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Instacart Market Basket Analysis

——Data Mining Final Project

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Introduction

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Dataset Description

File Name	Column Names
orders.csv	order_id,user_id,eval_set,order_number,order_dow,order_hour_of_day,days_since_prior_order
order_products__*.csv	order_id,product_id,add_to_cart_order,reordered
aisles.csv	aisle_id,aisle
departments.csv	department_id,department
products.csv	product_id,product_name,aisle_id,department_id

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Exploratory Data Analysis

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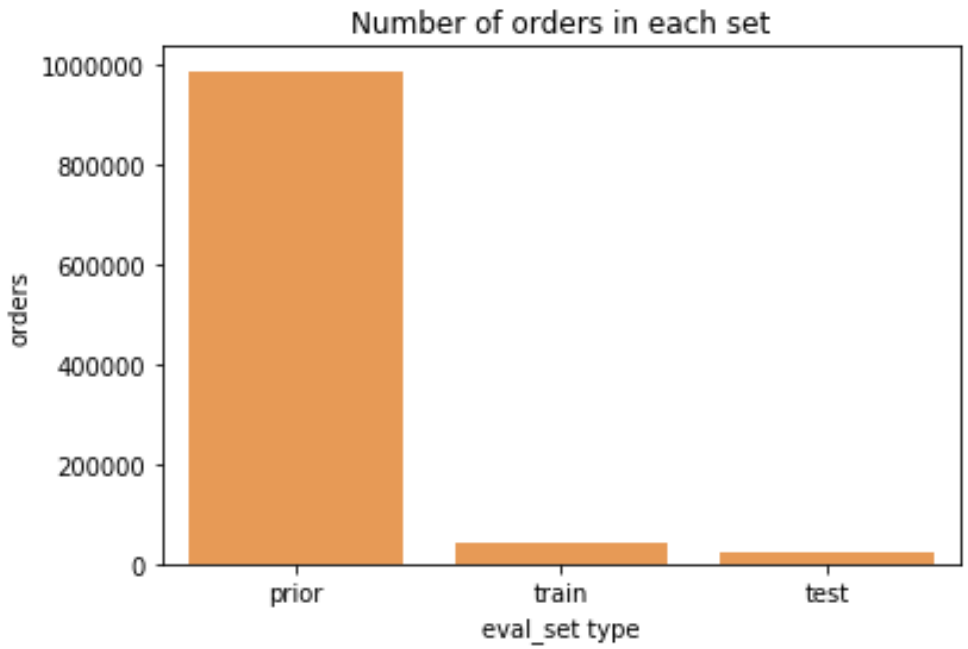
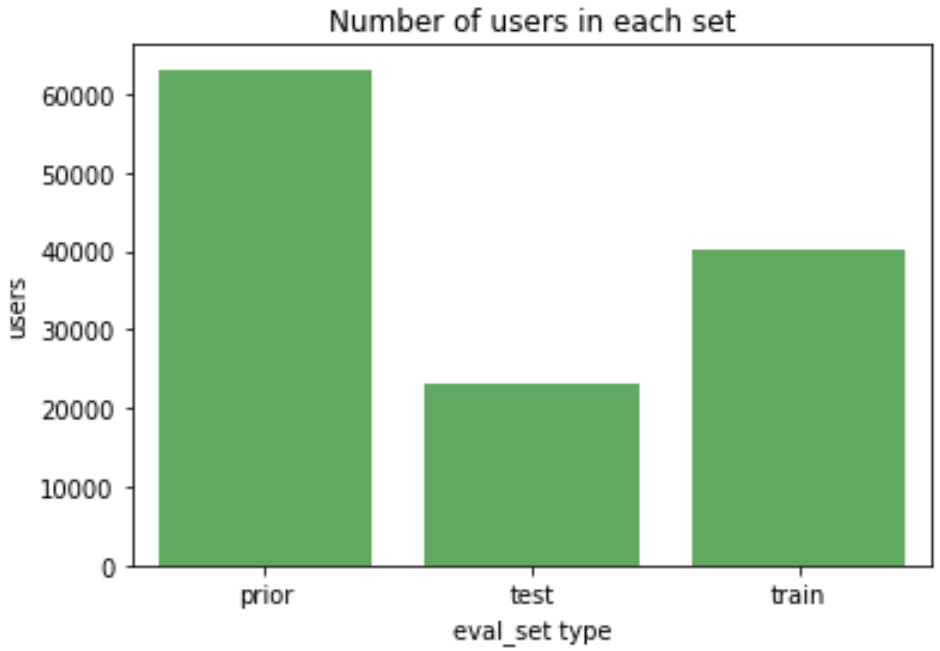
Orders Information

- Three sets.





