E6893 Big Data Analytics:

Market Basket Analysis: What’s in your shopping cart?

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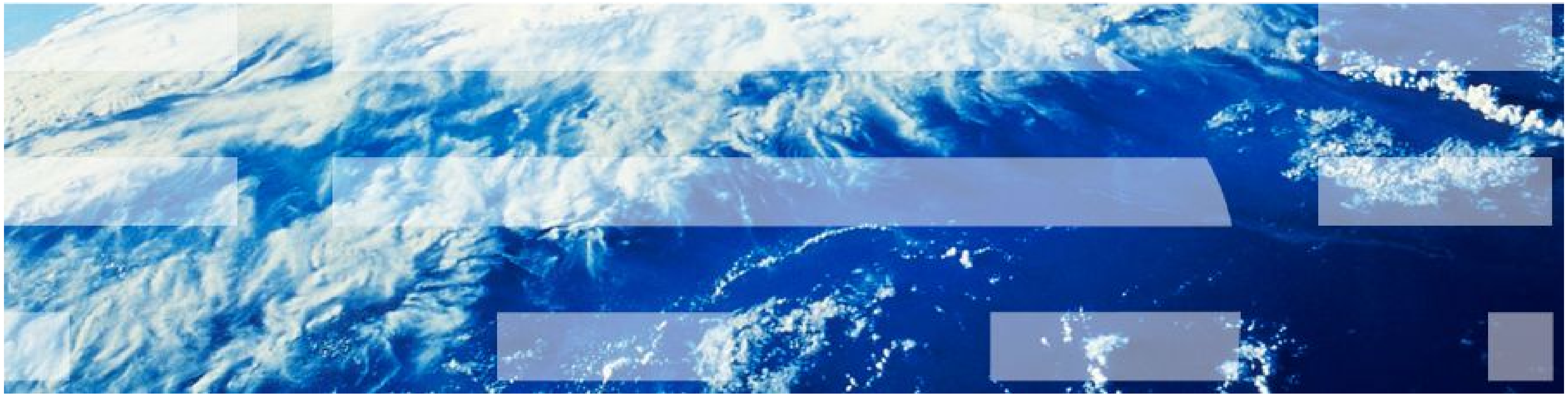
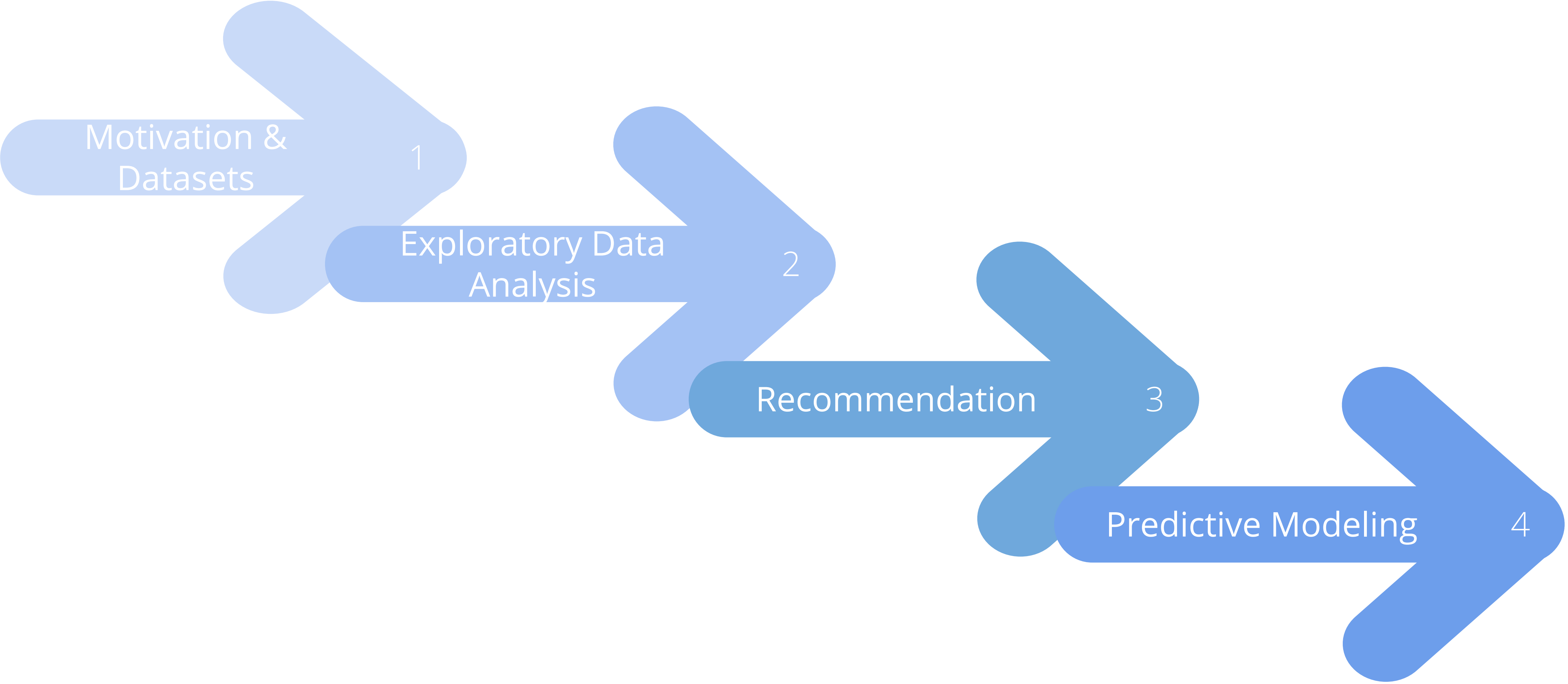


Project Pipeline



Motivation & Datasets 1

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Recommendation 3

Predictive Modeling 4

Motivation

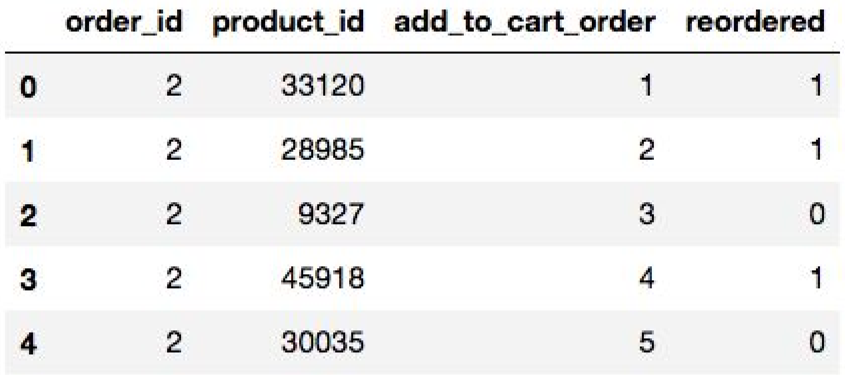
- Gain more users
- Provide delightful shopping experience to increase customer retention

- No need to go to grocery store to shop your favorites and save time
- Make it easy to fill your refrigerator and pantry with your personal favorites

