Planogram Optimization

Finding optimal product placement on shelf

Team: Ella (Yanhan) Liu, Yijia Yang
Advisor: Stephen C. Graves

Problem Statement

In the retail industry, placement of products plays an important role in affecting the profit. The products at the center of modular, for instance, are more likely to be purchased by customers.

Project Goal

1. Study the location-sales relationship
2. Build an optimization algorithm that maximizes sales

Data Description

Scope

1 Product Category: Dog Treats

↓

7 Product Groups: Biscuits, Meat...

Sales Data

- 4000+ stores & 300+ products
- Time span: 12/01/19 - 02/15/20
- Aggregated over time per store

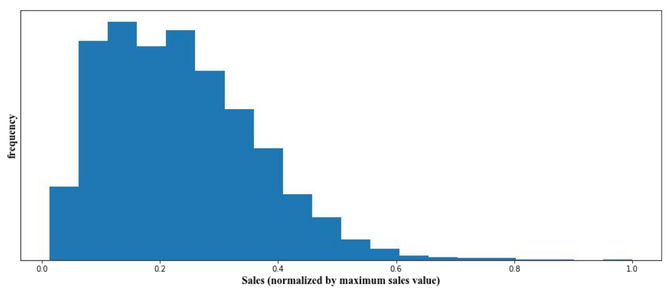


Figure 1 Distribution for store category sales

Location Data

- (x, y) location on modular
- Bottom left point is (0, 0)
- Normalized by modular size

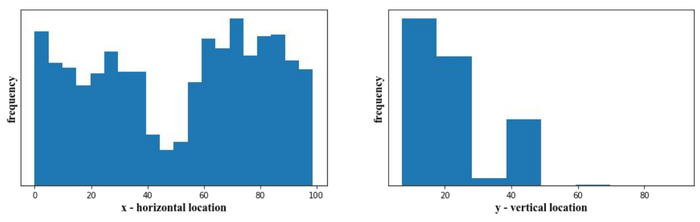


Figure 2 Distribution of historical locations for one group

Additional Data

Store-related:
- Size
- Location
- Demographic…

Product-related:
- Price
- Flavor
- Height…

Location-sales Analysis

Steps Store Effect → Location Effect → Optimization

Store Effect

1. Sales of a product could be strongly influenced by which store it is at
2. Need to account for store effect before studying location-sales relationship

Store Category Sales → Store-related Features

Location Effect*

1. Build one model per product group per modular size
2. Use the predicted values for dog treats category sales as a predictor to account for the store effect

Quantity Sold → Store Effect, Product-related Features, Transformed (x, y)

Group	Biscuits
x form	x^2+x
y form	y^2+y

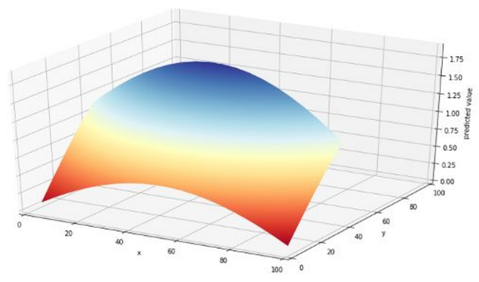


Figure 3 3-D illustration of location effect

**Possible qualification: location data not evenly distributed.*

Optimization

Based on the insights from location-sales analysis, an optimization formulation has been created to generate the product placement on planogram that maximizes sales.

Idea

The planogram is broken down into small blocks, and assign each block to some product group.

Objective

maximize expected sales

+

rewards if blocks of the same group stay close

Key Decision Variables

$z_{i,k} \in \{0,1\}$ 1 if block i is assigned to product group k

$e_{i,j} \in \{0,1\}$ 1 if block i and block j are near each other and assigned to the same group

Constraints

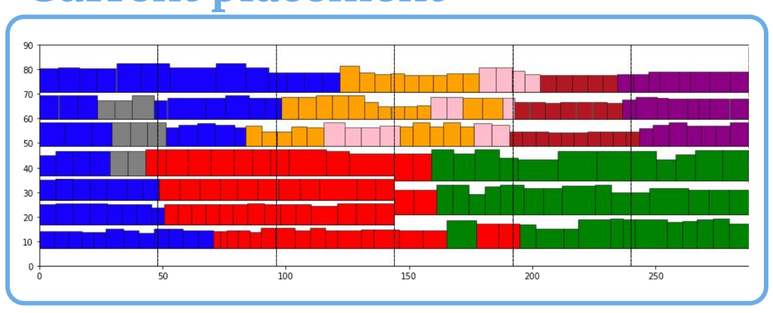
- Each block assigned to exactly one group
- Each group gets enough space
- Groups are in contiguous shape
- Exclude assignment to extremely uncommon locations

Results

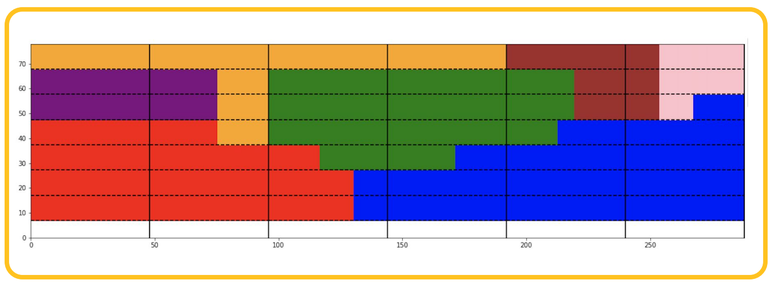
Results have been generated for 10 different sizes of planograms in Dog Treats category. Here is an example.

BISCUITS, DENTAL TREATS, HERO GREENIES, HERO PREMIUM, NATURAL MEAT, PREMIUM BISCUITS, SOFT & CHEWY

Current placement



Our recommendation



6%

Sales Uplift

In this example, by changing from current placement to our recommendation, we expect an overall uplift of 6% in sales

Conclusion

Different planograms with different sizes have different expected sales uplift. In general, the numbers range from 2% to 10%.
While the numbers are just rough estimations, they are good signs showing that there is a great potential that the produced recommendation will lead to increase in sales.
In the case of Walmart especially, the world's largest retailer, the numbers already indicate huge real world impacts.

Future Works

1. Add additional constraints
2. Generate results for more product categories
3. Improve modeling accuracy through experimentation and learning