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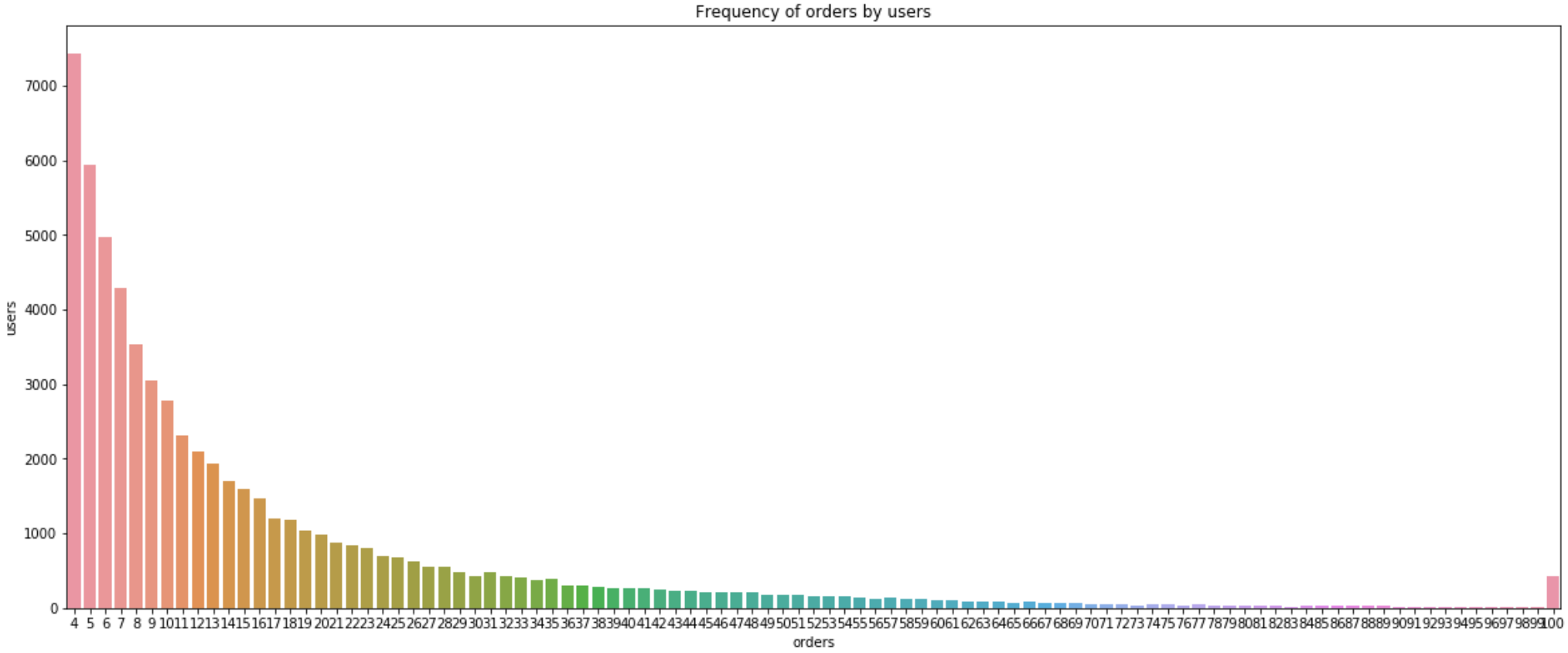
Orders Information

- Frequency of orders



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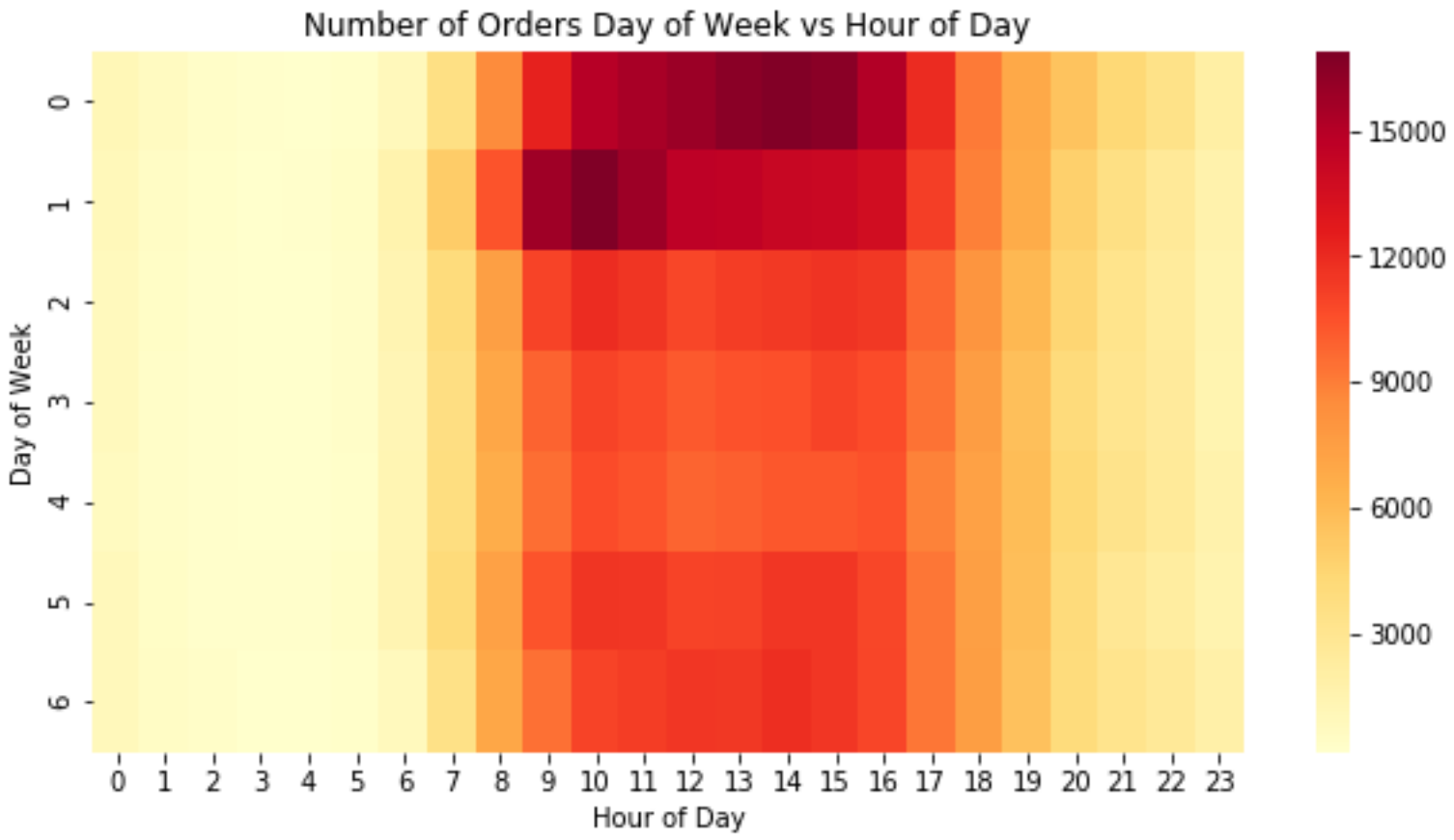
Orders Information