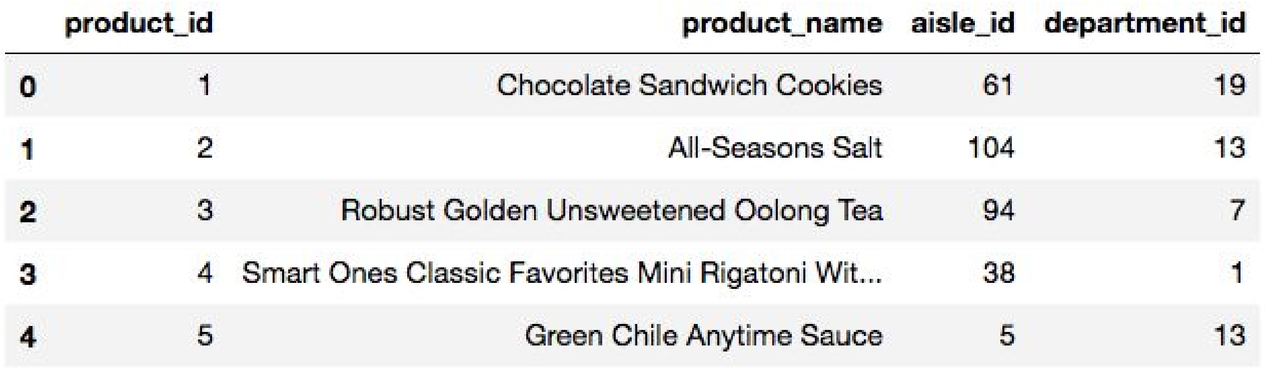
Instacart is an American company that operates as a **same-day grocery delivery service**

Datasets

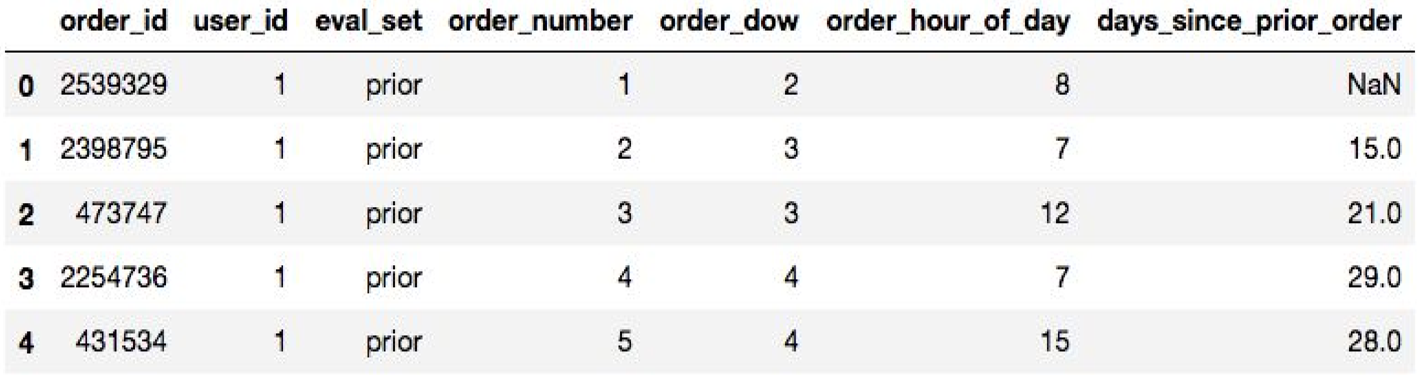
- **The Instacart Online Grocery Shopping Dataset 2017**
  - ***Relational set*** of files describing customers' orders
  - 3,346,083 orders for 49,685 products



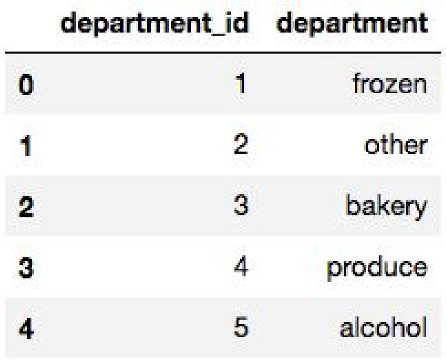
	order_id	product_id	add_to_cart_order	reordered
0	2	33120	1	1
1	2	28985	2	1
2	2	9327	3	0
3	2	45918	4	1
4	2	30035	5	0



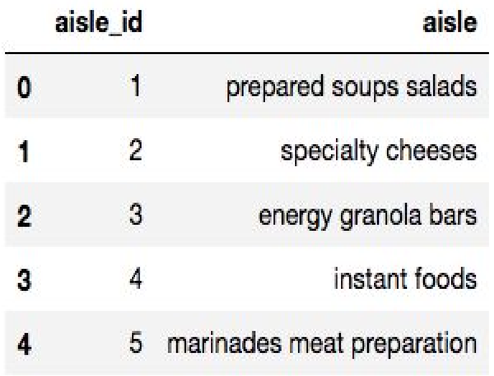
	product_id	product_name	aisle_id	department_id
0	1	Chocolate Sandwich Cookies	61	19
1	2	All-Seasons Salt	104	13
2	3	Robust Golden Unsweetened Oolong Tea	94	7
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38	1
4	5	Green Chile Anytime Sauce	5	13



	order_id	user_id	eval_set	order_number	order_dow	order_hour_of_day	days_since_prior_order
0	2539329	1	prior	1	2	8	NaN
1	2398795	1	prior	2	3	7	15.0
2	473747	1	prior	3	3	12	21.0
3	2254736	1	prior	4	4	7	29.0
4	431534	1	prior	5	4	15	28.0



	department_id	department
0	1	frozen
1	2	other
2	3	bakery
3	4	produce
4	5	alcohol

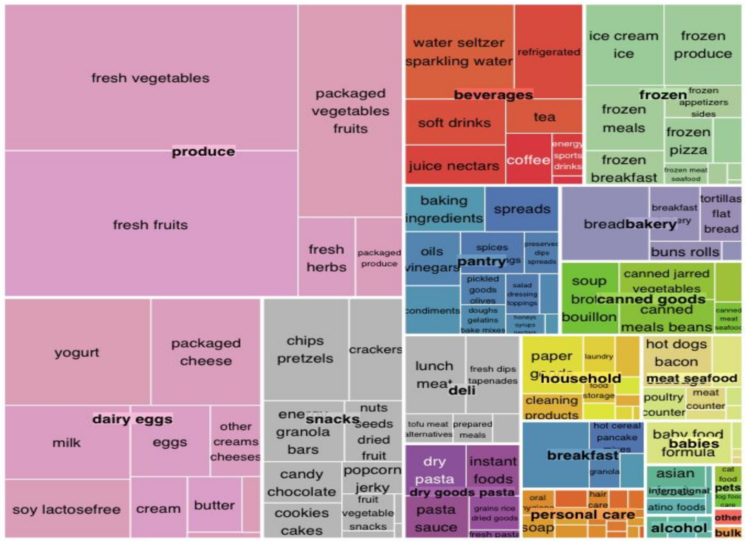


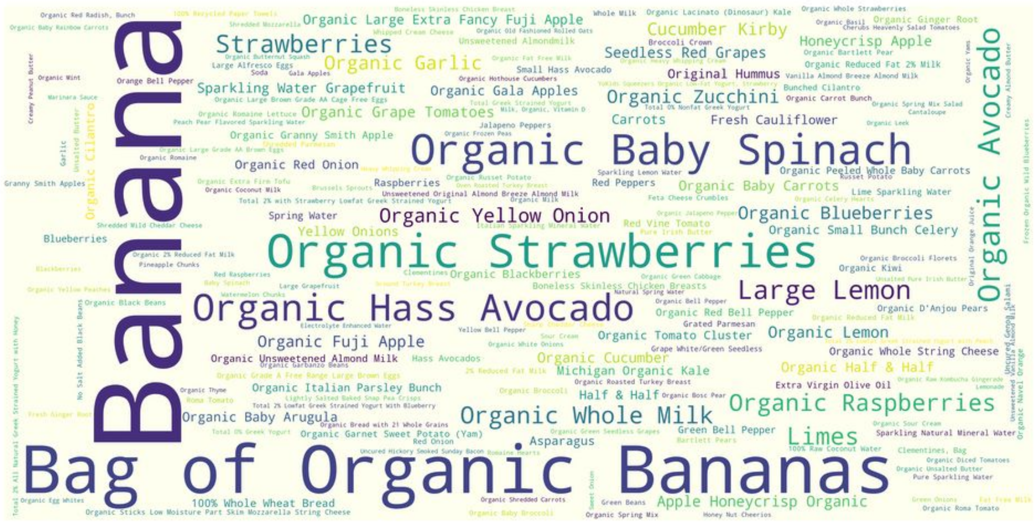
	aisle_id	aisle
0	1	prepared soups salads
1	2	specialty cheeses
2	3	energy granola bars
3	4	instant foods
4	5	marinades meat preparation

