

MRA Project – Milestone 2

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Project Description

- ▶ The project involves conducting a thorough analysis of Point of Sale (POS) Data for providing recommendations through which a grocery store can increase its revenue by popular combo offers & discounts for customers.

Problem Statement

- ▶ A Grocery Store shared the transactional data with you. Your job is to identify the most popular combos that can be suggested to the Grocery Store chain after a thorough analysis of the most commonly occurring sets of items in the customer orders. The Store doesn't have any combo offers. Can you suggest the best combos & offers?

Exploratory Data Analysis(EDA)

- Let's first look at the head and tail of the dataset:

Head

| | Date | Order_id | Product |
|---|------------|----------|---------------|
| 0 | 2018-01-01 | 1 | yogurt |
| 1 | 2018-01-01 | 1 | pork |
| 2 | 2018-01-01 | 1 | sandwich bags |
| 3 | 2018-01-01 | 1 | lunch meat |
| 4 | 2018-01-01 | 1 | all- purpose |

Tail

| | Date | Order_id | Product |
|-------|------------|----------|-------------------|
| 20636 | 2020-02-25 | 1138 | soda |
| 20637 | 2020-02-25 | 1138 | paper towels |
| 20638 | 2020-02-26 | 1139 | soda |
| 20639 | 2020-02-26 | 1139 | laundry detergent |
| 20640 | 2020-02-26 | 1139 | shampoo |

Basic information about the dataset

- ▶ Shape of the dataset: (20641, 3)
- ▶ Number of Rows: 20641
- ▶ Number of Columns: 3
- ▶ Distinct Columns: Date, Order_id, Product
- ▶ Data Types: Date(object), Order_id(int64), Product(object)
- ▶ Five point Summary/Describe:

Data columns (total 3 columns):

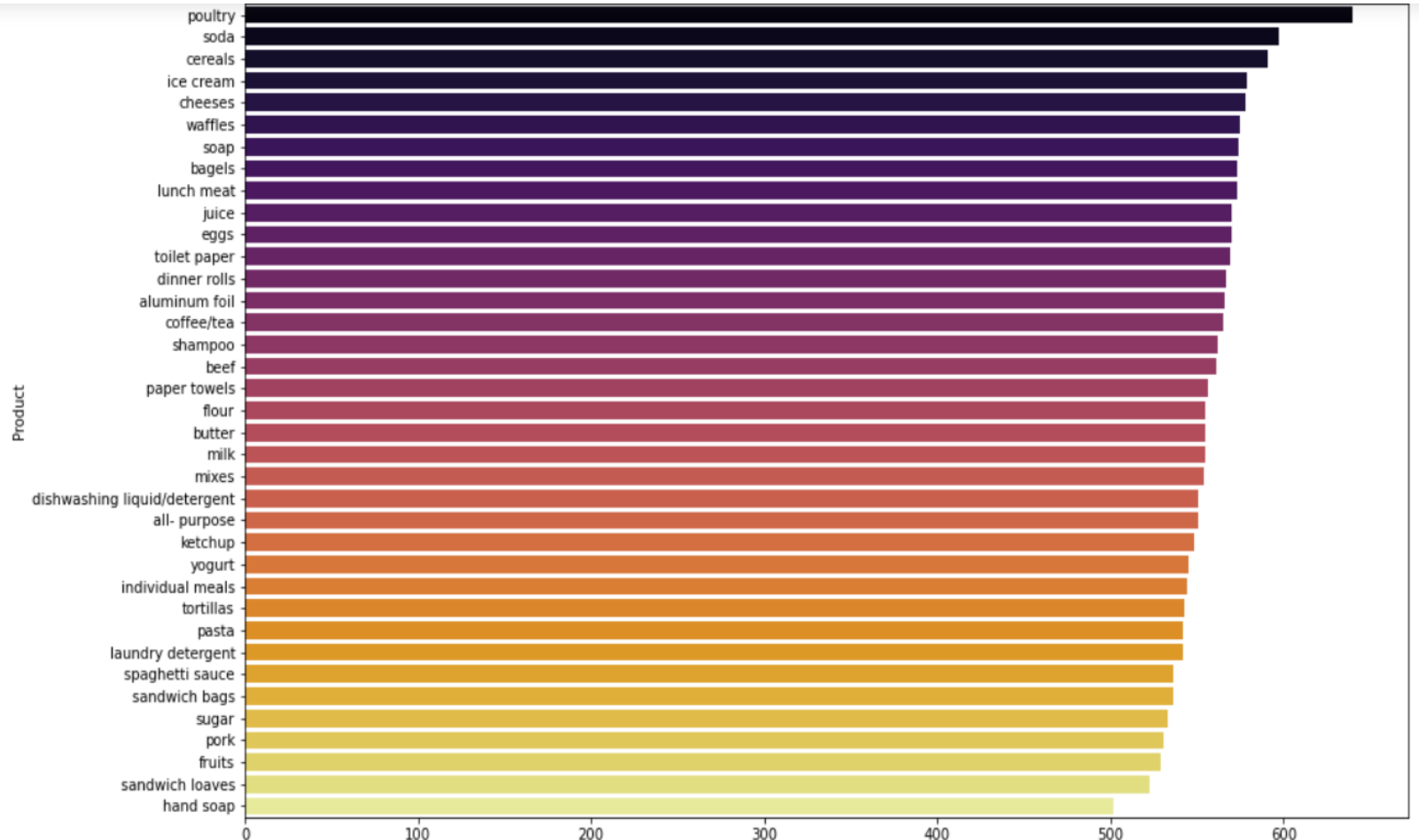
| # | Column | Non-Null Count | Dtype |
|---|----------|----------------|--------|
| 0 | Date | 20641 non-null | object |
| 1 | Order_id | 20641 non-null | int64 |
| 2 | Product | 20641 non-null | object |

dtypes: int64(1), object(2)

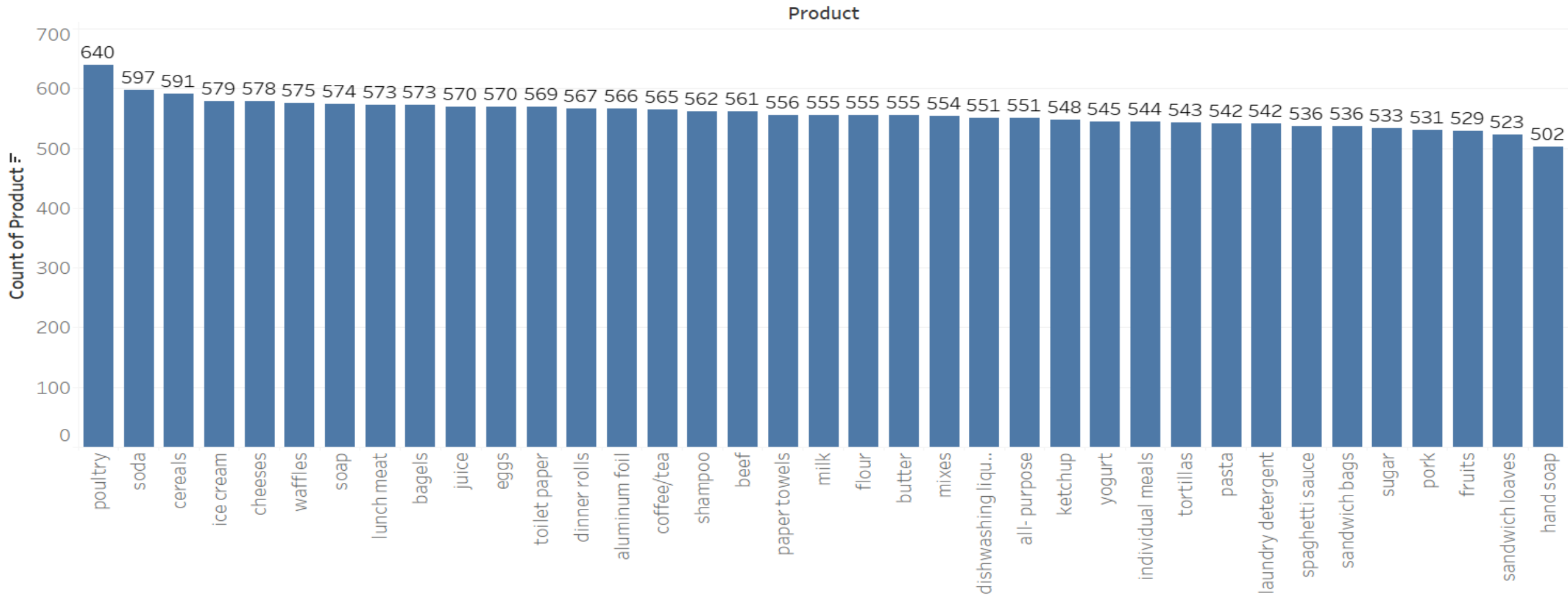
| | count | mean | std | min | 25% | 50% | 75% | max |
|----------|---------|------------|------------|-----|-------|-------|-------|--------|
| Order_id | 20641.0 | 575.986289 | 328.557078 | 1.0 | 292.0 | 581.0 | 862.0 | 1139.0 |