- Times of orders



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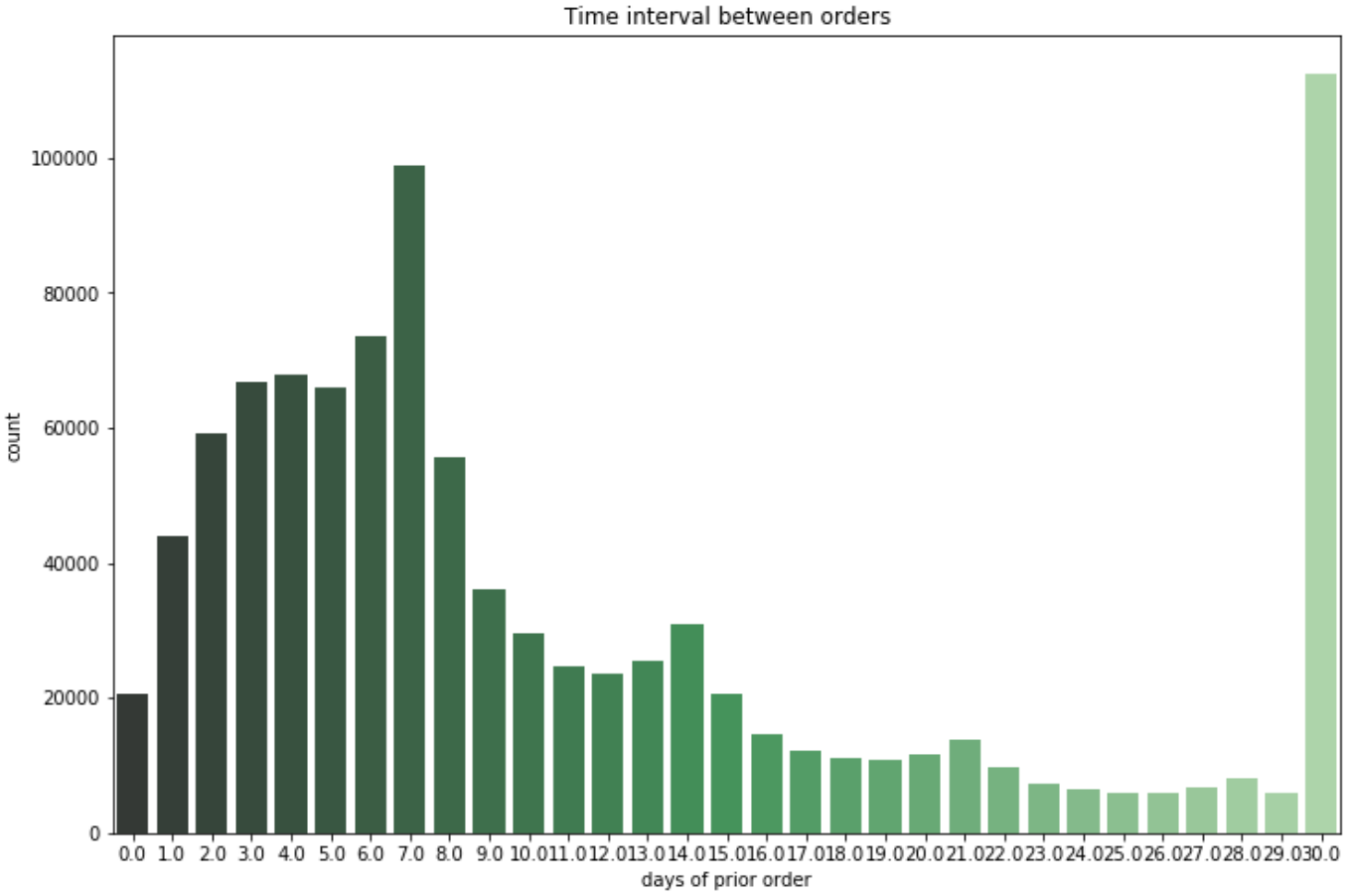
Orders Information