Exploratory Data Analysis

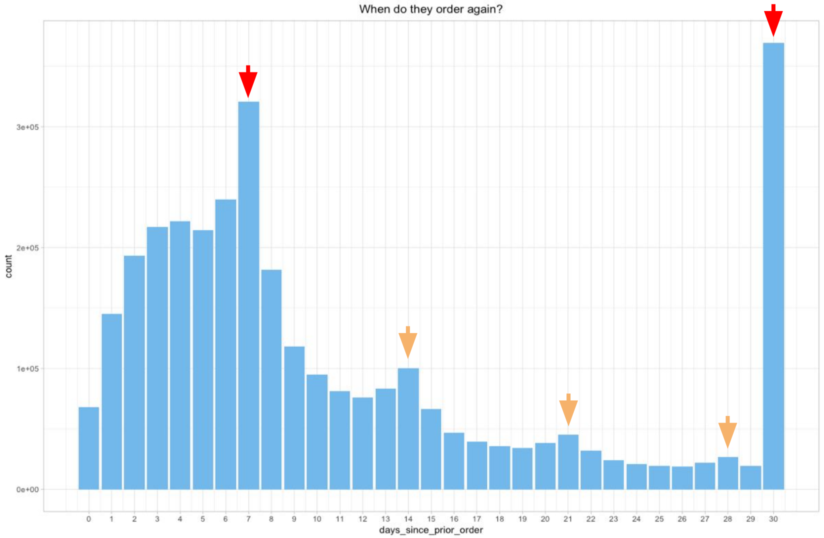
Exploratory Data Analysis

Number of Sales from the Department/Aisle





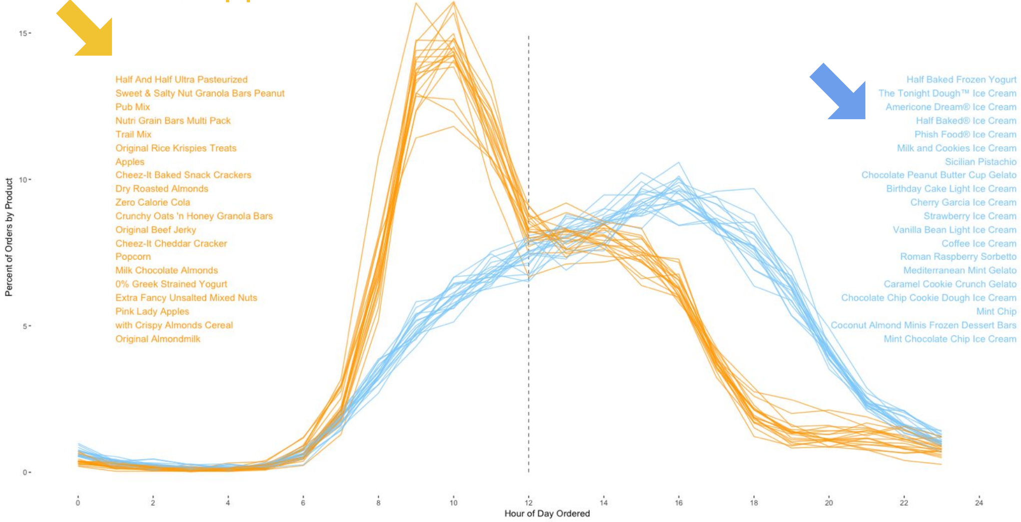
When do they order again?