Count of different Products

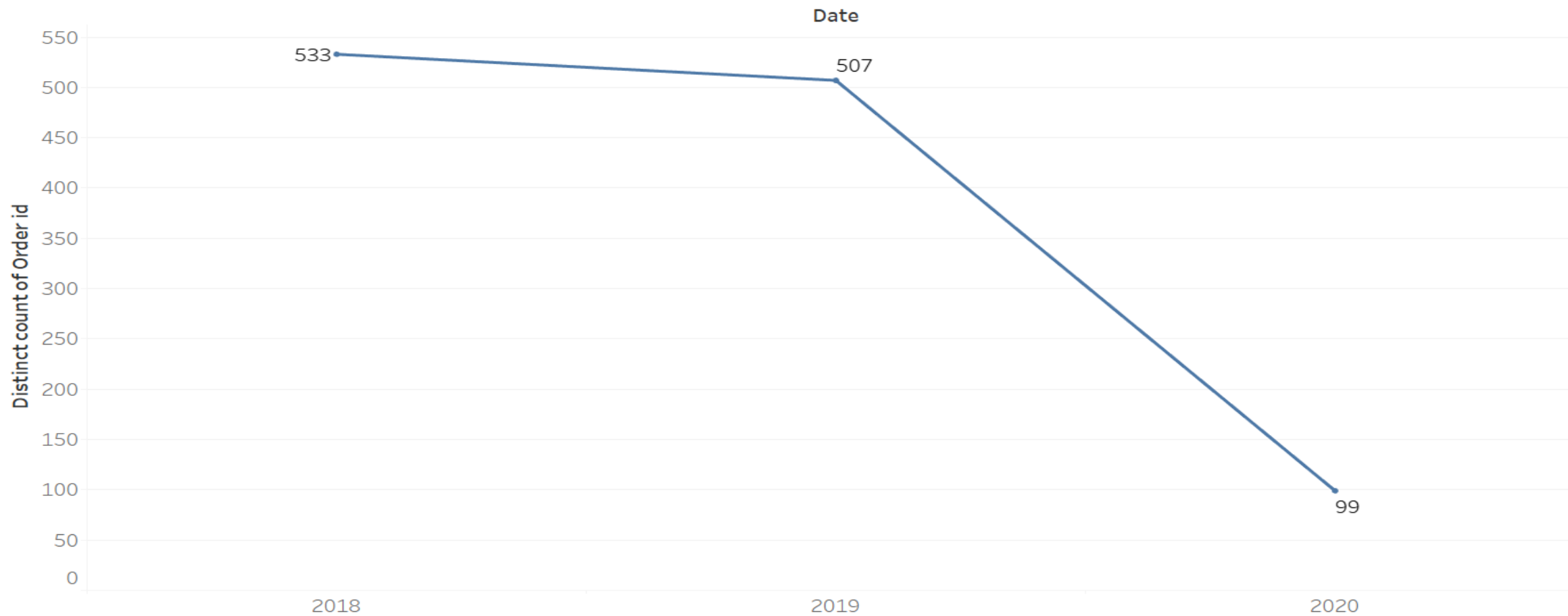
| | |
|------------------------------|-----|
| poultry | 640 |
| soda | 597 |
| cereals | 591 |
| ice cream | 579 |
| cheeses | 578 |
| waffles | 575 |
| soap | 574 |
| bagels | 573 |
| lunch meat | 573 |
| juice | 570 |
| eggs | 570 |
| toilet paper | 569 |
| dinner rolls | 567 |
| aluminum foil | 566 |
| coffee/tea | 565 |
| shampoo | 562 |
| beef | 561 |
| paper towels | 556 |
| flour | 555 |
| butter | 555 |
| milk | 555 |
| mixes | 554 |
| dishwashing liquid/detergent | 551 |
| all- purpose | 551 |
| ketchup | 548 |
| yogurt | 545 |
| individual meals | 544 |
| tortillas | 543 |
| pasta | 542 |
| laundry detergent | 542 |
| spaghetti sauce | 536 |
| sandwich bags | 536 |
| sugar | 533 |
| pork | 531 |
| fruits | 529 |
| sandwich loaves | 523 |
| hand soap | 502 |



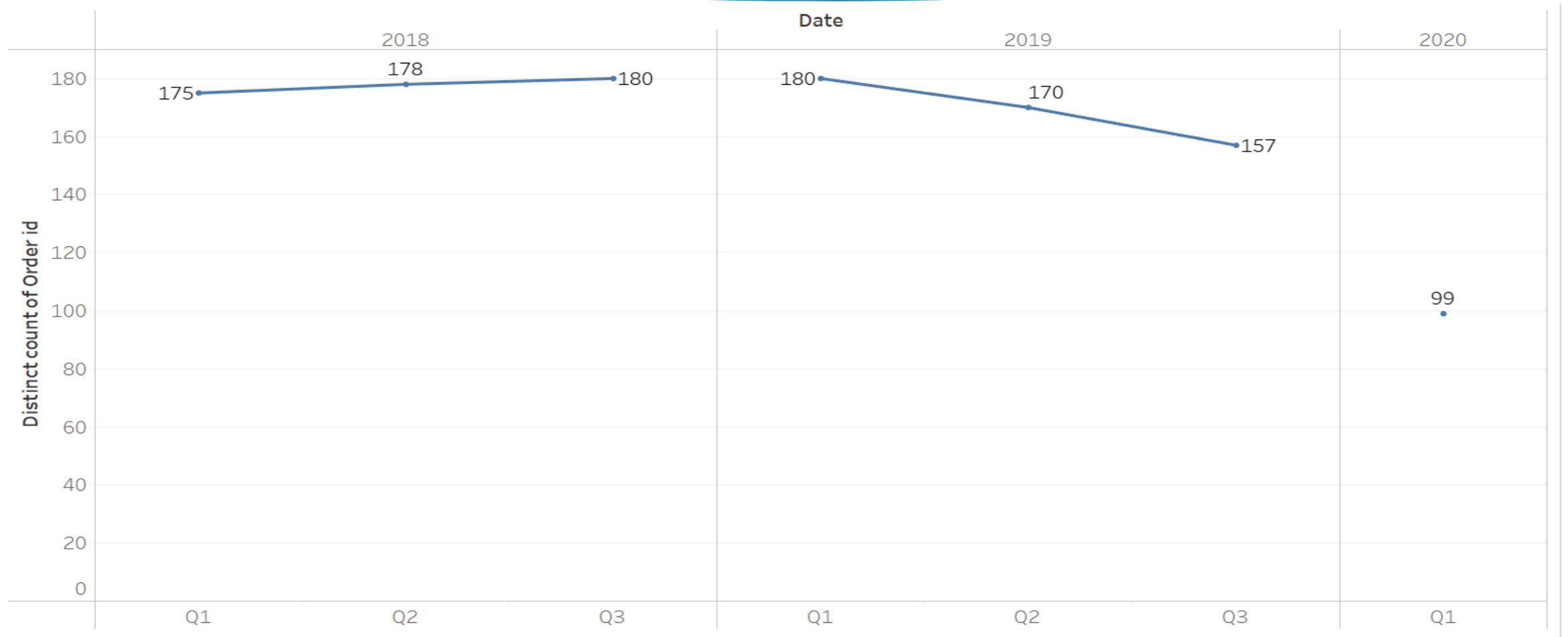
Visualizing the count:



