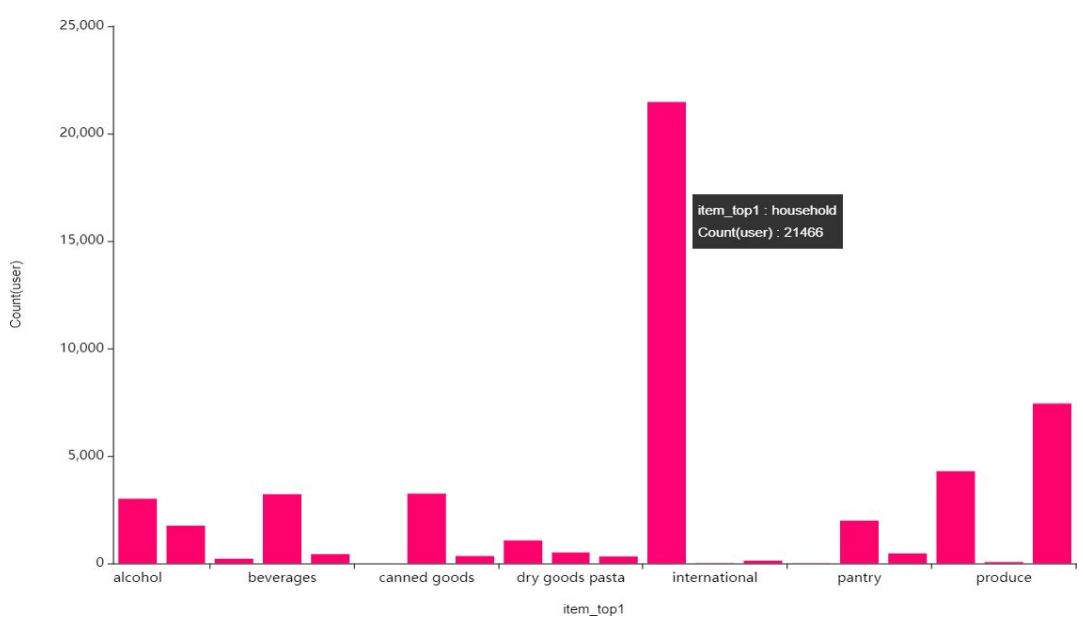
antecedent	consequent	confidence	lift ↑
["Organic Zucchini"]	["Organic Red Bell Pepper"]	0.08196721...	1.96855...
["Organic Zucchini"]	["Yellow Onions"]	0.09016393...	1.42032...
["Organic Zucchini"]	["Organic Tomato Cluster"]	0.06557377...	1.39225...



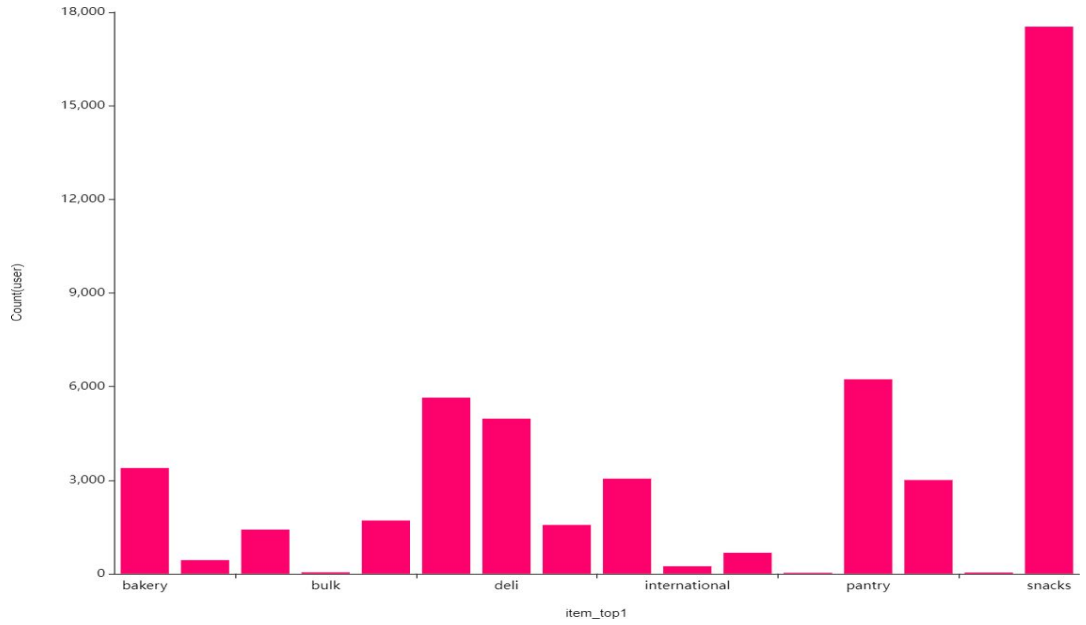
- As a result of association rule analysis, the purchase of Organic Zucchini has a positive (+) effect on the purchase of onions, tomatoes, and peppers. If recommended these products in the 'Related Items' section of customers who bought Organic Zucchini, they will be more likely to purchase them together.