Healthy: Almonds, Apples

Popular Products Purchased in the Morning VS in Evening

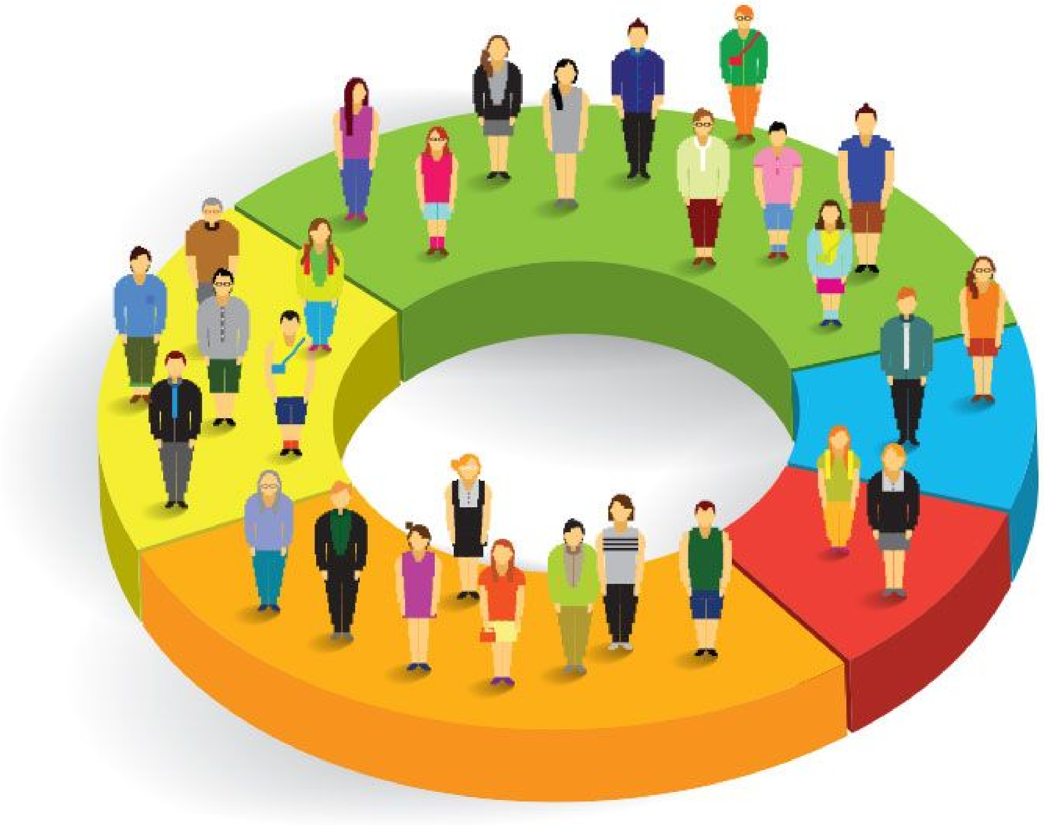
Unhealthy: Ice cream, Gelato



RECOMMENDATION

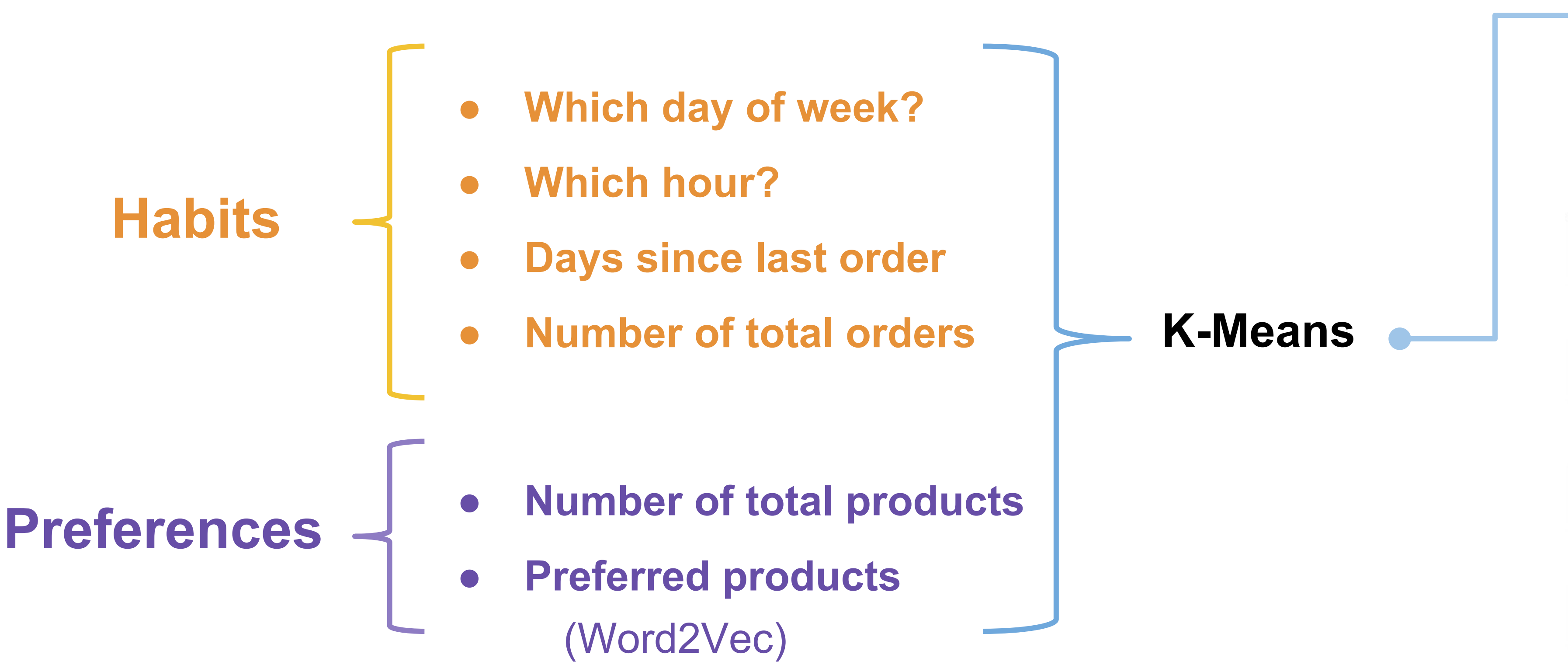
Recommendation Part I

- Recommend new products



IN GROUPS

Recommend New Products: Steps



Habits

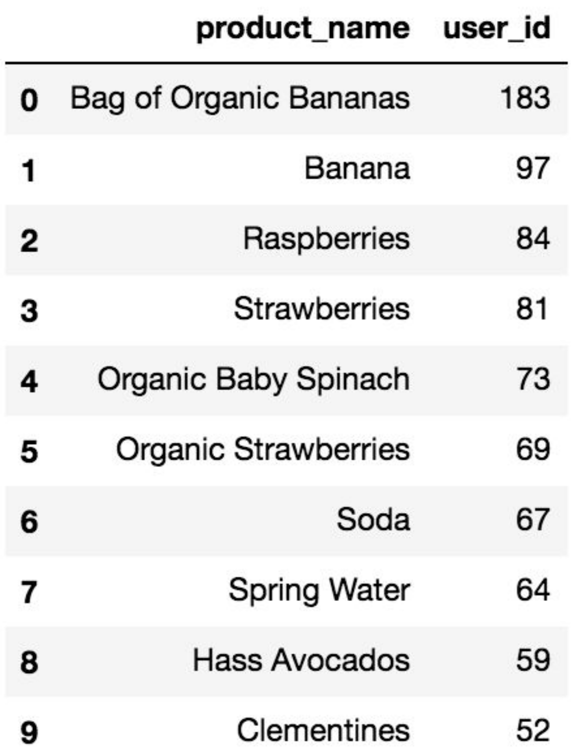
- Which day of week?
- Which hour?
- Days since last order
- Number of total orders

Preferences

- Number of total products
- Preferred products (Word2Vec)