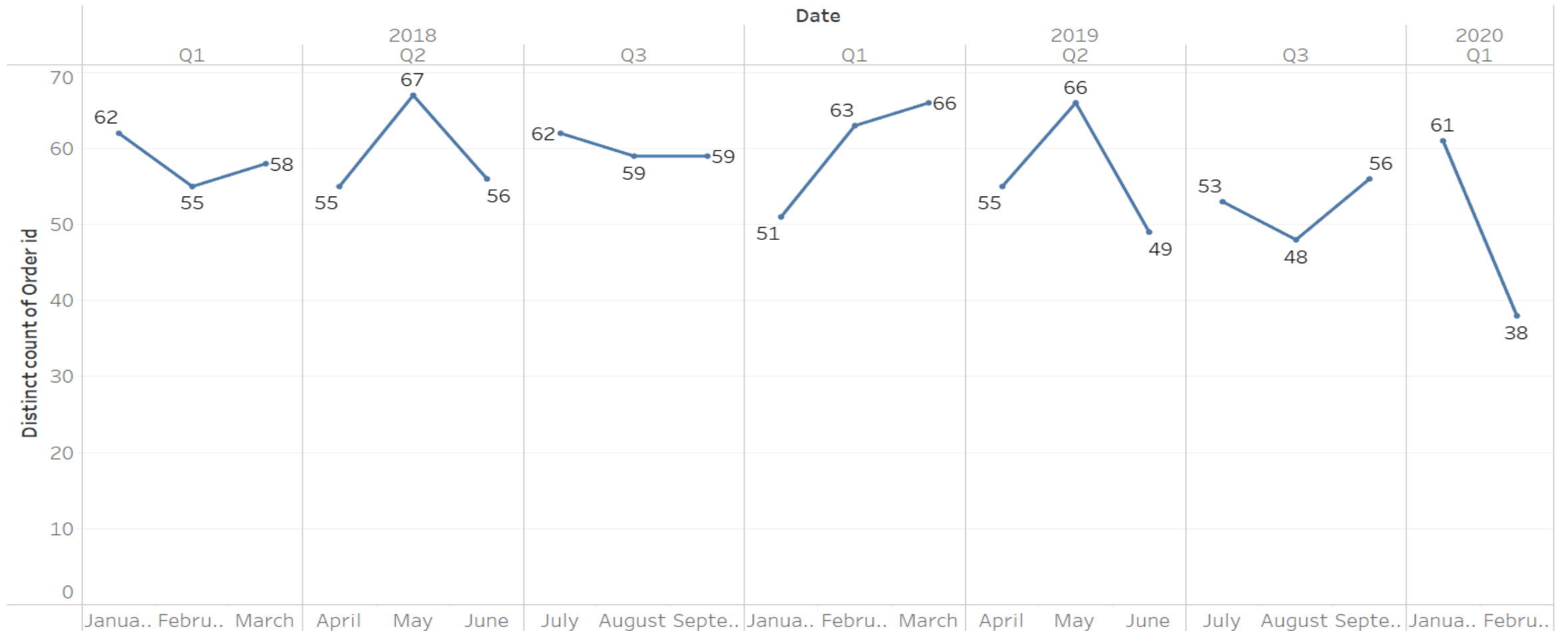
Yearly Trends based on Number of Orders



Quarterly Trends based on Number of Orders

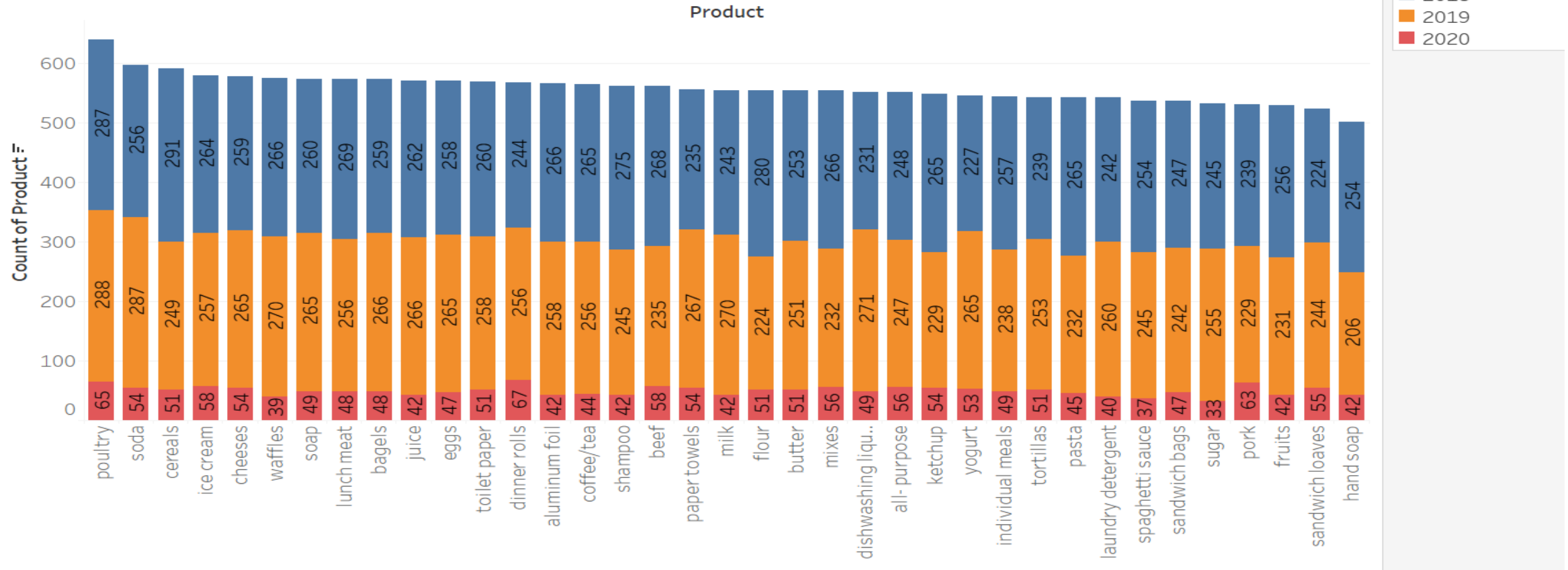


Monthly Trends based on Number of Orders



Visualizing Year Wise Count of Ordered Product

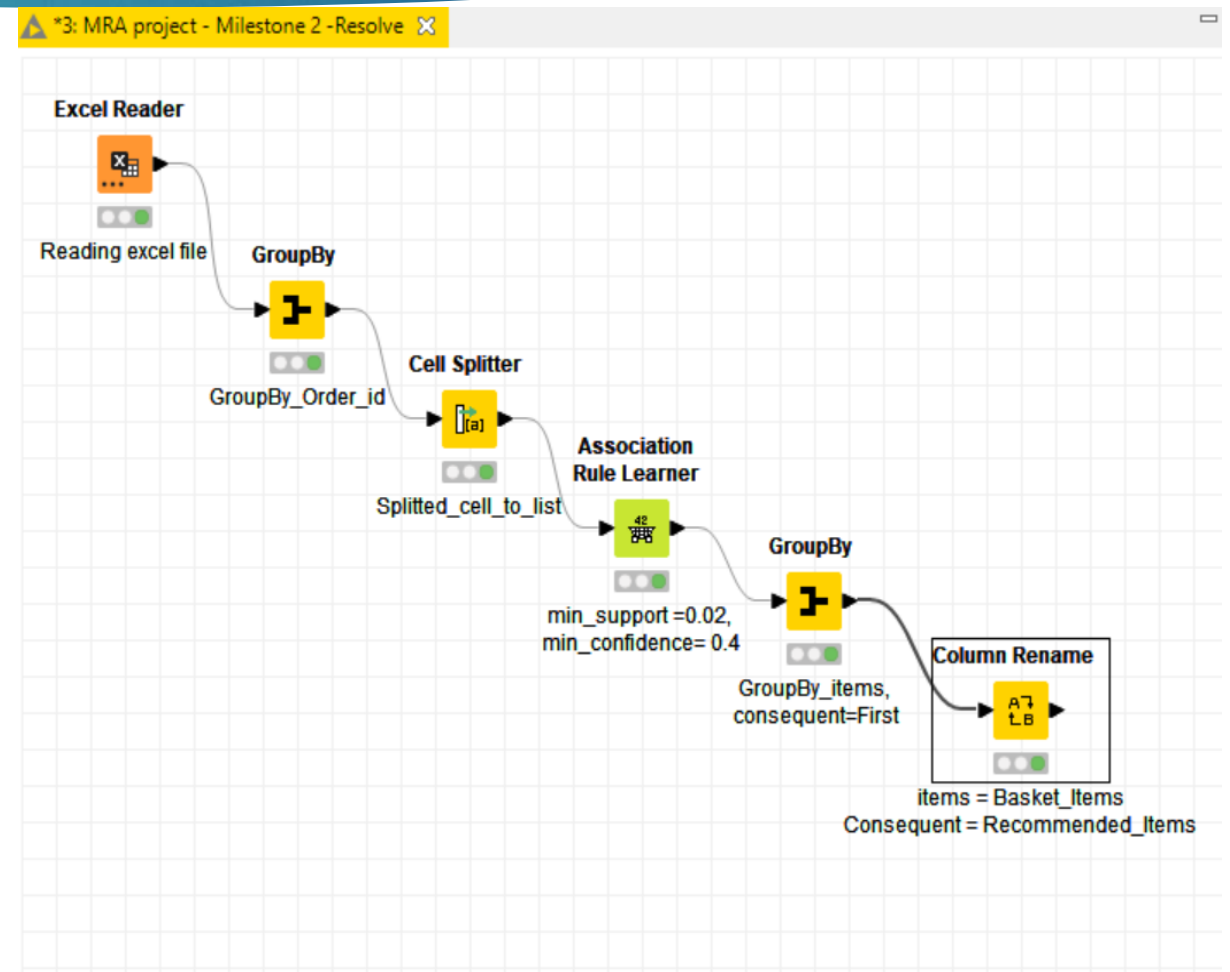
Year Wise Count of Product Ordered



KNIME Workflow Image:

Steps:

- 1) Reading the dataset using *Excel Reader*.
- 2) Applying *Group by* on 'Order_id'.
- 3) Splitting the cell to list using *Cell Splitter* node.
- 4) Applying the Association Rules using *Association Rule Learner*.
- 5) Again applying the *Group by* on Products(Items).
- 6) Renaming the item column to Basket_Items, and Consequent to Recommended_items.



Sample Image of Original dataset (after reading excel in KNIME)

- ▶ Displaying the sample image after reading the original dataset from the excel using Excel Reader.
- ▶ Here we have columns : Date, Order_id, and Product.
- ▶ Total Rows: 20641
- ▶ Total Columns: 3
- ▶ In the next step, we will apply group by on 'Order_id' and will do the concatenation on 'Product'.

Table "default" - Rows: 20641 Spec - Columns: 3 Properties Flow Variables

| Row ID | Date | Order_id | Product |
|--------|------------|----------|-----------------|
| Row0 | 2018-01-01 | 1 | yogurt |
| Row1 | 2018-01-01 | 1 | pork |
| Row2 | 2018-01-01 | 1 | sandwich bags |
