

Rotman

**Master of
Management
Analytics**

ENHANCING SHOPPERS' EXPERIENCE AT MM&A

Utilizing LLMs to generate a faster and smoother shopping experience

October 6, 2023 Prepared by Team 12: Niloufar Dadfar, Uxia Loji



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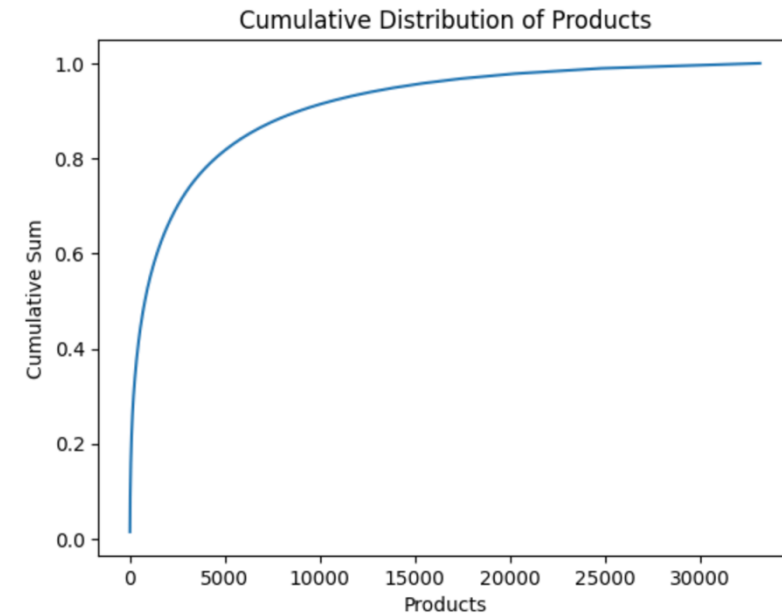
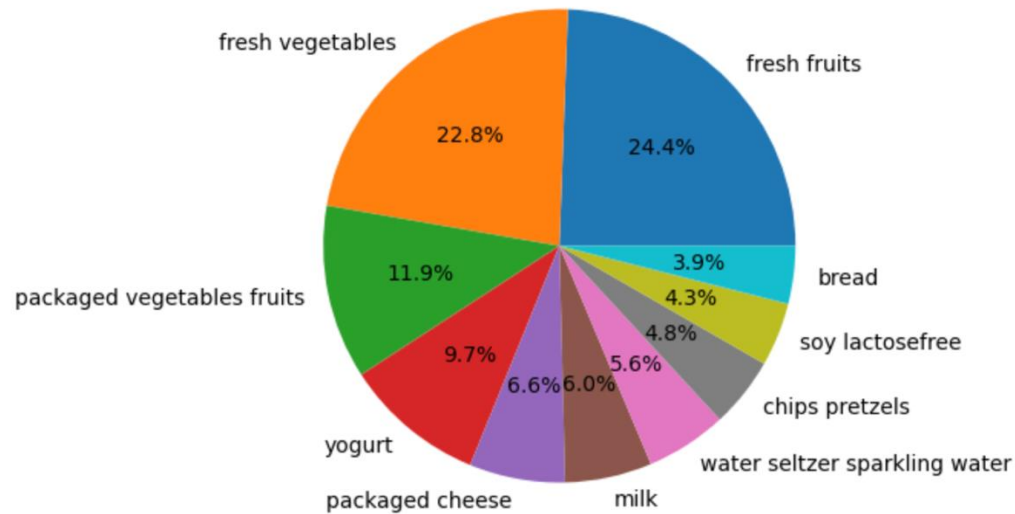
MM&A Instabasket Orders Overview

Why would we need to have a separate aisle

Did you know that **72%** of people spend less than **44 minutes** in a grocery store?*

Based on our data set**:

- **46%** of orders contain products from top 10 aisles
- **53.99 %** of the orders require top 1000 products



*[Grocery Store Statistics: Where, When, & How Much People Grocery Shop](#)

**Dataset based upon "The Instacart Online Grocery Shopping Dataset 2017", <https://www.kaggle.com/competitions/instacart-market-basket-analysis/>.