Recommending products from different department as purchased products

Excluding some departments from the data



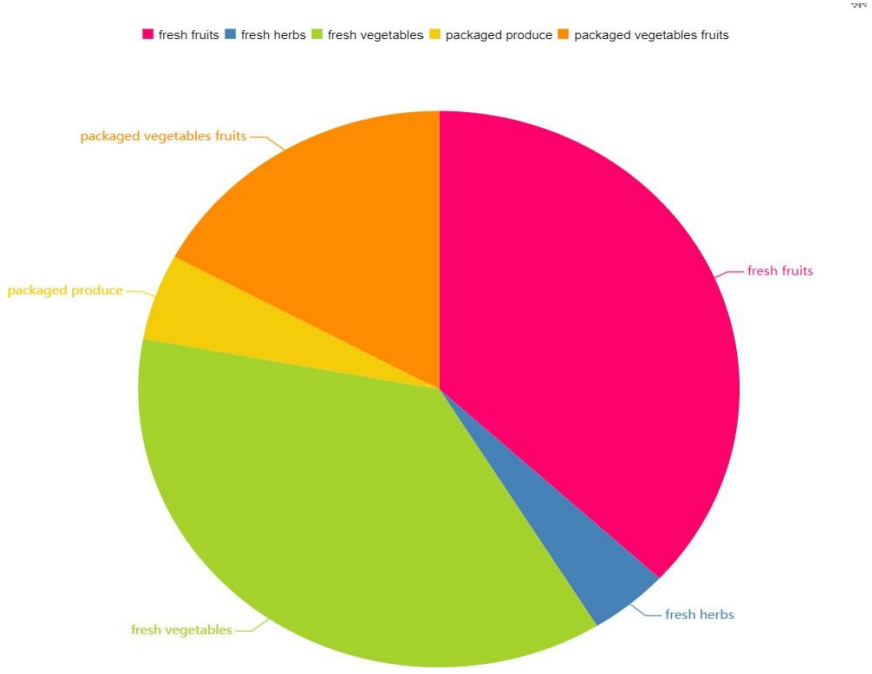
- The ALS Recommend function was executed with the rating data of products that included all departments.
- Among Item top 1, the department recommended by the most customers was “Household”, followed by “Pets” and “alcohol”.



- “Alcohol,” “Pets,” and “Babies,” which are unnecessary if recommended to customers who have purchased products from other departments, are excluded, and “Household,” which is less likely to be purchased online (*based on 2017 data), was also excluded. .
- Among Item top 1, the Department recommended by most customers was “Snacks”.

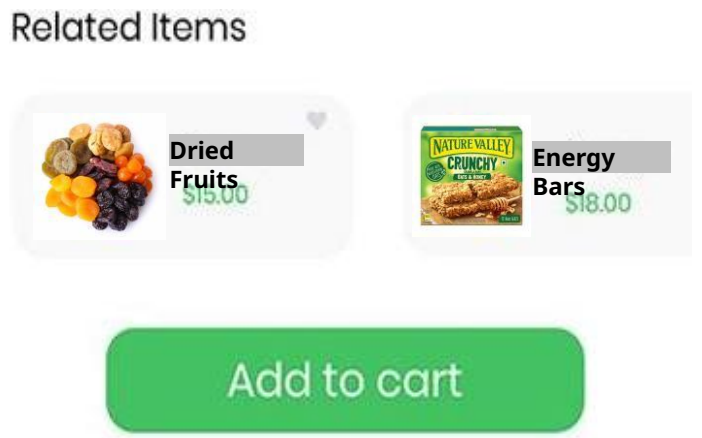
Recommending products from different department as purchased products

Recommend products in “Snacks” Department to customers who have purchased products in “Produce” Department



- When only customers who recommended “Snacks” were filtered, the most purchased Department was “Produce”.
- Among them, fresh fruits, fresh herbs, fresh vegetables, packaged produce and packaged vegetable fruits were purchased.

antecedent	consequent	confidence	lift
["fresh fruits","fresh vegetables","packaged vegetables fruits"]	["nuts seeds dried fruit"]	0.12348632...	1.28834...
["fresh fruits","packaged vegetables fruits"]	["energy granola bars"]	0.11481933...	1.14061...



- As a result of the association rule analysis, the purchase of the product purchased by the customer has a positive (+) effect on the purchase of “Snacks”.
- Among the customers who were recommended “Snacks”, if they purchased fruits and vegetables, dried fruits and snacks such as energy bars are recommended in the “Related Items” category.

5. Conclusion

Summary

Evaluation:

- Using the results from association rule analysis and implementation of a recommendation system, Instacart can achieve the effect of increasing customer satisfaction and sales by optimizing product placement.
- However, different products were used during the process because same products had different names even though they were the same bananas: ‘bag of bananas’, ‘bananas’, and ‘organic bananas’. In this case, grouping can be performed through text analysis and more accurate correlation analysis can be performed.

What I learned throughout the ambassador program:

- Through this program, I experienced an ML platform for the first time and learned full process of a data science project.
- In addition, I developed the ability to extract only the necessary information from raw data, and learned how to process it into new types of data depending on the situation.
- With the various functions of Brightics, I was able to build models and create visualizations for the recommendation algorithm analysis.

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Component based analytics studio on the web browser

THANK YOU