| Row3 | 2018-01-01 | 1 | lunch meat |
| Row4 | 2018-01-01 | 1 | all-purpose |
| Row5 | 2018-01-01 | 1 | flour |
| Row6 | 2018-01-01 | 1 | soda |
| Row7 | 2018-01-01 | 1 | butter |
| Row8 | 2018-01-01 | 1 | beef |
| Row9 | 2018-01-01 | 1 | aluminum foil |
| Row10 | 2018-01-01 | 1 | all-purpose |
| Row11 | 2018-01-01 | 1 | dinner rolls |
| Row12 | 2018-01-01 | 1 | shampoo |
| Row13 | 2018-01-01 | 1 | all-purpose |
| Row14 | 2018-01-01 | 1 | mixes |
| Row15 | 2018-01-01 | 1 | soap |
| Row16 | 2018-01-01 | 1 | laundry det... |
| Row17 | 2018-01-01 | 1 | ice cream |
| Row18 | 2018-01-01 | 1 | dinner rolls |
| Row19 | 2018-01-01 | 2 | toilet paper |
| Row20 | 2018-01-01 | 2 | shampoo |
| Row21 | 2018-01-01 | 2 | hand soap |
| Row22 | 2018-01-01 | 2 | waffles |
| Row23 | 2018-01-01 | 2 | cheeses |
| Row24 | 2018-01-01 | 2 | mixes |
| Row25 | 2018-01-01 | 2 | milk |
| Row26 | 2018-01-01 | 2 | sandwich bags |
| Row27 | 2018-01-01 | 2 | laundry det... |
| Row28 | 2018-01-01 | 2 | dishwashing... |
| Row29 | 2018-01-01 | 2 | waffles |
| Row30 | 2018-01-01 | 2 | individual m... |
| Row31 | 2018-01-01 | 2 | hand soap |
| Row32 | 2018-01-01 | 2 | individual m... |
| Row33 | 2018-01-01 | 2 | yogurt |
| Row34 | 2018-01-01 | 2 | cereals |
| Row35 | 2018-01-01 | 2 | shampoo |
| Row36 | 2018-01-01 | 2 | aluminum foil |

Sample image after applying the Group_by on 'Order_id' (KNIME)