- Times of orders



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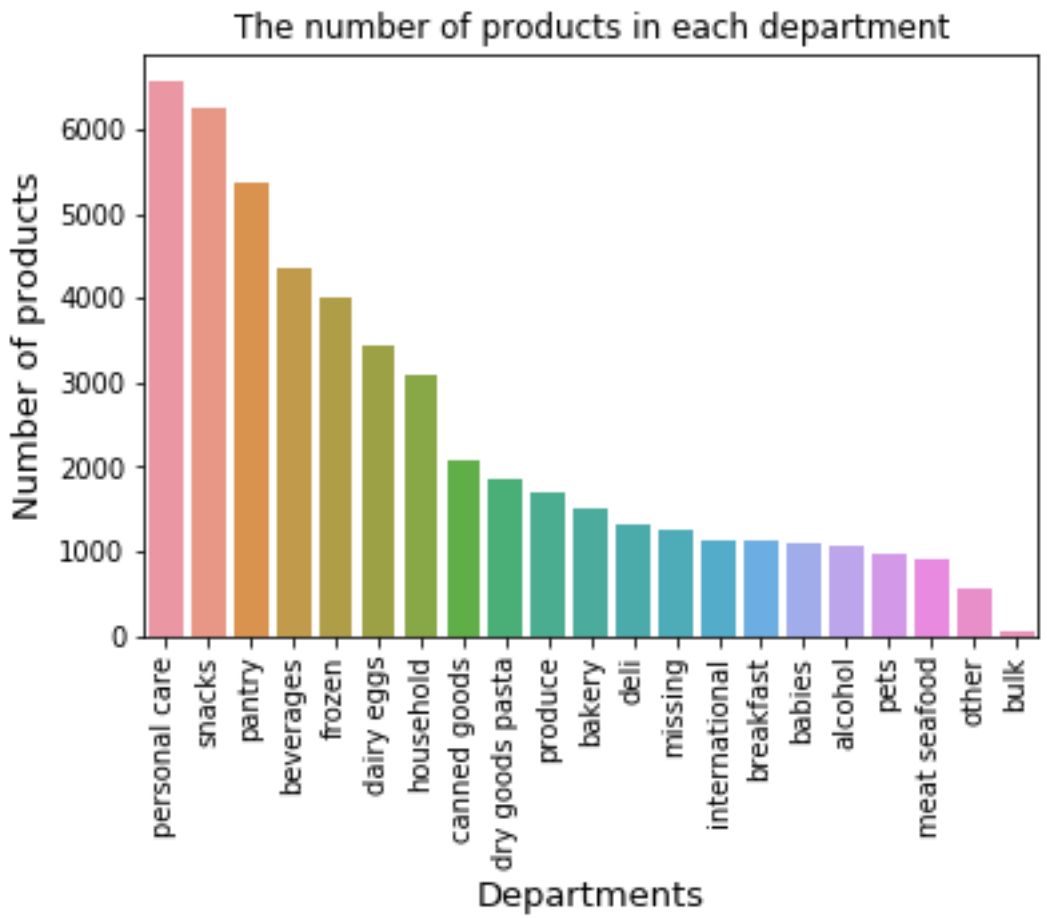
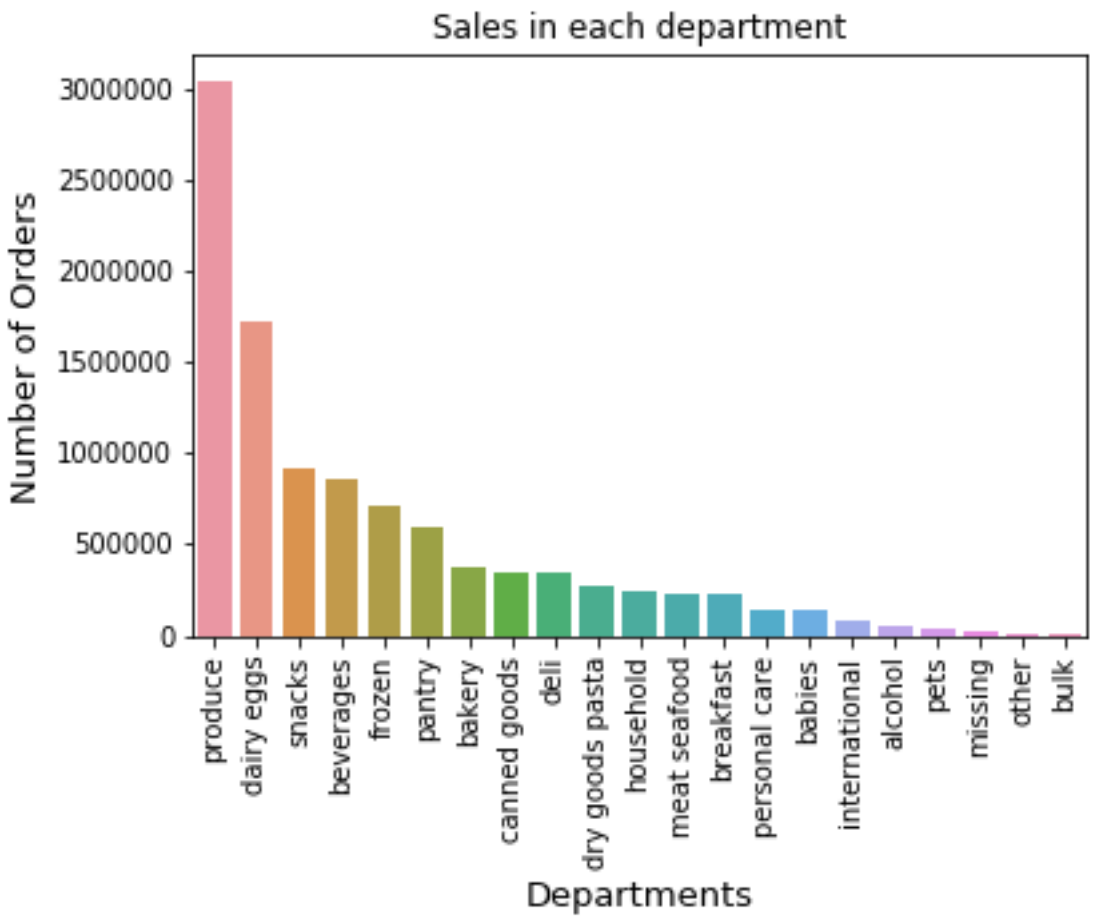
Product Information