Objectives



Main Objective:

Minimizing the number of trips to other aisles that would disrupt regular in-store customers.



Solution:

Introducing a “Quick aisle” for Instabasket shoppers containing their popular products



Capacity Constraints:

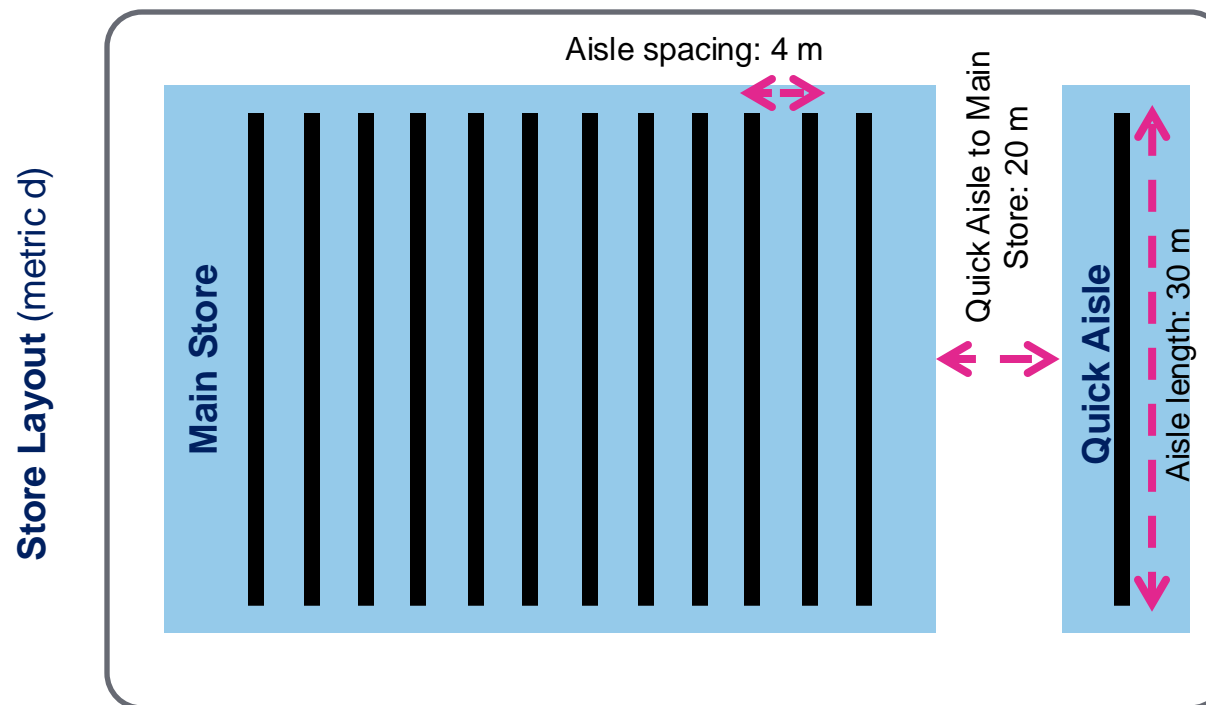
- Aisle: 1000 products
- Refrigerator: Up to 100 products
- Freezer: Up to 100 products

Our Methodology



Optimization Metrics

- **Metric (a)** = Orders with at least one item in Quick aisle
- **Metric (b)** = The average % of items in each order available in Quick aisle
- **Metric (c)** = The average % of orders that only use Quick aisle
- **Metric (d)** = The average distance to travel to pick up all the items in an order



Step 1: Data Investigation

The Simple Solution: No Constraints

Dataset split:

- Training set: 80%
- Test set: 20%

Deeper look into our training dataset:

- **Orders:** ~78,000
- **Products:** ~33,000
- **Aisles:** 134
- **Departments:** 21
- **Avg. walking distance** for an order: 669.64 (m)