Table "default" - Rows: 1139 Spec - Columns: 2 Properties Flow Variables

| Row ID | I Order_id | S Product |
|--------|------------|--|
| Row0 | 1 | yogurt, pork, sandwich bags, lunch meat, all- purpose, flour, soda, butter, beef, aluminum foil, all- purpose, dinner rolls, shampoo, all- purpose, mixes, soap, laundry detergent, ice cream, dinner rolls |
| Row1 | 2 | toilet paper, shampoo, hand soap, waffles, cheeses, mixes, milk, sandwich bags, laundry detergent, dishwashing liquid/detergent, waffles, individual meals, hand soap, individual meals, yogurt, cer... |
| Row2 | 3 | soda, pork, soap, ice cream, toilet paper, dinner rolls, hand soap, spaghetti sauce, milk, ketchup, sandwich loaves, poultry, toilet paper, ice cream, ketchup, laundry detergent, spaghetti sauce, ba... |
| Row3 | 4 | cereals, juice, lunch meat, soda, toilet paper, all- purpose |
| Row4 | 5 | sandwich loaves, pasta, tortillas, mixes, hand soap, toilet paper, paper towels, flour, pork, poultry, eggs, pork, spaghetti sauce, milk, waffles, individual meals, dinner rolls, all- purpose, soda, yogurt |
| Row5 | 6 | laundry detergent, toilet paper, eggs, toilet paper, bagels, dishwashing liquid/detergent, cereals, paper towels, laundry detergent, butter, cereals, bagels, paper towels, shampoo, toilet paper, soa... |
| Row6 | 7 | individual meals, paper towels, tortillas, milk, ice cream, juice, dishwashing liquid/detergent, soap, sandwich bags, pasta, ketchup, all- purpose, yogurt, mixes, mixes, toilet paper, beef, sandwich ba... |
| Row7 | 8 | ice cream, juice, paper towels, waffles, soda, cheeses, poultry, toilet paper |
| Row8 | 9 | juice, poultry, coffee/tea, coffee/tea, dishwashing liquid/detergent |
| Row9 | 10 | ketchup, coffee/tea, toilet paper, pork, flour, milk, soda, dishwashing liquid/detergent, eggs, tortillas, tortillas, fruits, sugar, soap, dishwashing liquid/detergent, juice, sandwich loaves, poultry, egg... |
| Row10 | 11 | sandwich loaves, ice cream, soda, bagels, dishwashing liquid/detergent, eggs, sugar, waffles, individual meals, toilet paper, pasta, sandwich loaves, cheeses, hand soap, ketchup, poultry, dinner r... |
| Row11 | 12 | pork, tortillas, pork, shampoo, lunch meat, pasta, juice, bagels, bagels, laundry detergent, yogurt, sugar, waffles, hand soap, hand soap, butter, juice, spaghetti sauce, flour |
| Row12 | 13 | sugar, fruits, all- purpose, aluminum foil, laundry detergent, individual meals, flour, pork, shampoo, sugar, aluminum foil, shampoo, soap, bagels, toilet paper, juice, ice cream, ice cream, sandwich l... |
| Row13 | 14 | fruits, dinner rolls, individual meals, shampoo, ketchup, cereals, sandwich bags, laundry detergent, sandwich loaves, cheeses |
| Row14 | 15 | individual meals, ice cream, cereals, paper towels, bagels, mixes, lunch meat, juice, toilet paper, cheeses, paper towels, paper towels, juice, aluminum foil, fruits, butter, sandwich loaves, tortillas, s... |
| Row15 | 16 | sugar, sandwich bags, flour, juice, milk, paper towels, cereals, sandwich bags, pasta, soda, dishwashing liquid/detergent, ice cream, soap, cheeses, beef, flour, dinner rolls |
| Row16 | 17 | milk, hand soap, pasta, individual meals, spaghetti sauce, cereals, sandwich loaves, hand soap, individual meals |
| Row17 | 18 | sandwich bags, toilet paper, bagels, shampoo, coffee/tea |
| Row18 | 19 | individual meals, laundry detergent, coffee/tea, eggs, aluminum foil, beef, juice, flour, sugar, individual meals, waffles, bagels, coffee/tea, spaghetti sauce, butter, beef |
| Row19 | 20 | shampoo, dishwashing liquid/detergent, yogurt, juice, sugar, soap, sandwich loaves, butter, sandwich loaves, coffee/tea, ketchup, aluminum foil, dishwashing liquid/detergent, mixes, laundry deter... |
| Row20 | 21 | waffles, fruits, all- purpose, pork, juice, bagels, mixes |
| Row21 | 22 | cheeses, cereals, sugar, bagels, soda |
| Row22 | 23 | aluminum foil, bagels, shampoo, shampoo, dishwashing liquid/detergent, cereals, cheeses, flour, lunch meat, pasta, soda, toilet paper, poultry, coffee/tea, flour, all- purpose, waffles, coffee/tea, ... |
| Row23 | 24 | fruits, all- purpose, pasta, cheeses, juice, sandwich bags, sandwich loaves, coffee/tea, juice, lunch meat, spaghetti sauce, paper towels, hand soap, soap, ice cream, individual meals, ketchup, but... |
| Row24 | 25 | bagels, sugar, pork, sandwich loaves, tortillas, ice cream, all- purpose, yogurt, fruits, pasta, lunch meat, dishwashing liquid/detergent, juice |
| Row25 | 26 | fruits, sandwich loaves, coffee/tea, aluminum foil, shampoo, cereals, dinner rolls, coffee/tea, poultry, butter, juice, paper towels, beef, mixes, lunch meat, bagels, tortillas, aluminum foil, individual ... |
| Row26 | 27 | laundry detergent, pork, pasta, cheeses, fruits, sugar, lunch meat, laundry detergent, paper towels, butter, sandwich loaves, ice cream, waffles, all- purpose, sandwich bags, lunch meat, sandwic... |
| Row27 | 28 | pork, bagels, poultry, pasta, butter, all- purpose, pasta, shampoo, sugar, ketchup, eggs, soda, tortillas, soap, individual meals, ketchup, butter, mixes, juice, lunch meat, cereals, waffles, shampoo... |
| Row28 | 29 | pasta, butter, sandwich loaves, spaghetti sauce, juice, dinner rolls, all- purpose, pork, yogurt, spaghetti sauce |
| Row29 | 30 | flour, bagels, cheeses, sandwich loaves, toilet paper |
| Row30 | 31 | aluminum foil, eggs, ice cream, pasta, juice, waffles, shampoo, dinner rolls, soda, laundry detergent, hand soap, waffles, cereals, toilet paper, individual meals, yogurt, spaghetti sauce, ice cream, ... |
| Row31 | 32 | soap, paper towels, individual meals, dinner rolls, lunch meat, sugar, soap, eggs, beef, yogurt, soda, sandwich loaves, aluminum foil, dinner rolls, soap, cheeses, sandwich loaves, ice cream, ketchup |
| Row32 | 33 | sandwich loaves, pork, sandwich bags, ketchup, coffee/tea, soda, poultry, pasta, all- purpose, coffee/tea, paper towels, individual meals, poultry, flour, aluminum foil, soap, yogurt, mixes, soda |
| Row33 | 34 | lunch meat, mixes, soap, hand soap, tortillas, coffee/tea, cheeses, tortillas, cheeses, ice cream, tortillas, beef, yogurt, spaghetti sauce, soda, eggs |
| Row34 | 35 | aluminum foil, cheeses, cereals, mixes, laundry detergent, juice, pork, bagels, sandwich loaves, yogurt, milk, sandwich loaves, spaghetti sauce, cereals, individual meals, eggs |
| Row35 | 36 | soap, lunch meat, flour, juice, yogurt, shampoo, spaghetti sauce, ketchup, laundry detergent, dinner rolls, ketchup, shampoo, sugar, flour, sandwich bags, paper towels, pork, butter, dinner rolls, ... |