- Products and Sales





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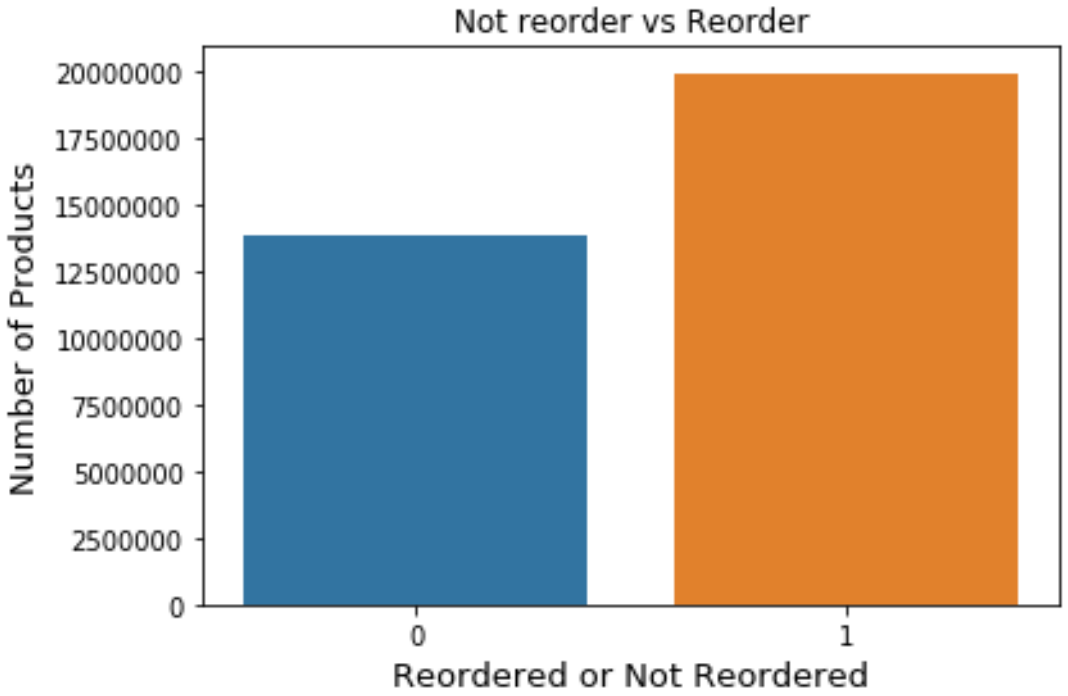
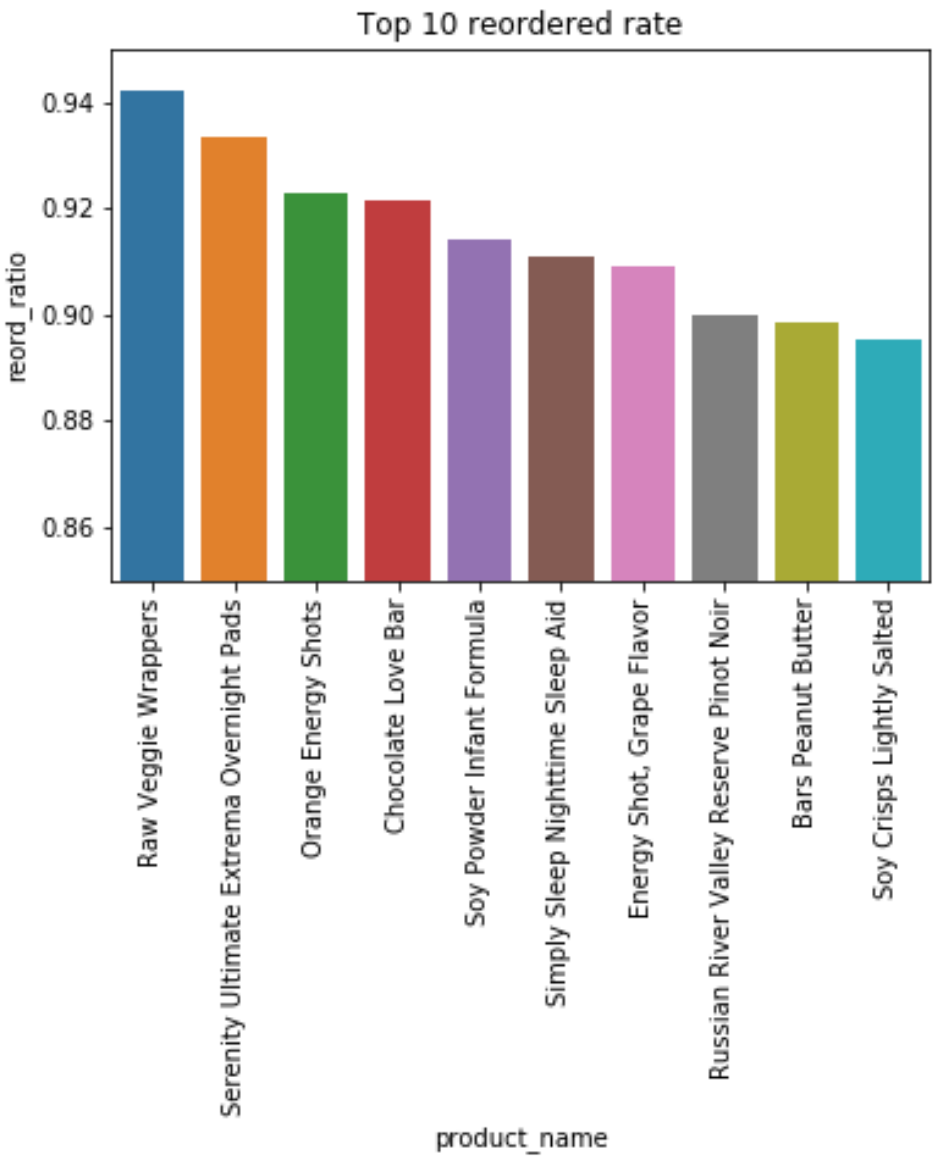
Product Information

- Reordered products





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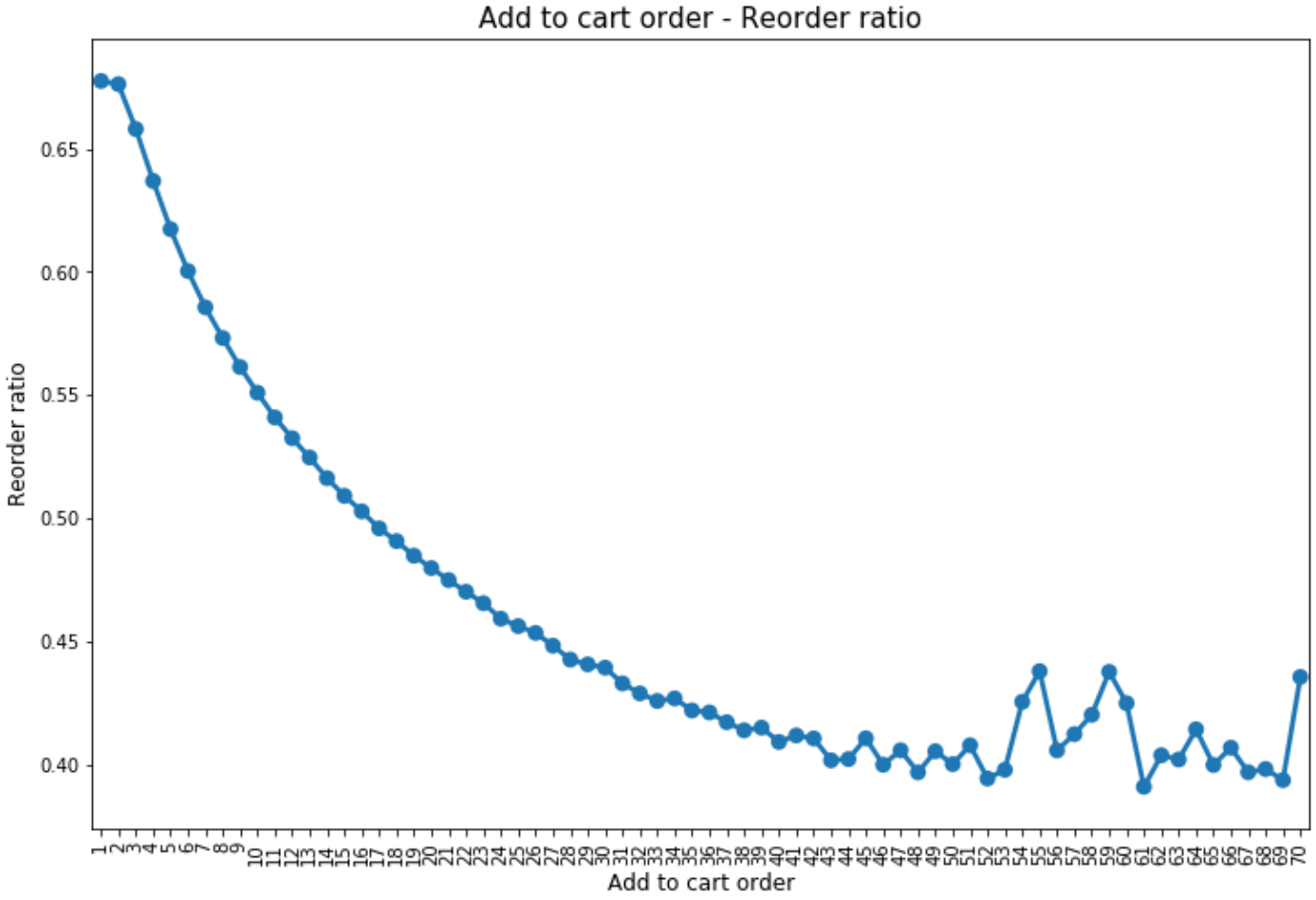
Product Information