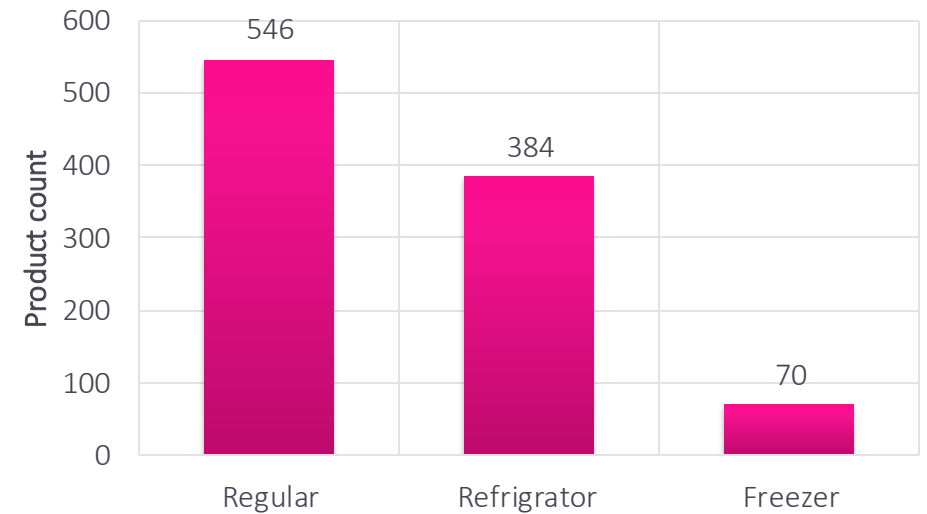
Top 1000 popular products selected for Quick Aisle:

product_name	total product count
Banana	11608
Bag of Organic Bananas	9353
Organic Strawberries	6457
Organic Baby Spinach	5872
Organic Hass Avocado	5183
...	...

Step 1 Results on Training Data

Metrics	Quick Aisle, No Constraints
Orders with at least one item in Quick aisle	92.14%
Avg. items in each order available in Quick aisle	53.98%
Avg. orders that only use Quick aisle	9.41%
Avg. distance pick up all the items in an order	528 m

Top 1000 Products Placement



Step 2: Applying the Constraints

How many of top products meet the refrigeration and freezer limitations?

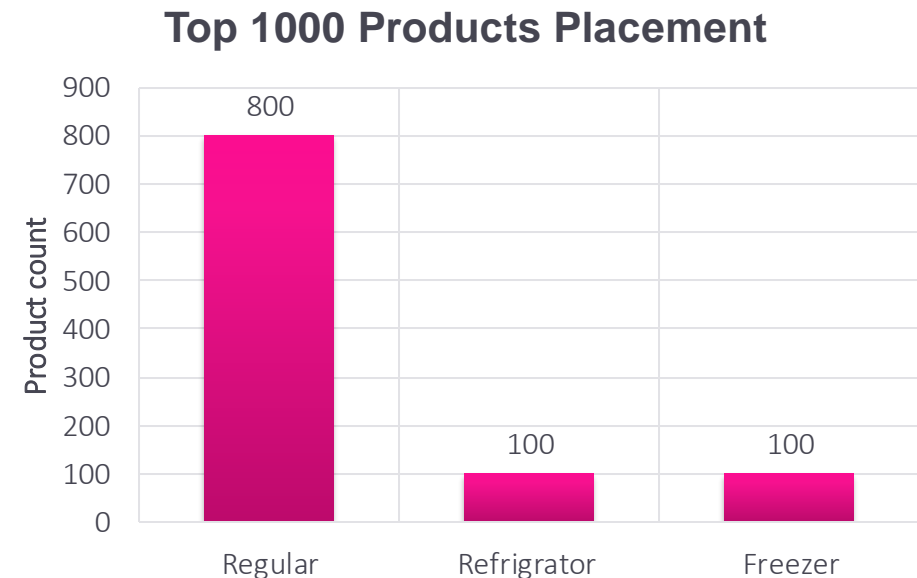
How to determine product placement? Based on Aisles

1. Identify the **departments** that only can have one type of placement and mark them
2. Investigate and mark the rest of the departments based on their **aisles**