Sample Image after applying Cell Splitter

| Row ID | Order_id | Product | Product_SplitResultList |
|--------|----------|--|--------------------------------------|
| Row0 | 1 | yogurt, pork, sandwich bags, lunch meat, all- purpose, flour, soda, butter, beef, aluminum foil, all- purpose, dinner rolls, shampoo, all- purpose, mixes, soap, laundry detergent... | [yogurt,pork,sandwich bags,... |
| Row1 | 2 | toilet paper, shampoo, hand soap, waffles, cheeses, mixes, milk, sandwich bags, laundry detergent, dishwashing liquid/detergent, waffles, individual meals, hand soap, individ... | [toilet paper,shampoo,hand s... |
| Row2 | 3 | soda, pork, soap, ice cream, toilet paper, dinner rolls, hand soap, spaghetti sauce, milk, ketchup, sandwich loaves, poultry, toilet paper, ice cream, ketchup, laundry detergent... | [soda,pork,soap,...] |
| Row3 | 4 | cereals, juice, lunch meat, soda, toilet paper, all- purpose | [cereals,juice,lunch meat,...] |
| Row4 | 5 | sandwich loaves, pasta, tortillas, mixes, hand soap, toilet paper, paper towels, flour, pork, poultry, eggs, pork, spaghetti sauce, milk, waffles, individual meals, dinner rolls, all-... | [sandwich loaves,pasta,tortill... |
| Row5 | 6 | laundry detergent, toilet paper, eggs, toilet paper, bagels, dishwashing liquid/detergent, cereals, paper towels, laundry detergent, butter, cereals, bagels, paper towels, sha... | [laundry detergent,toilet pap... |
| Row6 | 7 | individual meals, paper towels, tortillas, milk, ice cream, juice, dishwashing liquid/detergent, soap, sandwich bags, pasta, ketchup, all- purpose, yogurt, mixes, mixes, toilet pap... | [individual meals,paper towel... |
| Row7 | 8 | ice cream, juice, paper towels, waffles, soda, cheeses, poultry, toilet paper | [ice cream,juice,paper towels... |
| Row8 | 9 | juice, poultry, coffee/tea, coffee/tea, dishwashing liquid/detergent | [juice,poultry,coffee/tea,...] |
| Row9 | 10 | ketchup, coffee/tea, toilet paper, pork, flour, milk, soda, dishwashing liquid/detergent, eggs, tortillas, tortillas, fruits, sugar, soap, dishwashing liquid/detergent, juice, sandwic... | [ketchup,coffee/tea,toilet pa... |
| Row10 | 11 | sandwich loaves, ice cream, soda, bagels, dishwashing liquid/detergent, eggs, sugar, waffles, individual meals, toilet paper, pasta, sandwich loaves, cheeses, hand soap, ketc... | [sandwich loaves,ice cream,s... |
| Row11 | 12 | pork, tortillas, pork, shampoo, lunch meat, pasta, juice, bagels, bagels, laundry detergent, yogurt, sugar, waffles, hand soap, hand soap, butter, juice, spaghetti sauce, flour | [pork,tortillas,pork,...] |
| Row12 | 13 | sugar, fruits, all- purpose, aluminum foil, laundry detergent, individual meals, flour, pork, shampoo, sugar, aluminum foil, shampoo, soap, bagels, toilet paper, juice, ice cream, ... | [sugar,fruits,all- purpose,...] |
| Row13 | 14 | fruits, dinner rolls, individual meals, shampoo, ketchup, cereals, sandwich bags, laundry detergent, sandwich loaves, cheeses | [fruits,dinner rolls,individual ...] |
| Row14 | 15 | individual meals, ice cream, cereals, paper towels, bagels, mixes, lunch meat, juice, toilet paper, cheeses, paper towels, paper towels, juice, aluminum foil, fruits, butter, sand... | [individual meals,ice cream,ce... |
| Row15 | 16 | sugar, sandwich bags, flour, juice, milk, paper towels, cereals, sandwich bags, pasta, soda, dishwashing liquid/detergent, ice cream, soap, cheeses, beef, flour, dinner rolls | [sugar,sandwich bags,flour,...] |
| Row16 | 17 | milk, hand soap, pasta, individual meals, spaghetti sauce, cereals, sandwich loaves, hand soap, individual meals | [milk,hand soap,pasta,...] |
| Row17 | 18 | sandwich bags, toilet paper, bagels, shampoo, coffee/tea | [sandwich bags,toilet paper,...] |
| Row18 | 19 | individual meals, laundry detergent, coffee/tea, eggs, aluminum foil, beef, juice, flour, sugar, individual meals, waffles, bagels, coffee/tea, spaghetti sauce, butter, beef | [individual meals,laundry det... |
| Row19 | 20 | shampoo, dishwashing liquid/detergent, yogurt, juice, sugar, soap, sandwich loaves, butter, sandwich loaves, coffee/tea, ketchup, aluminum foil, dishwashing liquid/detergent... | [shampoo,dishwashing liquid/... |
| Row20 | 21 | waffles, fruits, all- purpose, pork, juice, bagels, mixes | [waffles,fruits,all- purpose,...] |
| Row21 | 22 | cheeses, cereals, sugar, bagels, soda | [cheeses,cereals,sugar,...] |
| Row22 | 23 | aluminum foil, bagels, shampoo, shampoo, dishwashing liquid/detergent, cereals, cheeses, flour, lunch meat, pasta, soda, toilet paper, poultry, coffee/tea, flour, all- purpose, ... | [aluminum foil,bagels,shampo... |
| Row23 | 24 | fruits, all- purpose, pasta, cheeses, juice, sandwich bags, sandwich loaves, coffee/tea, juice, lunch meat, spaghetti sauce, paper towels, hand soap, soap, ice cream, individu... | [fruits,all- purpose,pasta,...] |
| Row24 | 25 | bagels, sugar, pork, sandwich loaves, tortillas, ice cream, all- purpose, yogurt, fruits, pasta, lunch meat, dishwashing liquid/detergent, juice | [bagels,sugar,pork,...] |
| Row25 | 26 | fruits, sandwich loaves, coffee/tea, aluminum foil, shampoo, cereals, dinner rolls, coffee/tea, poultry, butter, juice, paper towels, beef, mixes, lunch meat, bagels, tortillas, alu... | [fruits,sandwich loaves,coffe... |
| Row26 | 27 | laundry detergent, pork, pasta, cheeses, fruits, sugar, lunch meat, laundry detergent, paper towels, butter, sandwich loaves, ice cream, waffles, all- purpose, sandwich bags,... | [laundry detergent,pork,past... |
| Row27 | 28 | pork, bagels, poultry, pasta, butter, all- purpose, pasta, shampoo, sugar, ketchup, eggs, soda, tortillas, soap, individual meals, ketchup, butter, mixes, juice, lunch meat, cere... | [pork,bagels,poultry,...] |
| Row28 | 29 | pasta, butter, sandwich loaves, spaghetti sauce, juice, dinner rolls, all- purpose, pork, yogurt, spaghetti sauce | [pasta,butter,sandwich loave... |
| Row29 | 30 | flour, bagels, cheeses, sandwich loaves, toilet paper | [flour,bagels,cheeses,...] |
| Row30 | 31 | aluminum foil, eggs, ice cream, pasta, juice, waffles, shampoo, dinner rolls, soda, laundry detergent, hand soap, waffles, cereals, toilet paper, individual meals, yogurt, spagh... | [aluminum foil,eggs,ice cream... |
| Row31 | 32 | soap, paper towels, individual meals, dinner rolls, lunch meat, sugar, soap, eggs, beef, yogurt, soda, sandwich loaves, aluminum foil, dinner rolls, soap, cheeses, sandwich loa... | [soap,paper towels,individual... |
| Row32 | 33 | sandwich loaves, pork, sandwich bags, ketchup, coffee/tea, soda, poultry, pasta, all- purpose, coffee/tea, paper towels, individual meals, poultry, flour, aluminum foil, soap, y... | [sandwich loaves,pork,sandw... |
| Row33 | 34 | lunch meat, mixes, soap, hand soap, tortillas, coffee/tea, cheeses, tortillas, cheeses, ice cream, tortillas, beef, yogurt, spaghetti sauce, soda, eggs | [lunch meat,mixes,soap,...] |
| Row34 | 35 | aluminum foil, cheeses, cereals, mixes, laundry detergent, juice, pork, bagels, sandwich loaves, yogurt, milk, sandwich loaves, spaghetti sauce, cereals, individual meals, eggs | [aluminum foil,cheeses,cereal... |
| Row35 | 36 | soap, lunch meat, flour, juice, yogurt, shampoo, spaghetti sauce, ketchup, laundry detergent, dinner rolls, ketchup, shampoo, sugar, flour, sandwich bags, paper towels, pork... | [soap,lunch meat,flour,...] |
| Row36 | 37 | fruits, lunch meat, dinner rolls, shampoo, hand soap, mixes, pasta, sugar | [fruits,lunch meat,dinner rolls... |