- Add to cart-reorder ratio



GOAL: PREDICT WHICH PREVIOUSLY PURCHASED PRODUCTS WILL BE IN A USER'S NEXT ORDER

0 MEANS WILL NOT BUY, 1 MEANS WILL BUY

14 FEATURES WE CREATED

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Data Preprocessing

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Data Preprocessing

- Almost no missing value
- except for `days_since_prior_order` in orders.csv
  - 1048575 missing values
  - means these orders are first ordered by the user.
- replace NaN with -1 to indicate that it is a different level.

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Feature Engineering

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FEATURE SELECTION

User Features

Product Features

User and Product Features

USER FEATURES

n_orders_users

The number of orders for each user

n_productss_users

The number of products for each user

avg_products_users

Average number of products per user ordered

dow_most_user

The day on which each user ordered most frequently

times_h

The time of a day on which each user ordered most frequently

reorder_ratio_user

Reordered ratio per user

shopping_freq

Shopping frequency for each user

USER FEATURES

	user_id	n_orders_users	n_products_users	avg_products_users	dow_most_user	hod_most_user	reorder_ratio_user	shopping_freq
0	1	10	59	5.900000	4	7	0.694915	17.600000
1	2	14	195	13.928571	2	9	0.476923	14.142857
2	3	12	88	7.333333	0	16	0.625000	11.083333
3	4	5	18	3.600000	4	15	0.055556	11.000000
4	5	4	37	9.250000	3	18	0.378378	10.000000

We combine all the user features above into a new data frame. ‘user_id’ is the key variable in this data frame.

PRODUCT FEATURES

times_bought_prod

Ordering frequency for each product.

reorder_ratio_prod

Reordered ratio for each product.

position_cart_prod

Average sequence in the cart for each product.

reorder_ratio_prod

Reordered ratio for each department

PRODUCT FEATURES

	product_id	times_bought_prod	reorder_ratio_prod	position_cart_prod	department_id	reorder_ratio_dept
0	1	1852	0.613391	5.801836	19	0.438319
1	2	90	0.133333	9.888889	13	0.242846
2	3	277	0.732852	6.415162	7	0.471714
3	4	329	0.446809	9.507599	1	0.418642
4	5	15	0.600000	6.466667	13	0.242846

Next, we merged these product features together. ‘product_id’ is the key variable in this data frame.

USER & PRODUCT FEATURES

times_bought_up

Times of each product bought by each user.

reorder_ratio_up

The ratio at which each product is reordered by each user.

ratio_last4_orders_up

The ratio of each product bought in each user's last four orders

USER & PRODUCT FEATURES

	user_id	product_id	times_bought_up	reorder_ratio_up	ratio_last4_orders_up
0	1	196	10	1.000000	1.0
1	1	10258	9	1.000000	1.0
2	1	10326	1	0.166667	NaN
3	1	12427	10	1.000000	1.0
4	1	13032	3	0.333333	0.5

Next, we merged these new features we just created

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Get Features and Target

Features

Target

	user_id	product_id	times_bought_up	reorder_ratio_up	ratio_last4_orders_up	n_orders_users	n_products_users	avg_products_users	dow_most_user	hod_most_user	reorder_ratio_user	shopping_freq	times_bought_prod	reorder_ratio_prod	position_cart_prod	reorder_ratio_dept	reordered
0	1	196	10	1.000000	1.00	10	59	5.900000	4	7	0.694915	20.259259	35791	0.776480	3.721774	0.471714	1.0
1	1	10258	9	1.000000	1.00	10	59	5.900000	4	7	0.694915	20.259259	1946	0.713772	4.277492	0.438319	1.0
2	1	10326	1	0.166667	0.00	10	59	5.900000	4	7	0.694915	20.259259	5526	0.652009	4.191097	0.412660	0.0
3	1	12427	10	1.000000	1.00	10	59	5.900000	4	7	0.694915	20.259259	6476	0.740735	4.760037	0.438319	0.0
4	1	13032	3	0.333333	0.50	10	59	5.900000	4	7	0.694915	20.259259	3751	0.657158	5.622767	0.466878	1.0
5	1	13176	2	0.222222	0.00	10	59	5.900000	4	7	0.694915	20.259259	379450	0.832555	5.095947	0.412660	0.0
6	1	14084	1	0.100000	0.00	10	59	5.900000	4	7	0.694915	20.259259	15935	0.810982	5.792595	0.505622	0.0
7	1	17122	1	0.166667	0.00	10	59	5.900000	4	7	0.694915	20.259259	13880	0.675576	6.257421	0.412660	0.0
8	1	25133	8	1.000000	1.00	10	59	5.900000	4	7	0.694915	20.259259	6196	0.740155	7.001614	0.505622	1.0
9	1	26088	2	0.200000	0.00	10	59	5.900000	4	7	0.694915	20.259259	2523	0.539041	6.495838	0.438319	1.0
10	1	26405	2	0.200000	0.00	10	59	5.900000	4	7	0.694915	20.259259	1214	0.441516	3.116969	0.250641	1.0

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Model Development and Evaluation

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A Problem Happens

- When developing logistic regression, we found that the model accuracy is high, but the confusion matrix shows it is not a good model.