Applying the constraints to the top 1000 products:

- Go over the most popular products:
 - Check their placement requirement
 - If required space is available: Select it
 - Otherwise skip to the next product
 - Continue until we fill up 1000 overall products

→ We scanned 1431 products to fill up Quick Aisle



Metrics	Quick aisle, without constraints	Quick aisle
Orders with at least one item in Quick aisle	92.14%	91.11%
Avg. items in each order available in Quick aisle	53.98%	49.64%
Avg. orders that only use Quick aisle	9.41%	6.9%
Avg. distance pick up all the items in an order	528 m	558 m

Step 3: Harnessing The Power Of Substitutes

Using BERT, a deep learning language model (LLM), to identify accurate substitutes

How can BERT recognizes products:

This model represents each product name as a vector. Intuitively, this vector describes products in a vector space where related products are close to each other.

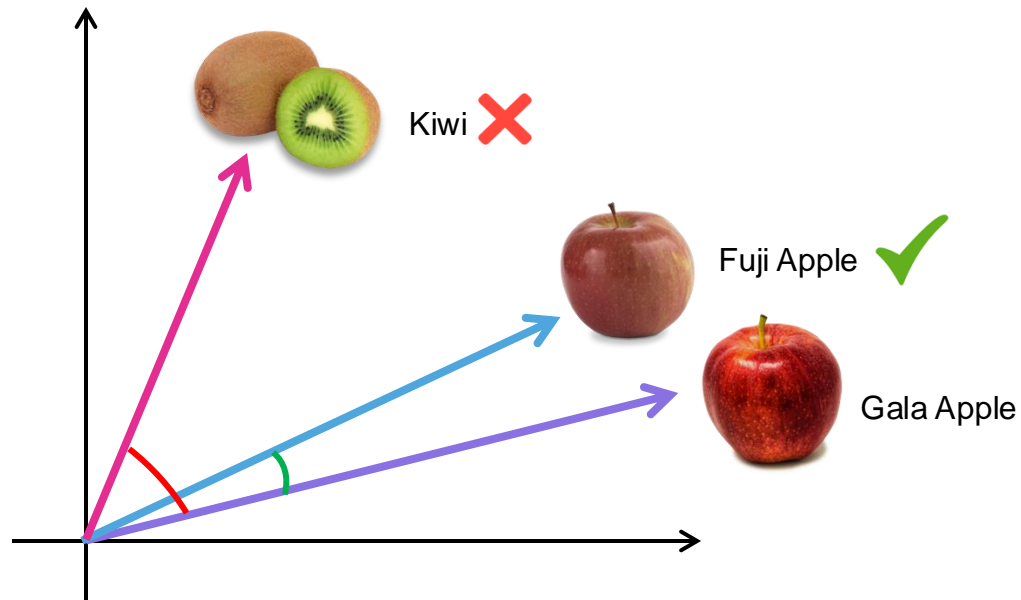


Question	Animal?	Food?	Big?	Fruit?	Sweet?
Answer	No	Yes	No	Yes	Yes
Representation vector	0.02	0.78	0.12	0.98	0.85

Harnessing The Power Of Substitutes

Cosine Similarity matches the substitute products

We can fine tune the model by changing its threshold. Based on our studies threshold of 95% yield the most optimized and accurate results.



Step 3: Results on Training Data

Metrics	Quick aisle, without constraints	Quick aisle	Quick aisle + substitutes
Orders with at least one item in Quick aisle	92.14%	91.11%	94.59%
Avg. items in each order available in Quick aisle	53.98%	49.64%	58.95%
Avg. orders that only use Quick aisle	9.41%	6.9%	10.66%
Avg. distance pick up all the items in an order	528 m	558 m	512 m