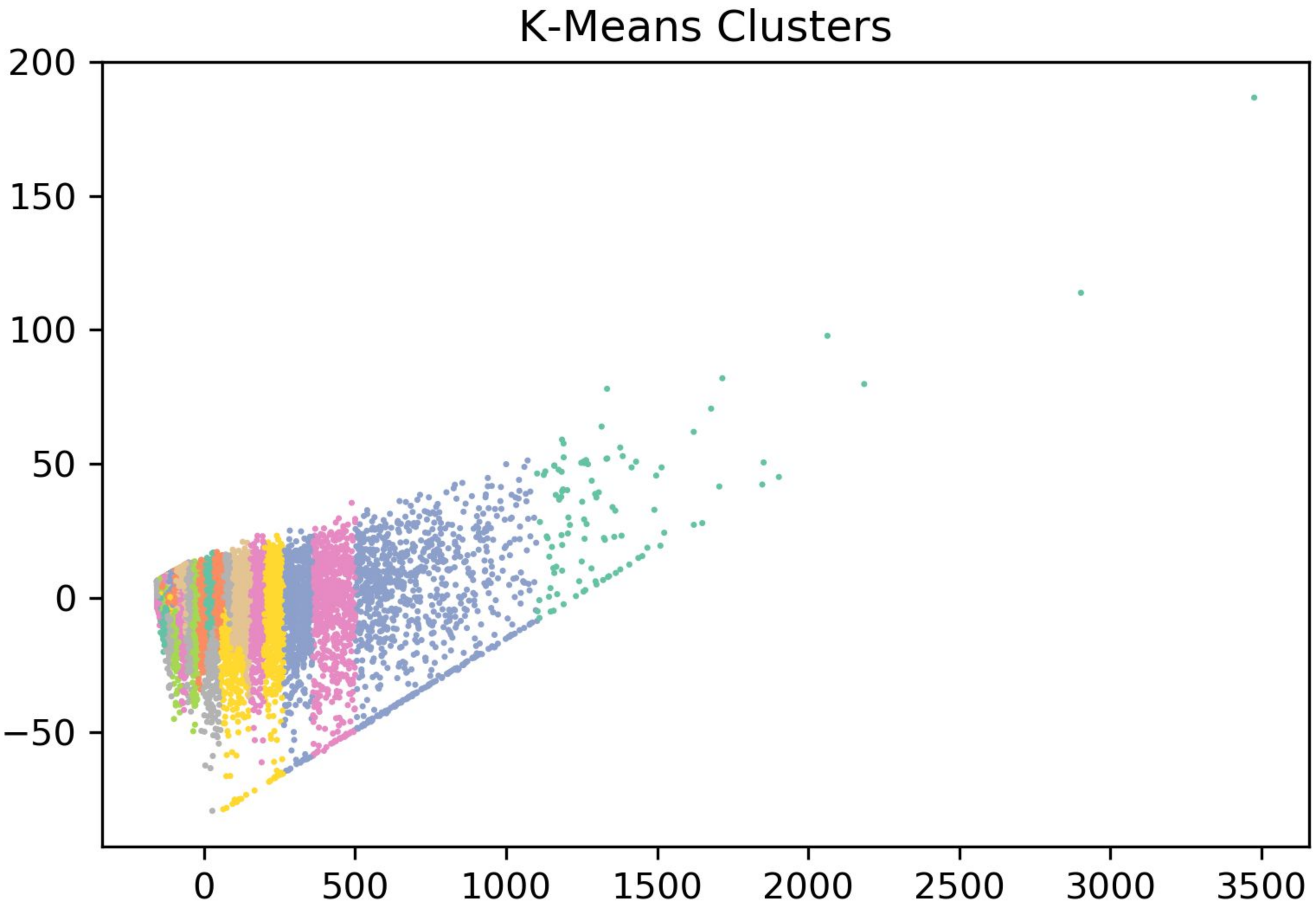
K-Means

Recommend: Popular Products in Each Group

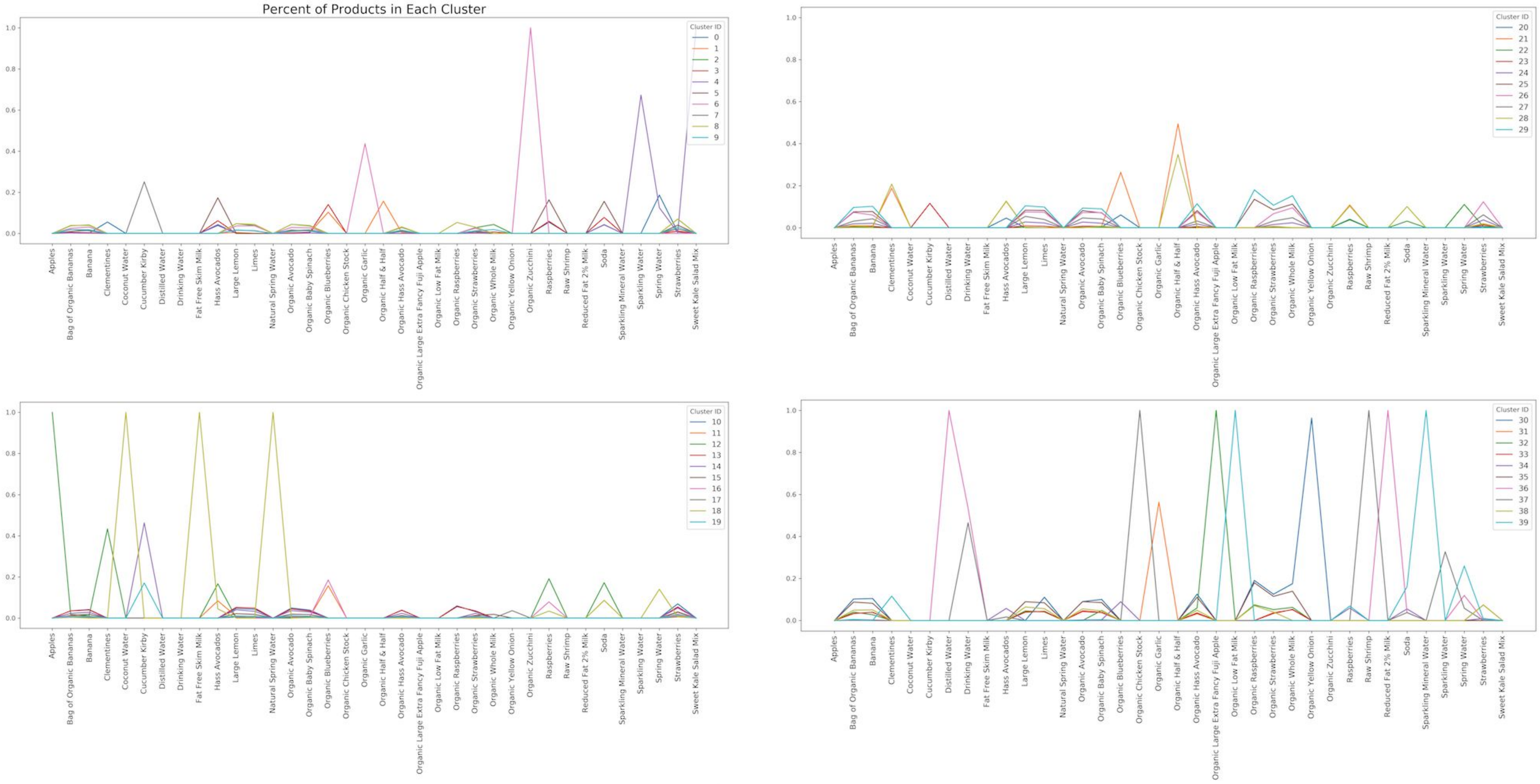


	product_name	user_id
0	Bag of Organic Bananas	183
1	Banana	97
2	Raspberries	84
3	Strawberries	81
4	Organic Baby Spinach	73
5	Organic Strawberries	69
6	Soda	67
7	Spring Water	64
8	Hass Avocados	59
9	Clementines	52