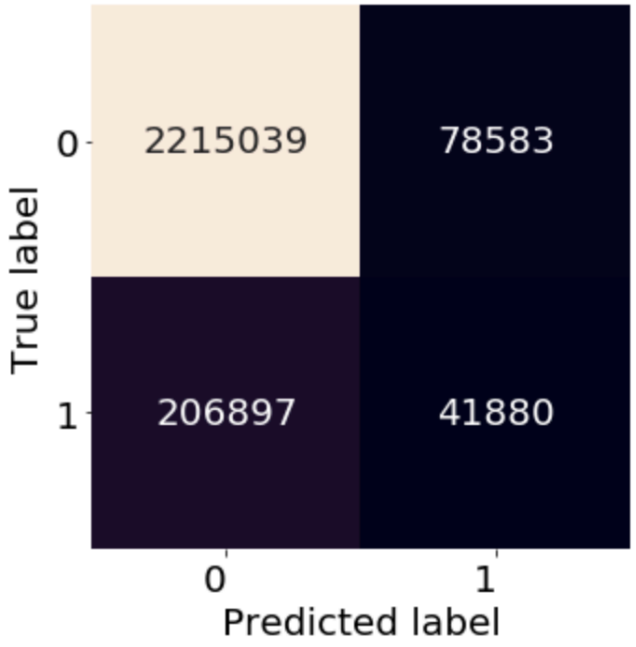
```
Classification Report:
              precision    recall  f1-score   support

         0.0       0.91      0.99      0.95   1529168
         1.0       0.62      0.11      0.19    165765

    accuracy                           0.91   1694933
   macro avg       0.77      0.55      0.57   1694933
weighted avg       0.88      0.91      0.88   1694933


Accuracy :  90.6327860747298


ROC_AUC :  79.50233767175897
```



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Oversampling

- Target ‘reordered’ is a binary variable. Level 0 accounts for 90%, while level 1 only accounts for 10%.
- Even without modeling, we can have 90% accuracy.

target	frequency
0	2,334,883
1	253,930

target	frequency
0	2,334,883
1	2,334,883

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Train and Test Split

- Data shape (4669766, 15)

- Train dataset 70%, test dataset 30%

- Train dataset shape (3268836, 15)
- Test dataset shape (1400930, 15)

- We use train dataset to train the model, and test dataset to predict.

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Logistic Regression

- Misclassification rate = $\frac{False\ Positives + False\ Negatives}{Total\ instances} = \frac{172213+231781}{1400930}$ = 28.84%.

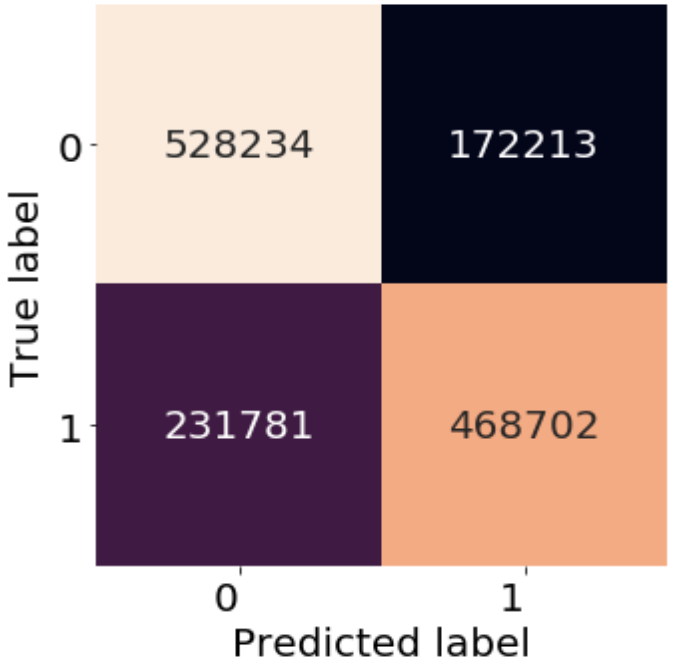
```
Classification Report:
              precision    recall  f1-score   support

         0.0       0.70      0.75      0.72    700447
         1.0       0.73      0.67      0.70    700483

    accuracy                           0.71   1400930
   macro avg       0.71      0.71      0.71   1400930
weighted avg       0.71      0.71      0.71   1400930


Accuracy :  71.16244209203886


ROC_AUC :  77.71164554475179
```



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K-Nearest-Neighbor

- K = 3
- Misclassification rate = 9.99%.

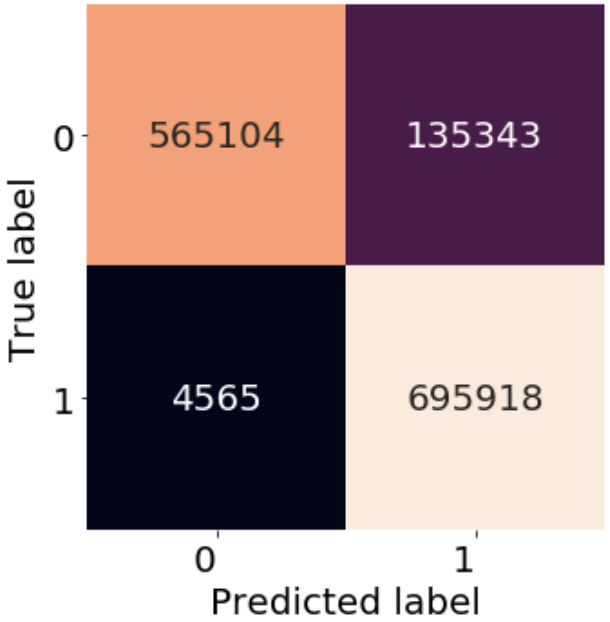
```
Classification Report:
              precision    recall  f1-score   support

         0.0       0.99      0.81      0.89    700447
         1.0       0.84      0.99      0.91    700483

    accuracy                           0.90   1400930
   macro avg       0.91      0.90      0.90   1400930
weighted avg       0.91      0.90      0.90   1400930


Accuracy :  90.01320551348033


ROC_AUC :  99.97228979749896
```



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Random Forest

- n_estimators=100
- Misclassification rate = 2.06%.