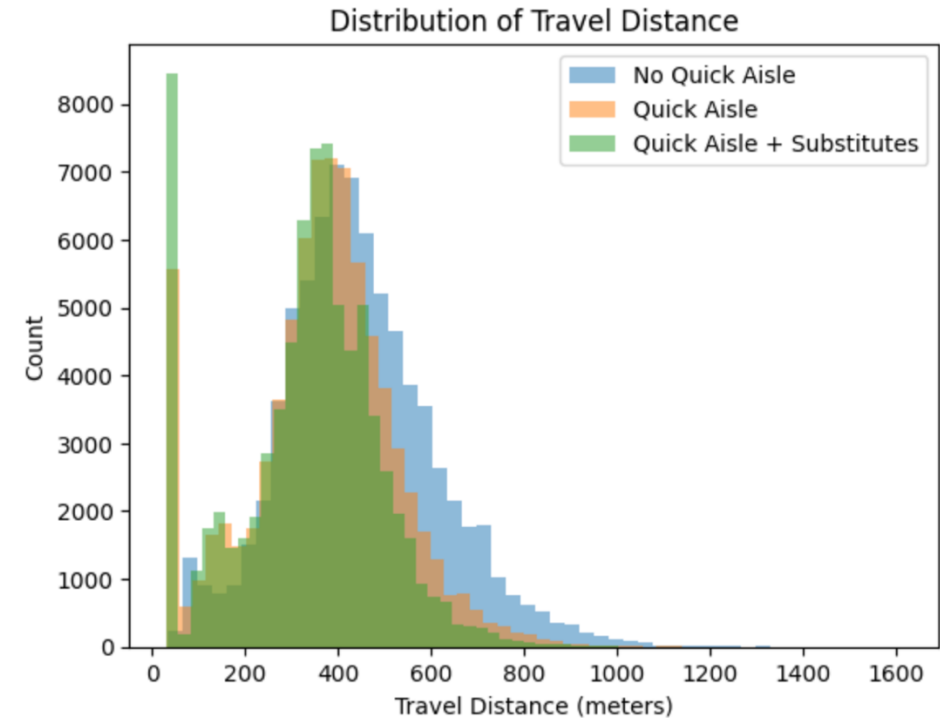
Step 4: Evaluation

Evaluating our methodology using testing data

Metrics	No Quick aisle	Quick aisle, No constraints	Quick aisle	Quick aisle + Substitutes
Orders with at least one item in Quick aisle	N/A	92.48%	91.46%	94.71%
Avg. items in each order available in Quick aisle	N/A	53.78%	49.68%	59%
Avg. orders that only use Quick aisle	N/A	9.53%	7.04%	10.77%
Avg. distance pick up all the items in an order	670 m	531 m	560 m	513 m