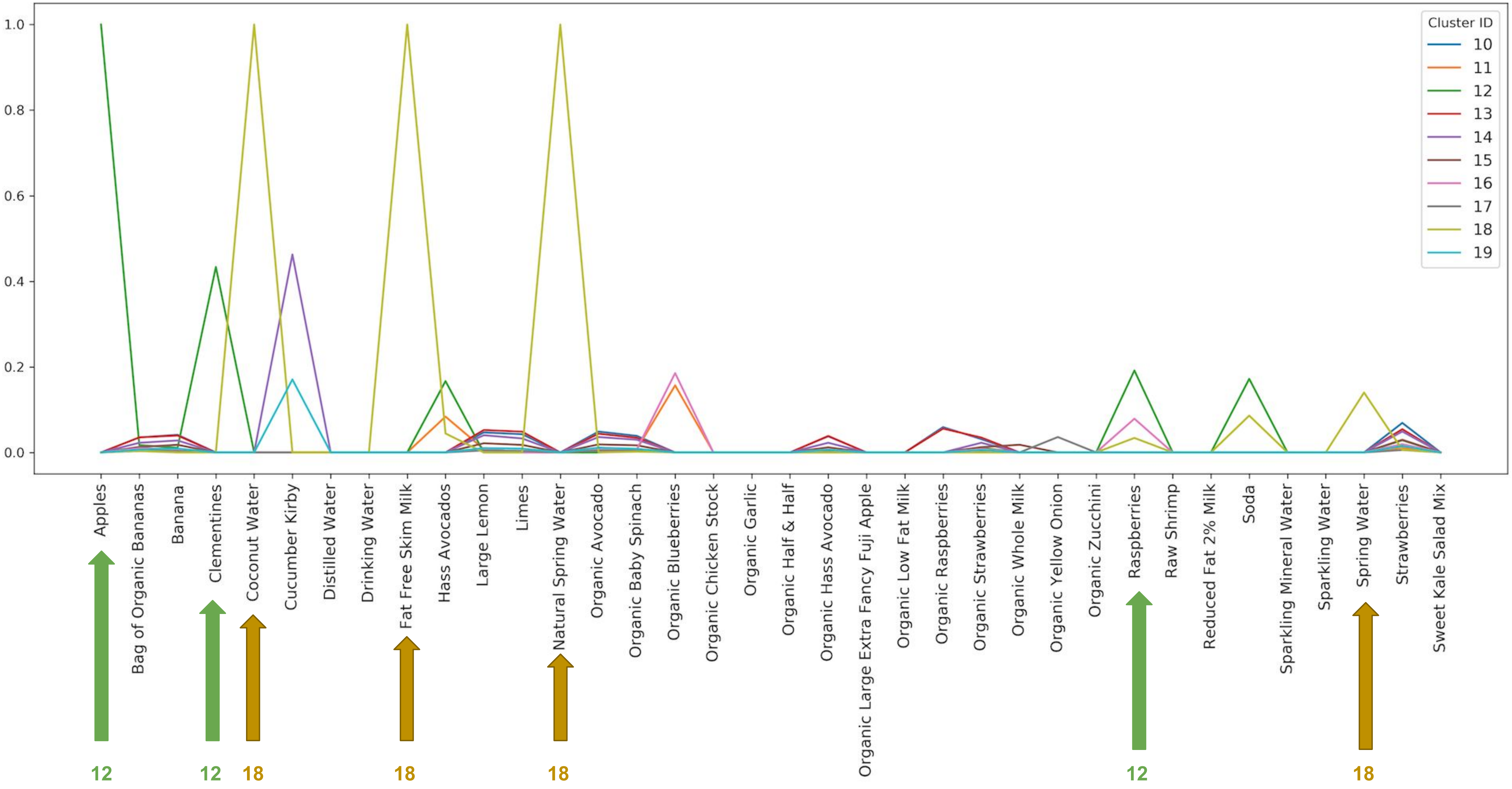
K-Means Visualization



Popular Products in Each Group



Popular Products in Cluster 10-19



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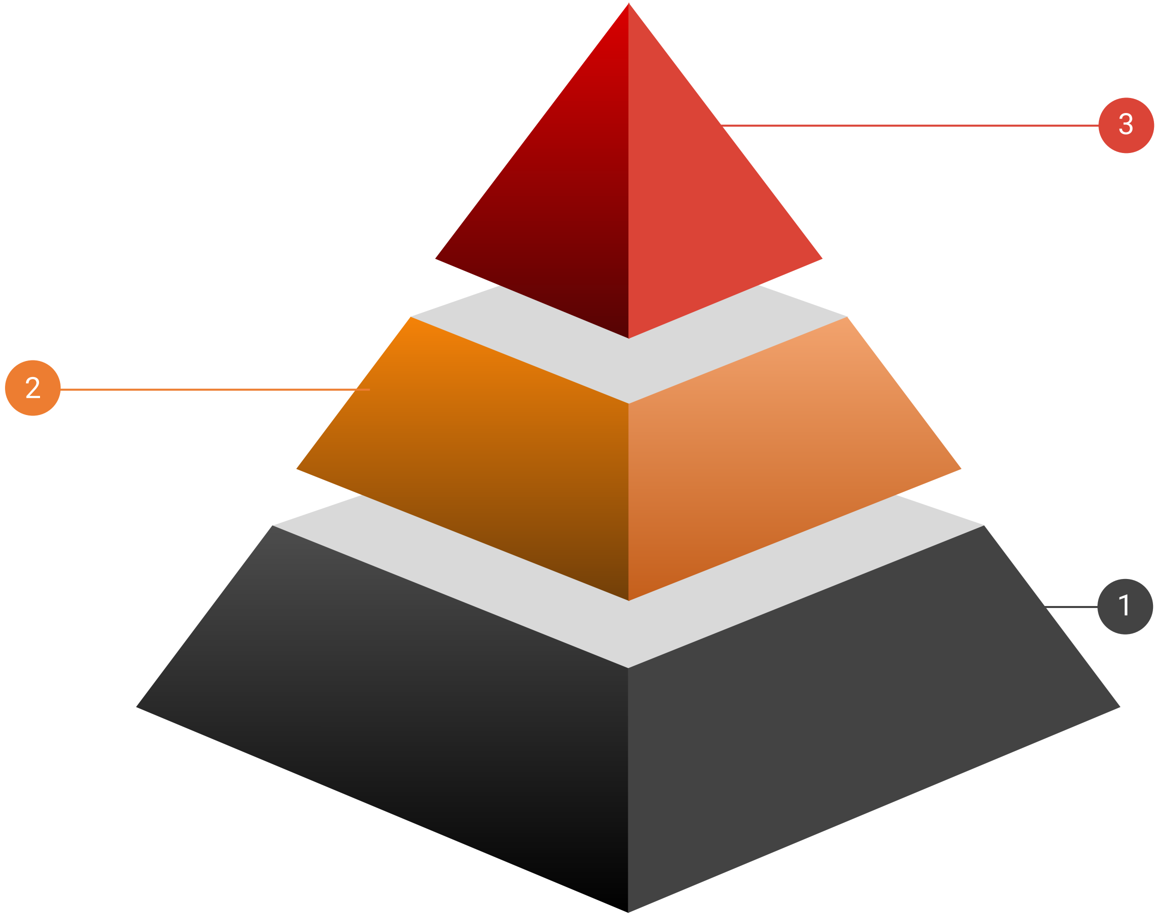
Recommendation Part II

- Recommend product bundles

Recommendation Product Bundles: Steps



Evaluation

Test Score: In each order, how many percent of products bought are from our recommendation list?

Recommendation List

Frequency + Randomness

Frequently Bought Together?

Bi-gram + Frequency

Bi-grams

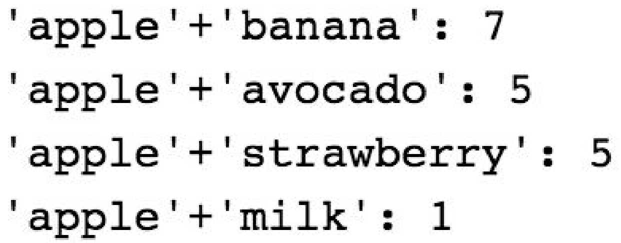
Popular Bundles:

```
Organic_Hass_Avocado  +  Bag_of_Organic_Bananas :  26
Banana  +  Organic_Avocado :  36
Banana  +  Organic_Fuji_Apple :  25
Banana  +  Honeycrisp_Apple :  23
Banana  +  Organic_Strawberries :  27
Bag_of_Organic_Bananas  +  Organic_Strawberries :  31
Bag_of_Organic_Bananas  +  Organic_Hass_Avocado :  30
Bag_of_Organic_Bananas  +  Organic_Baby_Spinach :  23
Organic_Avocado  +  Banana :  22
Large_Lemon  +  Limes :  24
```

Generate Recommendation List

1. Sort bi-gram frequencies

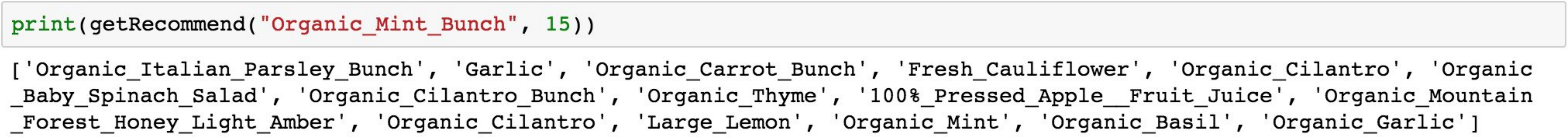
For example, if we have {'apple': {'strawberry': 5, 'avocado':5, 'banana': 7, 'milk': 1}}, it will be sorted as



```
'apple'+'banana': 7
'apple'+'avocado': 5
'apple'+'strawberry': 5
'apple'+'milk': 1
```

2. Specify number of recommendation k

- k = 3 : banana, avocado, strawberry
- k = 2 : banana + randomly pick one in {avocado, strawberry}
- k > 4 : all four + new recommendation of ‘banana’



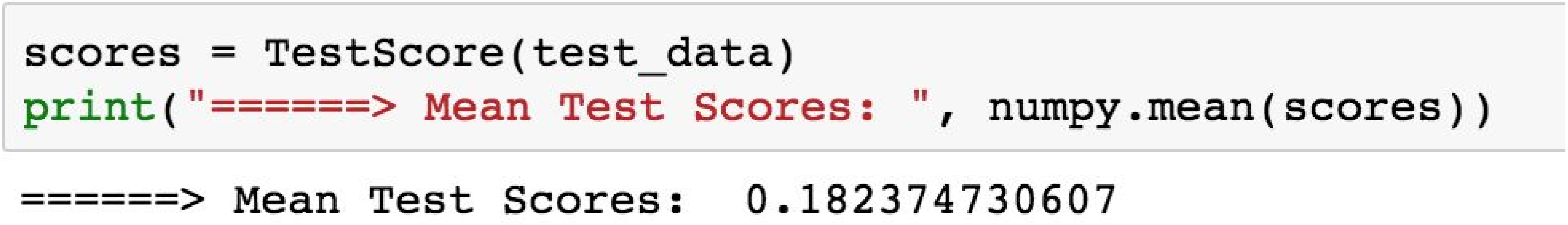
```
print(getRecommend("Organic_Mint_Bunch", 15))
```

```
['Organic_Italian_Parsley_Bunch', 'Garlic', 'Organic_Carrot_Bunch', 'Fresh_Cauliflower', 'Organic_Cilantro', 'Organic
_Baby_Spinach_Salad', 'Organic_Cilantro_Bunch', 'Organic_Thyme', '100%_Pressed_Apple__Fruit_Juice', 'Organic_Mountain
_Forest_Honey_Light_Amber', 'Organic_Cilantro', 'Large_Lemon', 'Organic_Mint', 'Organic_Basil', 'Organic_Garlic']
```