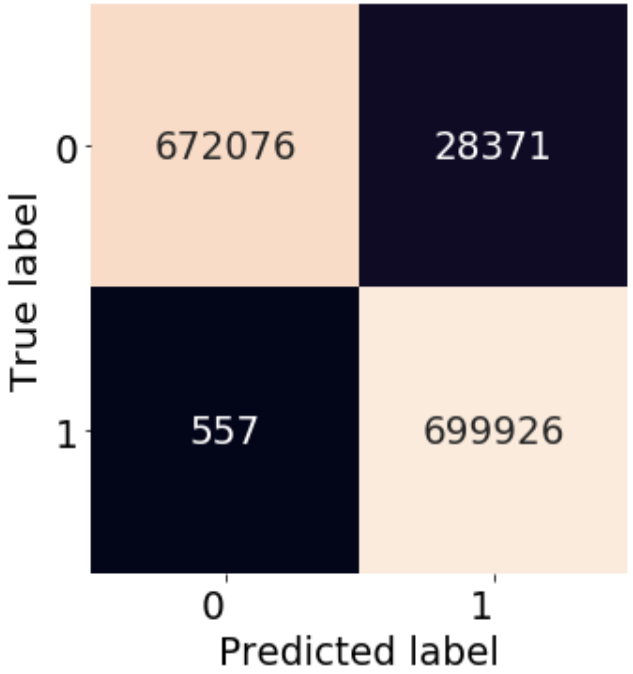
```
Classification Report:
              precision    recall  f1-score   support

         0.0       1.00      0.96      0.98    700447
         1.0       0.96      1.00      0.98    700483

    accuracy                           0.98   1400930
   macro avg       0.98      0.98      0.98   1400930
weighted avg       0.98      0.98      0.98   1400930


Accuracy :  97.93508597859993


ROC_AUC :  99.97318652685728
```



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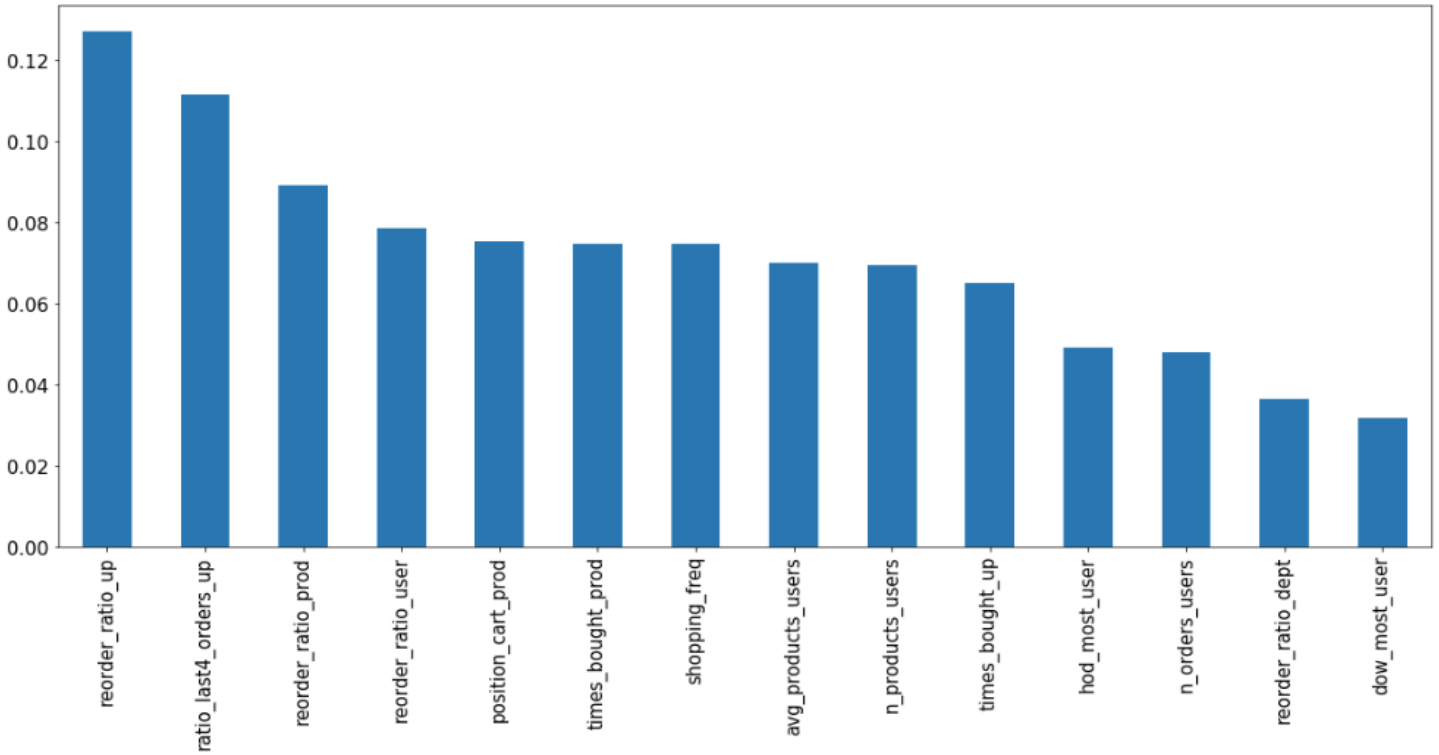
Random Forest

- Feature importance plot



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06

Summary

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Summary

Goal

- Predict whether a user will buy a product in the next order.

Process

- We create 14 features and merge them all into one dataset.
- Then, we use oversampling to deal with the imbalance of the dataset.
- After splitting train and test dataset, we train logistic regression, KNN, random forest and other classifiers.

Improvements

- Hyperparameter tuning
- Gradient Boosting

Thanks for listening