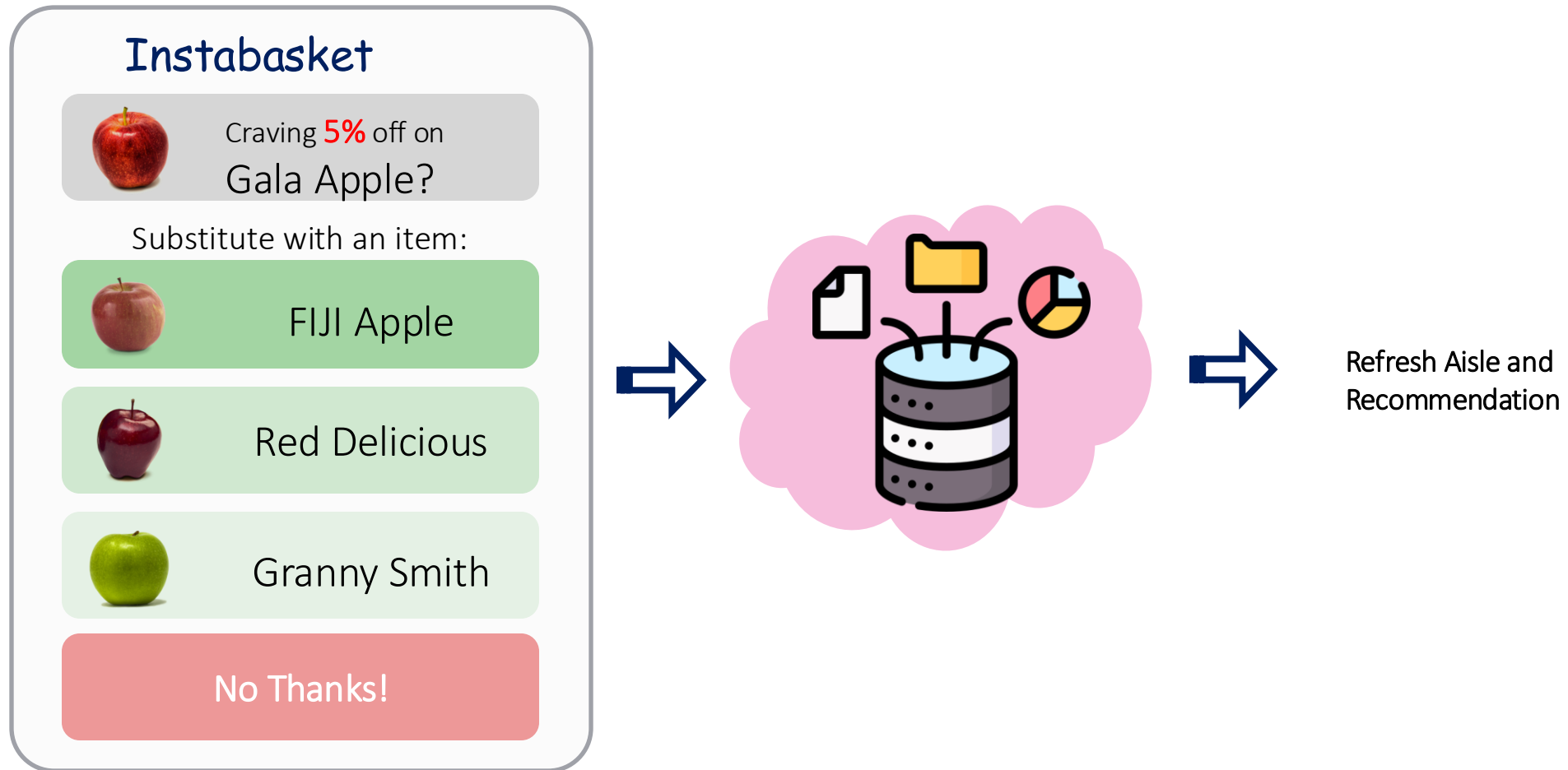
Conclusion and Suggestions

- Quick aisle reduce the walking distance by **16%**
- Many popular items need fridge: Constraints have negative effect on all metrics
- Substitutes not only compensate for the constraints but improve all metrics: (e.g., **24%** for walking distance)
- Leveraging LLMs helps to find the most relevant substitutes.



Next steps to improve substitutes

Collecting users feedback helps with fine tuning the substitutes method



Appendix 1: Placements example

aisle_id	aisle	department	placement
1	prepared soups salads	deli	R
2	specialty cheeses	dairy eggs	R
3	energy granola bars	snacks	N
4	instant foods	dry goods pasta	N
5	marinades meat preparation	pantry	N
6	other	other	N
7	packaged meat	meat seafood	R
8	bakery desserts	bakery	N
9	pasta sauce	dry goods pasta	N
10	kitchen supplies	household	N
11	cold flu allergy	personal care	N
12	fresh pasta	dry goods pasta	N
13	prepared meals	deli	R
14	tofu meat alternatives	deli	R
15	packaged seafood	meat seafood	R
16	fresh herbs	produce	R
17	baking ingredients	pantry	N
18	bulk dried fruits vegetables	bulk	N
19	oils vinegars	pantry	N
20	oral hygiene	personal care	N
21	packaged cheese	dairy eggs	R
22	hair care	personal care	N
23	popcorn jerky	snacks	N
24	fresh fruits	produce	N
25	soap	personal care	N
26	coffee	beverages	N
27	beers coolers	alcohol	R
28	red wines	alcohol	N
29	honeys syrups nectars	pantry	N
30	latino foods	international	N
31	refrigerated	beverages	R
32	packaged produce	produce	R
33	kosher foods	international	N
34	frozen meat seafood	frozen	F
35	poultry counter	meat seafood	R
36	butter	dairy eggs	R
37	ice cream ice	frozen	F
38	frozen meals	frozen	F
39	seafood counter	meat seafood	R
40	dog food care	pets	N
41	cat food care	pets	N
42	frozen vegan vegetarian	frozen	F
43	buns rolls	bakery	N
44	eye ear care	personal care	N
45	candy chocolate	snacks	N
46	mint gum	snacks	N
47	vitamins supplements	personal care	N