Evaluation

{ A Basket of Recommendation }

Score = right predictions / len(order)



```
scores = TestScore(test_data)
print("======> Mean Test Scores: ", numpy.mean(scores))
```

```
======> Mean Test Scores:  0.182374730607
```

Predictive Modeling

Feature Engineering

order_ratio_with_product

user_total_distinct_product

user_total_orders

user_average_items_per_cart

ratio_of_daysSincePriorOrder_avgDaysBetwOrders

15 Newly Added Features

product_total_reorder

length_between_orders

average_position_for_the_product

......

product_reorder_rate

user_total_unique_item

num_order_user_purchase_specific_product

user_product_hour

Algorithms

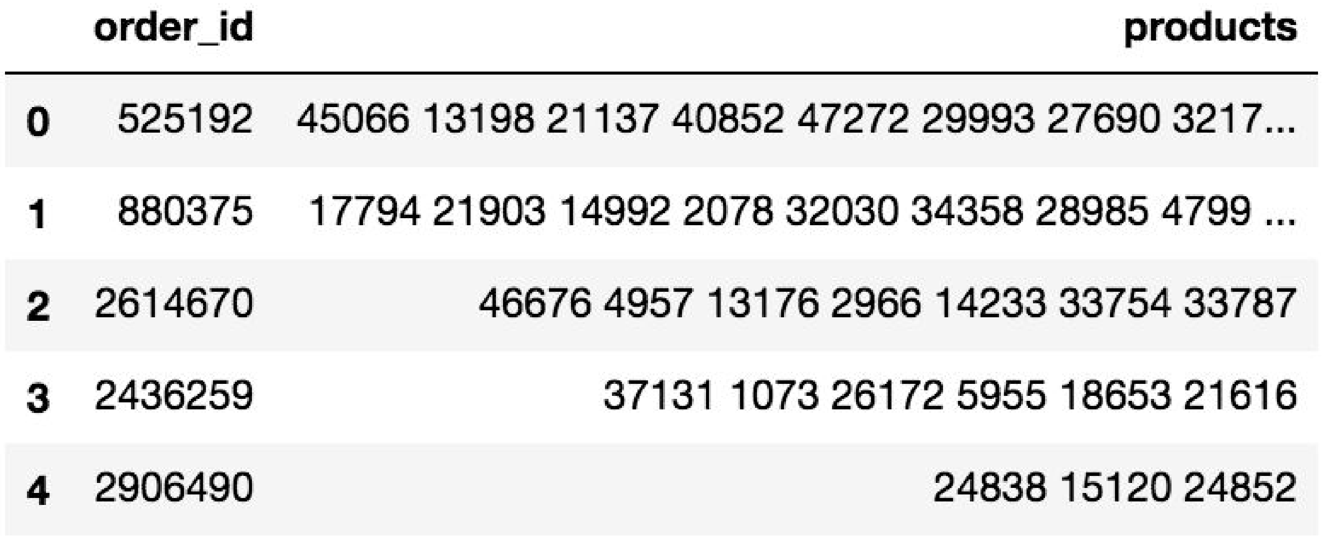
XGBoost, Light GBM

WHY?

- Faster training speed and higher efficiency
- Lower memory usage
- Better accuracy
- Parallel and GPU learning supported
- Capable of handling large-scale data

Reference: https://github.com/Microsoft/LightGBM

Desired Output

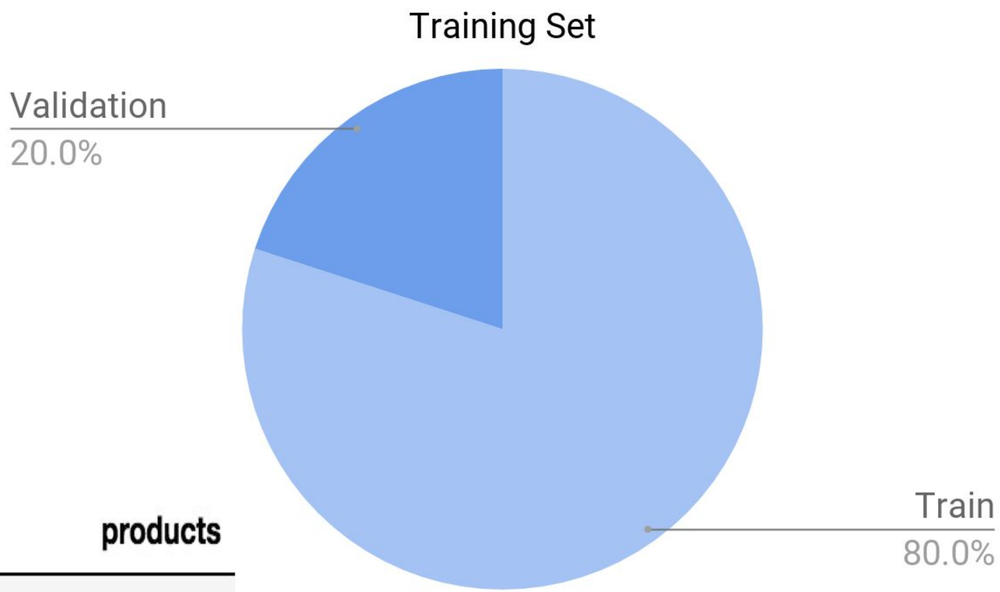


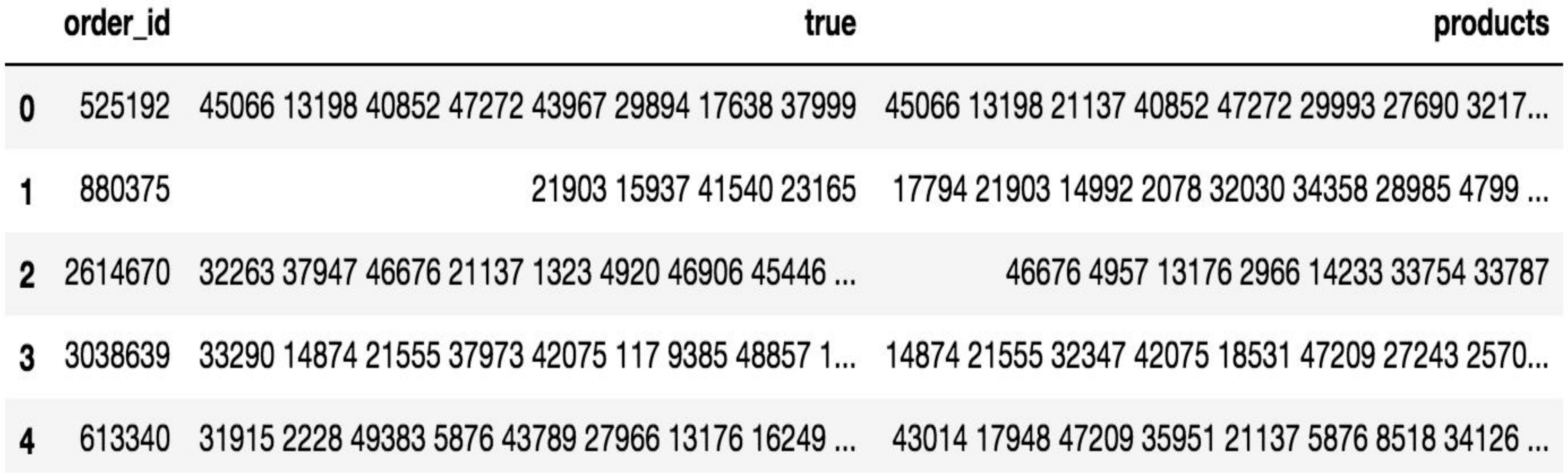
	order_id	products
0	525192	45066 13198 21137 40852 47272 29993 27690 3217...
1	880375	17794 21903 14992 2078 32030 34358 28985 4799 ...
2	2614670	46676 4957 13176 2966 14233 33754 33787
3	2436259	37131 1073 26172 5955 18653 21616
4	2906490	24838 15120 24852

What’s the **threshold probability** to select product into the corresponding order?