Sample Image after applying Association Rules : Support=0.02, Min confidence=0.4

Table "default" - Rows: 348944 Spec - Columns: 6 Properties Flow Variables

| Row ID | [D] Support | [D] Confidence | [D] Lift | [S] Consequent | [S] implies | [...] Items |
|--------|-------------|----------------|----------|-------------------|-------------|---|
| rule0 | 0.02 | 0.426 | 1.108 | yogurt | <--- | [pasta,pork,soap] |
| rule1 | 0.02 | 0.404 | 1.135 | pork | <--- | [yogurt,dishwashing liquid/detergent,hand soap] |
| rule2 | 0.02 | 0.404 | 1.076 | all- purpose | <--- | [yogurt,ice cream,hand soap] |
| rule3 | 0.02 | 0.426 | 1.108 | yogurt | <--- | [butter,hand soap,beef] |
| rule4 | 0.02 | 0.418 | 1.115 | beef | <--- | [yogurt,butter,hand soap] |
| rule5 | 0.02 | 0.418 | 1.07 | cheeses | <--- | [yogurt,butter,hand soap] |
| rule6 | 0.02 | 0.418 | 0.992 | poultry | <--- | [yogurt,butter,hand soap] |
| rule7 | 0.02 | 0.418 | 1.103 | coffee/tea | <--- | [yogurt,butter,hand soap] |
| rule8 | 0.02 | 0.404 | 1.064 | coffee/tea | <--- | [yogurt,ice cream,hand soap] |
| rule9 | 0.02 | 0.404 | 1.019 | cereals | <--- | [yogurt,dishwashing liquid/detergent,hand soap] |
| rule10 | 0.02 | 0.411 | 1.155 | pork | <--- | [sandwich loaves,toilet paper,sandwich bags] |
| rule11 | 0.02 | 0.411 | 1.116 | sandwich bags | <--- | [eggs,fruits,pork] |
| rule12 | 0.02 | 0.404 | 1.035 | eggs | <--- | [pasta,lunch meat,pork] |
| rule13 | 0.02 | 0.434 | 1.158 | all- purpose | <--- | [sandwich loaves,laundry detergent,pork] |
| rule14 | 0.02 | 0.426 | 1.198 | pork | <--- | [all- purpose,hand soap,individual meals] |
| rule15 | 0.02 | 0.404 | 1.135 | pork | <--- | [all- purpose,hand soap,bagels] |
| rule16 | 0.02 | 0.434 | 1.23 | flour | <--- | [sandwich loaves,laundry detergent,pork] |
| rule17 | 0.02 | 0.404 | 1.143 | flour | <--- | [fruits,milk,pork] |
| rule18 | 0.02 | 0.411 | 1.068 | aluminum foil | <--- | [butter,fruits,pork] |
| rule19 | 0.02 | 0.426 | 1.158 | butter | <--- | [shampoo,fruits,pork] |
| rule20 | 0.02 | 0.411 | 1.114 | shampoo | <--- | [butter,fruits,pork] |
| rule21 | 0.02 | 0.411 | 1.042 | waffles | <--- | [butter,fruits,pork] |
| rule22 | 0.02 | 0.404 | 1.097 | butter | <--- | [fruits,milk,pork] |
| rule23 | 0.02 | 0.411 | 1.08 | milk | <--- | [butter,fruits,pork] |
| rule24 | 0.02 | 0.411 | 0.975 | poultry | <--- | [butter,fruits,pork] |
| rule25 | 0.02 | 0.411 | 1.138 | sugar | <--- | [butter,fruits,pork] |
| rule26 | 0.02 | 0.426 | 1.136 | beef | <--- | [pasta,pork,soap] |
| rule27 | 0.02 | 0.434 | 1.129 | aluminum foil | <--- | [sandwich loaves,laundry detergent,pork] |
| rule28 | 0.02 | 0.404 | 1.049 | aluminum foil | <--- | [hand soap,cereals,pork] |
| rule29 | 0.02 | 0.404 | 1.037 | dinner rolls | <--- | [sandwich loaves,pork,sugar] |
| rule30 | 0.02 | 0.426 | 1.076 | cereals | <--- | [shampoo,fruits,pork] |
| rule31 | 0.02 | 0.404 | 1.074 | mixes | <--- | [hand soap,cereals,pork] |
| rule32 | 0.02 | 0.404 | 1.064 | soap | <--- | [fruits,hand soap,pork] |
| rule33 | 0.02 | 0.426 | 1.133 | individual meals | <--- | [pasta,pork,soap] |
| rule34 | 0.02 | 0.426 | 1.141 | spaghetti sauce | <--- | [pasta,pork,soap] |
| rule35 | 0.02 | 0.426 | 1.123 | coffee/tea | <--- | [pasta,pork,soap] |
| rule36 | 0.02 | 0.404 | 1.066 | laundry detergent | <--- | [fruits,toilet paper,pork] |

Reason behind Association Rules

- ▶ Since we need to get the best and enough association rules for our list of given products and recommended products on the basis of each individual orders, we should start with the minimum support and min confidence levels.
- ▶ As it is an iterative process, I tried selecting minimum support at different levels like 0.05, 0.04, 0.03, 0.02 but got the best results and enough rules by using support at 0.02, so I chose 0.02 as the minimum support.
- ▶ And same goes for minimum confidence, I chose 0.4 as the minimum confidence level.
- ▶ The lift value is a measure of importance of a rule. The lift value of an association rule is the ratio of the confidence of the rule and the expected confidence of the rule.
- ▶ There are different lift values for different combination of products in the basket.
- ▶ A lift ratio larger than **1.0** implies that the relationship between the antecedent and the consequent is more significant than would be expected if the two sets were independent. The larger the lift ratio, the more significant the association.

Sample image after applying Group_by on items, consequent = First

| Table "default" - Rows: 36668 Spec - Columns: 6 Properties Flow Variables | | | | | | |
|---|---|-------------|----------------|----------|---------------|-------------|
| Row ID | [...] Items | [D] Support | [D] Confide... | [D] Lift | [S] Conseq... | [S] implies |
| Row0 | [all- purpose,aluminum foil,ketchup] | 0.033 | 0.476 | 1.259 | sandwich bags | <--- |
| Row1 | [all- purpose,aluminum foil,soap,...] | 0.022 | 0.55 | 1.469 | butter | <--- |
| Row2 | [all- purpose,aluminum foil,soap] | 0.035 | 0.474 | 1.256 | sandwich bags | <--- |
| Row3 | [all- purpose,aluminum foil,sugar] | 0.026 | 0.465 | 1.221 | flour | <--- |
| Row4 | [all- purpose,aluminum foil] | 0.07 | 0.448 | 1.177 | cheeses | <--- |
| Row5 | [all- purpose,bagels,aluminum foil] | 0.031 | 0.444 | 1.178 | soap | <--- |
| Row6 | [all- purpose,bagels,beef,...] | 0.021 | 0.667 | 1.799 | fruits | <--- |
| Row7 | [all- purpose,bagels,beef] | 0.026 | 0.477 | 1.269 | butter | <--- |
| Row8 | [all- purpose,bagels,cereals,...] | 0.022 | 0.735 | 1.861 | lunch meat | <--- |
| Row9 | [all- purpose,bagels,cereals] | 0.029 | 0.47 | 1.248 | sandwich bags | <--- |
| Row10 | [all- purpose,bagels,coffee/tea] | 0.029 | 0.459 | 1.214 | ice cream | <--- |
| Row11 | [all- purpose,bagels,individual meals] | 0.028 | 0.476 | 1.257 | beef | <--- |
| Row12 | [all- purpose,bagels,juice,...] | 0.02 | 0.605 | 1.574 | yogurt | <--- |
| Row13 | [all- purpose,bagels,juice] | 0.032 | 0.473 | 1.252 | dinner rolls | <--- |
| Row14 | [all- purpose,bagels,ketchup] | 0.028 | 0.452 | 1.191 | yogurt | <--- |
| Row15 | [all- purpose,bagels,laundry detergent] | 0.028 | 0.446 | 1.169 | sandwich bags | <--- |
| Row16 | [all- purpose,bagels,lunch meat,...] | 0.022 | 0.622 | 1.627 | juice | <--- |
| Row17 | [all- purpose,bagels,lunch meat,...] | 0.022 | 0.615 | 1.636 | pork | <--- |
| Row18 | [all- purpose,bagels,lunch meat,...] | 0.021 | 0.585 | 1.567 | butter | <--- |
| Row19 | [all- purpose,bagels,lunch meat] | 0.032 | 0.462 | 1.227 | dinner rolls | <--- |
| Row20 | [all- purpose,bagels,milk] | 0.03 | 0.461 | 1.215 | butter | <--- |
| Row21 | [all- purpose,bagels,mixes] | 0.029 | 0.45 | 1.19 | dinner rolls | <--- |
| Row22 | [all- purpose,bagels,pasta,...] | 0.02 | 0.697 | 1.788 | eggs | <--- |
| Row23 | [all- purpose,bagels,pasta,...] | 0.021 | 0.706 | 1.811 | eggs | <--- |
| Row24 | [all- purpose,bagels,pasta] | 0.029 | 0.454 | 1.196 | yogurt | <--- |
| Row25 | [all- purpose,bagels,pork,...] | 0.02 | 0.605 | 1.617 | toilet paper | <--- |
| Row26 | [all- purpose,bagels,pork,...] | 0.021 | 0.573 | 1.492 | toilet paper | <--- |
| Row27 | [all- purpose,bagels,pork] | 0.03 | 0.456 | 1.205 | beef | <--- |
| Row28 | [all- purpose,bagels,sandwich bags] | 0.026 | 0.464 | 1.225 | flour | <--- |
| Row29 | [all- purpose,bagels,soap] | 0.028 | 0.472 | 1.25 | flour | <--- |
| Row30 | [all- purpose,bagels,soda] | 0.026 | 0.467 | 1.237 | yogurt | <--- |
| Row31 | [all- purpose,bagels,sugar] | 0.029 | 0.467 | 1.227 | waffles | <--- |
| Row32 | [all- purpose,bagels,toilet paper,...] | 0.02 | 0.605 | 1.672 | pork | <--- |
| Row33 | [all- purpose,bagels,toilet paper,...] | 0.021 | 0.649 | 1.664 | eggs | <--- |
| Row34 | [all- purpose,bagels,toilet paper,...] | 0.02 | 0.575 | 1.617 | pork | <--- |
| Row35 | [all- purpose,bagels,toilet paper,...] | 0.022 | 0.628 | 1.668 | paper towels | <--- |
| Row36 | [all- purpose,bagels,toilet paper,...] | 0.021 | 0.632 | 1.776 | pork | <--- |