Appendix 2: Quick Aisle items: top 20

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quick_aisle.head(20)
```

✓ 0.0s

	order_id	product_id	product_name	aisle_id	aisle	department_id	department	placement	order_count
0	10	24852	Banana	24	fresh fruits	4	produce	N	11608
1	1	13176	Bag of Organic Bananas	24	fresh fruits	4	produce	N	9353
2	10	21137	Organic Strawberries	24	fresh fruits	4	produce	N	6457
3	3	21903	Organic Baby Spinach	123	packaged vegetables fruits	4	produce	R	5872
4	1	47209	Organic Hass Avocado	24	fresh fruits	4	produce	N	5183
5	10	47766	Organic Avocado	24	fresh fruits	4	produce	N	4257
6	28	47626	Large Lemon	24	fresh fruits	4	produce	N	3752
7	47	16797	Strawberries	24	fresh fruits	4	produce	N	3436
8	62	26209	Limes	24	fresh fruits	4	produce	N	3392
9	5	27966	Organic Raspberries	123	packaged vegetables fruits	4	produce	R	3332
10	14	27845	Organic Whole Milk	84	milk	16	dairy eggs	R	3278
11	31	22935	Organic Yellow Onion	83	fresh vegetables	4	produce	N	2687
12	56	24964	Organic Garlic	83	fresh vegetables	4	produce	N	2625
13	98	45007	Organic Zucchini	83	fresh vegetables	4	produce	N	2570
14	47	39275	Organic Blueberries	123	packaged vegetables fruits	4	produce	R	2481
15	1	49683	Cucumber Kirby	83	fresh vegetables	4	produce	N	2354
16	53	5876	Organic Lemon	24	fresh fruits	4	produce	N	2204
17	39	28204	Organic Fuji Apple	24	fresh fruits	4	produce	N	2163
18	77	8277	Apple Honeycrisp Organic	24	fresh fruits	4	produce	N	2093
19	31	4920	Seedless Red Grapes	123	packaged vegetables fruits	4	produce	R	2022

Appendix 3: Quick Aisle items: Bottom 20

quick_aisle.tail(20)

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order_id	product_id	product_name	aisle_id	aisle	department_id	department	placement	order_count
980	1457	14491 Happy Baby Spinach, Mango, and Pear Baby Food	92	baby food formula	18	babies	N	97
981	112	9047 Premium Epsom Salt	133	muscles joints pain relief	11	personal care	N	97
982	20	42633 Red Delicious Apple	24	fresh fruits	4	produce	N	97
983	678	29398 Organic Seedless Watermelon	24	fresh fruits	4	produce	N	97
984	1230	26315 Organic White Corn & Wheat Tortillas	128	tortillas flat bread	3	bakery	N	97
985	582	39430 New Mexico Taco Skillet Sauce For Chicken	30	latino foods	6	international	N	97
986	213	21077 Cara Cara Navel Orange	24	fresh fruits	4	produce	N	97
987	328	41165 Cheese Puffs	107	chips pretzels	19	snacks	N	97
988	1286	46505 Organic Long Grain Brown Rice	63	grains rice dried goods	9	dry goods pasta	N	97
989	108	21847 Lemongrass Citrus Scent Disinfecting Wipes	114	cleaning products	17	household	N	97
990	128	7010 Organic White Basmati Rice	63	grains rice dried goods	9	dry goods pasta	N	97
991	698	17530 Unsweetened Watermelon Water	115	water seltzer sparkling water	7	beverages	N	97
992	993	12564 Rigatoni Pasta	131	dry pasta	9	dry goods pasta	N	96
993	612	35948 Tonic Water	115	water seltzer sparkling water	7	beverages	N	96