Threshold Probability

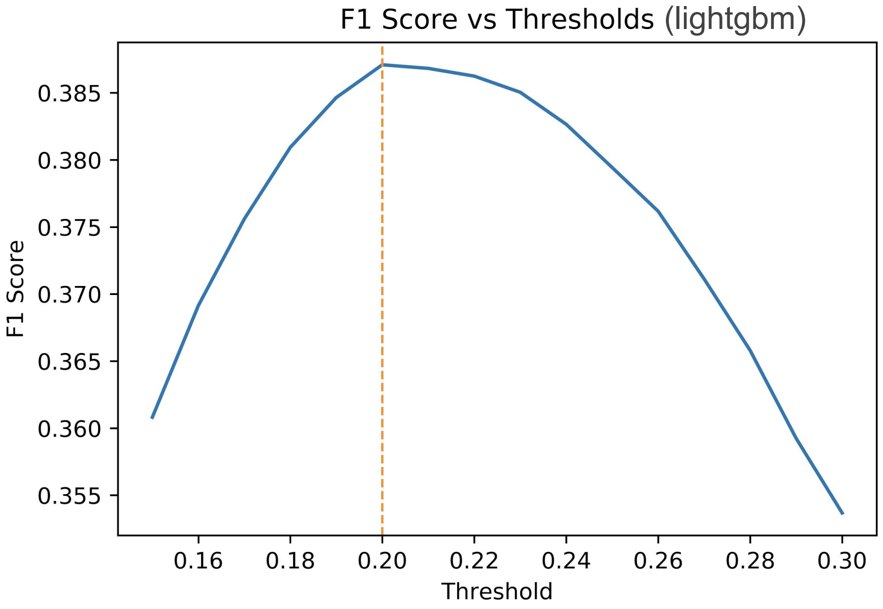
- Produce equivalent output with the train ground truth data.

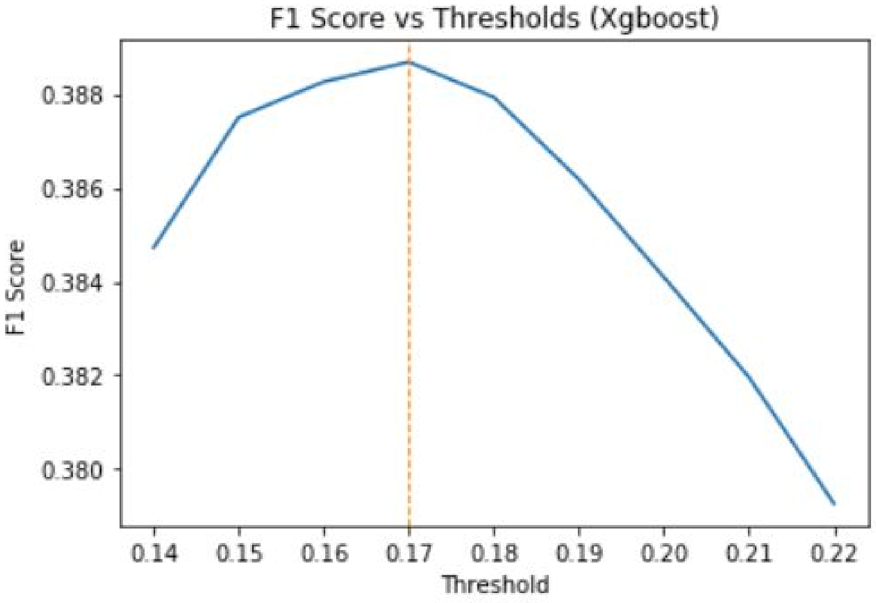




	order_id	true	products
0	525192	45066 13198 40852 47272 43967 29894 17638 37999	45066 13198 21137 40852 47272 29993 27690 3217...
1	880375	21903 15937 41540 23165	17794 21903 14992 2078 32030 34358 28985 4799 ...
2	2614670	32263 37947 46676 21137 1323 4920 46906 45446 ...	46676 4957 13176 2966 14233 33754 33787
3	3038639	33290 14874 21555 37973 42075 117 9385 48857 1...	14874 21555 32347 42075 18531 47209 27243 2570...
4	613340	31915 2228 49383 5876 43789 27966 13176 16249 ...	43014 17948 47209 35951 21137 5876 8518 34126 ...

Threshold Probability

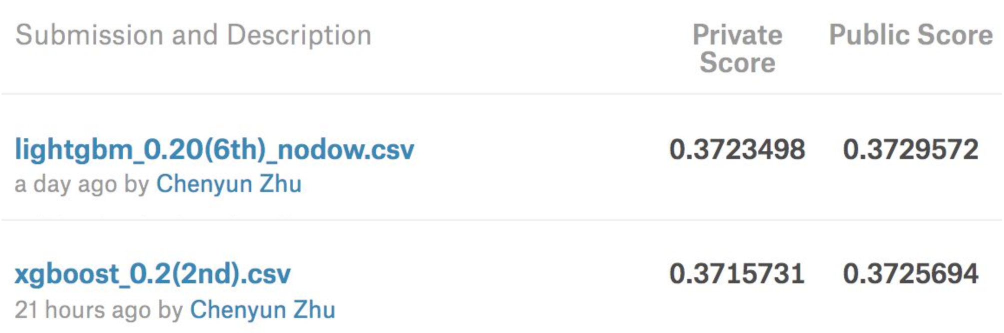




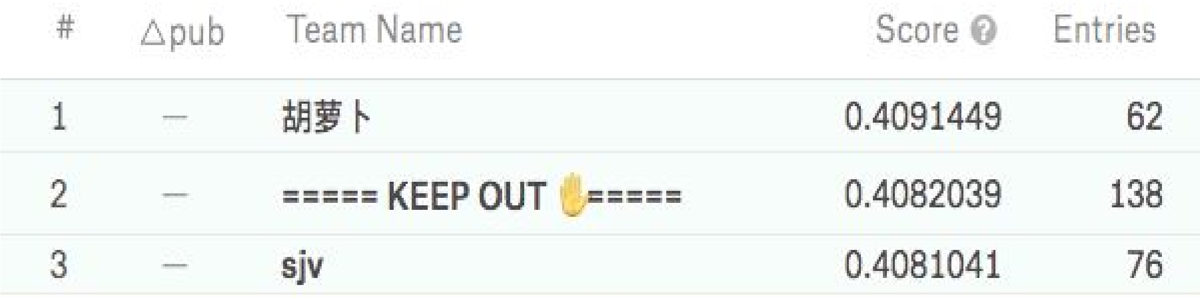
Results

Our Result	XGBoost	Light GBM
'Equivalent' Result	0.383	0.384
Kaggle Result	0.373	0.373

Our Scores vs Kaggle Highest Scores



Submission and Description	Private Score	Public Score
lightgbm_0.20(6th)_nodow.csv a day ago by Chenyun Zhu	0.3723498	0.3729572
xgboost_0.2(2nd).csv 21 hours ago by Chenyun Zhu	0.3715731	0.3725694



#	△pub	Team Name	Score	Entries
1	—	胡萝卜	0.4091449	62
2	—	===== KEEP OUT ✋=====	0.4082039	138
3	—	sjv	0.4081041	76

Next Steps

- Get more correlated features
- Systematically tuning the models to improve accuracy

Q & A?