Sample Image after renaming column names

| Row ID | [...] Basket_Items | [D] Support | [D] Confide... | [D] Lift | [S] Recommended_Items |
|--------|---|-------------|----------------|----------|-----------------------|
| Row0 | [all- purpose,aluminum foil,ketchup] | 0.033 | 0.476 | 1.259 | sandwich bags |
| Row1 | [all- purpose,aluminum foil,soap,...] | 0.022 | 0.55 | 1.469 | butter |
| Row2 | [all- purpose,aluminum foil,soap] | 0.035 | 0.474 | 1.256 | sandwich bags |
| Row3 | [all- purpose,aluminum foil,sugar] | 0.026 | 0.465 | 1.221 | flour |
| Row4 | [all- purpose,aluminum foil] | 0.07 | 0.448 | 1.177 | cheeses |
| Row5 | [all- purpose,bagels,aluminum foil] | 0.031 | 0.444 | 1.178 | soap |
| Row6 | [all- purpose,bagels,beef,...] | 0.021 | 0.667 | 1.799 | fruits |
| Row7 | [all- purpose,bagels,beef] | 0.026 | 0.477 | 1.269 | butter |
| Row8 | [all- purpose,bagels,cereals,...] | 0.022 | 0.735 | 1.861 | lunch meat |
| Row9 | [all- purpose,bagels,cereals] | 0.029 | 0.47 | 1.248 | sandwich bags |
| Row10 | [all- purpose,bagels,coffee/tea] | 0.029 | 0.459 | 1.214 | ice cream |
| Row11 | [all- purpose,bagels,individual meals] | 0.028 | 0.476 | 1.257 | beef |
| Row12 | [all- purpose,bagels,juice,...] | 0.02 | 0.605 | 1.574 | yogurt |
| Row13 | [all- purpose,bagels,juice] | 0.032 | 0.473 | 1.252 | dinner rolls |
| Row14 | [all- purpose,bagels,ketchup] | 0.028 | 0.452 | 1.191 | yogurt |
| Row15 | [all- purpose,bagels,laundry detergent] | 0.028 | 0.446 | 1.169 | sandwich bags |
| Row16 | [all- purpose,bagels,lunch meat,...] | 0.022 | 0.622 | 1.627 | juice |
| Row17 | [all- purpose,bagels,lunch meat,...] | 0.022 | 0.615 | 1.636 | pork |
| Row18 | [all- purpose,bagels,lunch meat,...] | 0.021 | 0.585 | 1.567 | butter |
| Row19 | [all- purpose,bagels,lunch meat] | 0.032 | 0.462 | 1.227 | dinner rolls |
| Row20 | [all- purpose,bagels,milk] | 0.03 | 0.461 | 1.215 | butter |
| Row21 | [all- purpose,bagels,mixes] | 0.029 | 0.45 | 1.19 | dinner rolls |
| Row22 | [all- purpose,bagels,pasta,...] | 0.02 | 0.697 | 1.788 | eggs |
| Row23 | [all- purpose,bagels,pasta,...] | 0.021 | 0.706 | 1.811 | eggs |
| Row24 | [all- purpose,bagels,pasta] | 0.029 | 0.454 | 1.196 | yogurt |
| Row25 | [all- purpose,bagels,pork,...] | 0.02 | 0.605 | 1.617 | toilet paper |
| Row26 | [all- purpose,bagels,pork,...] | 0.021 | 0.573 | 1.492 | toilet paper |
| Row27 | [all- purpose,bagels,pork] | 0.03 | 0.456 | 1.205 | beef |
| Row28 | [all- purpose,bagels,sandwich bags] | 0.026 | 0.464 | 1.225 | flour |
| Row29 | [all- purpose,bagels,soap] | 0.028 | 0.472 | 1.25 | flour |
| Row30 | [all- purpose,bagels,soda] | 0.026 | 0.467 | 1.237 | yogurt |
| Row31 | [all- purpose,bagels,sugar] | 0.029 | 0.467 | 1.227 | waffles |
| Row32 | [all- purpose,bagels,toilet paper,...] | 0.02 | 0.605 | 1.672 | pork |
| Row33 | [all- purpose,bagels,toilet paper,...] | 0.021 | 0.649 | 1.664 | eggs |
| Row34 | [all- purpose,bagels,toilet paper,...] | 0.02 | 0.575 | 1.617 | pork |
| Row35 | [all- purpose,bagels,toilet paper,...] | 0.022 | 0.628 | 1.668 | paper towels |
| Row36 | [all- purpose,bagels,toilet paper,...] | 0.021 | 0.632 | 1.776 | pork |

Suggestion of Possible Combos with Lucrative Offers

- ▶ After applying the association rules, we can see in the final table that the customers who bought dinner rolls, cheese, fruits, also bought yogurt, aluminum foil, eggs, ice cream. So, in this category, we can make a food combo with some percent discount to get the customers all at once at some discounted price.
- ▶ In the category of hand soap, shampoo, toilet paper, we could see people also added paper towels in their basket, so we can give a offer on a bundle of toilet paper and paper towels. We can also provide free hand soap with the big bottle of shampoo.
- ▶ Customers who bought pork and eggs also bought beef, so in this food category we can give a discount based on some minimum quantity(in kilograms and grams).
- ▶ With 0.021 support and at 0.649 confidence, we see that the people who bought ice cream, lunch meat, sugar together also added flour, beef and pasta in their basket. So we can make a '*lunch items combo deal*' of these items all together and we can offer cheese or butter on some total minimum transaction amount.
- ▶ We can also do a deal with online payment partners to provide cashback offers to our customers on particular payment method. In this way all will get some benefits.