994	2586	45374 Newman O's Creme Filled Chocolate Cookies	61	cookies cakes	19	snacks	N	96
995	976	38313 Organic Apple Banana GoGo Squeez	50	fruit vegetable snacks	19	snacks	N	96
996	27	27451 Almond Meal/Flour	17	baking ingredients	13	pantry	N	96
997	230	41177 Sea Salt Roasted Seaweed	50	fruit vegetable snacks	19	snacks	N	96
998	1821	546 Tomatillo Salsa	51	preserved dips spreads	13	pantry	N	96
999	2562	22890 Toll House Semi-Sweet Chocolate Morsels	17	baking ingredients	13	pantry	N	96

Appendix 4: Substitutes example

D	K
product_name	substitute item
Organic 1% Milk	Organic 2% Reduced Fat Milk
Cream Cheese	Whipped Cream Cheese
Broccoli Florets	Organic Broccoli Florets
Organic Skim Milk	Organic Whole Milk
Whole White Mushrooms	Organic Whole White Mushrooms
Baby Spinach Salad	Organic Baby Spinach Salad
Coconut Almond Unsweetened Creamer Blend	Unsweetened Vanilla Almond Milk
Sharp Cheddar Thick Slices Cheese	Sharp Cheddar Cheese
Large Pineapple Chunks	Pineapple Chunks
Organic Fresh Squeezed Orange Juice	Organic Orange Juice
Organic Low Fat Chocolate Milk	Organic Reduced Fat Milk
Goldfish Cheddar Baked Snack Crackers Multi Packs	Goldfish Cheddar Baked Snack Crackers
Stringless Sugar Snap Peas	Sugar Snap Peas
Organic Fancy Shredded Mozzarella Cheese	Organic Shredded Mozzarella
Chicken & Apple Smoked Chicken Sausage	Chicken & Maple Breakfast Sausage
Boneless And Skinless Chicken Breast	Boneless Skinless Chicken Breast
Light Sour Cream	Sour Cream
Sweet Cream Salted Butter	Salted Butter
Organic Fat-Free Milk	Organic Fat Free Milk
Total Plain Greek Strained Yogurt	Total Greek Strained Yogurt
Mexican Finely Shredded Cheese	Organic Mexican Blend Finely Shredded Cheese
Organic Large Grade A Eggs	Organic Large Grade AA Brown Eggs
Grassmilk 2% Reduced Fat Milk	Organic 2% Reduced Fat Milk
Large Organic Omega3 Brown Eggs	Organic Large Grade AA Brown Eggs
Chicken Noodle Soup	Organic Chicken Noodle Soup
Lowfat Milk	Fat Free Milk
Medium Cheddar Cheese	Sharp Cheddar Cheese
Orange Juice 100% Juice	100% Lemon Juice
Organic 4% Milk Fat Whole Milk Cottage Cheese	Organic 2% Reduced Fat Milk
Grapefruit Juice	Ruby Red Grapefruit Juice
Shredded Mozzarella Cheese	Organic Shredded Mozzarella
Organic Raw Sharp Cheddar Cheese	Shredded Mild Cheddar Cheese
Organic Baby Romaine Lettuce	Organic Romaine Lettuce
Non Fat Greek Yogurt	Total Greek Strained Yogurt
Large Grade AA Organic Eggs	Organic Large Grade AA Brown Eggs
Chocolate Peanut Butter Ice Cream	Vanilla Bean Light Ice Cream
Natural Vanilla Ice Cream	Vanilla Ice Cream
Organic Low Fat Cottage Cheese	Organic Whole String Cheese
Extralean Ground Turkey Breast	Ground Turkey Breast
Cheese Enchilada Meal	Kitchen Cheese Enchilada
Sliced Sourdough Bread	Sourdough Bread
Dairy Free Unsweetened Vanilla Coconut Milk	Organic Unsweetened Almond Milk
Dark Sweet Cherries	Organic Dark Sweet Cherries