What Products Should Be Displayed?  
Double Assortment Optimization

Problem Statement

Zara is the largest global apparel retailer specializing in women's fashion. With many women products introduced every season, the key decision in their business model is what items to display on the floor for customers to explore. We construct an optimization to provide the revenue-maximizing assortment decision.

Impact

The optimization is data-driven and serves as a decision-aid tool for Zara:
1. Maximize total retail revenue
2. Re-display which Backroom Items
3. Remove which Existing Items
4. Personalized store-wise decision
5. Run twice a week

Business Impact:
Increase revenue by 6.5% (test on 2 stores from Nov 1, 2018 - Nov. 4, 2018)

Business Context

Assortment Rule:
- Store floor has limited capacity
- Newly arrived items have to be displayed
- Backroom items could be re-displayed to floor
- Existing items could be removed to backroom to give space

Data Pre-processing

Problem Definition

- April
- Data Scope
  - Women's fashion, 2018 winter campaign
  - Worldwide Top 10 largest stores
  - Half-week granularity
- Result Scope
  - Two stores: one US, one German
- Time: Nov. 1, 2018 - Nov. 4, 2018

Data Acquisition & Preprocessing

May

- Merge Sales, Stock
- Data Preprocess

Demand Prediction Model

June

- Features
  - Historical Sales
  - Product Characteristics
  - Stocks, etc.

Demand Prediction Framework

June - Aug

- Random Forest
- Prediction

Double Assortment (Bi-level) Optimization

Upper Level Assortment

Zara Headquarters
- Re-display which backroom items
- Maximize revenue of existing & re-displayed items
- New arrivals have to be displayed

Lower Level Assortment

Zara Stores
- Remove which existing items
- Maximize revenue of existing items
- Remove enough items
- Keep # items in each product line the same

Demand Prediction

- How Zara Stores decide what existing items to remove?
  - Higher Accumulated Sales
  - Higher Probability of Being Kept on Floor (Not removed)

Bounded Rationality (Suboptimal Zara Stores)

Extent of bounded rationality ($\beta$): higher $\beta$, more suboptimal decision

Bi-level with BR

- Makes re-display decisions considering Zara Stores' BR

BR Myopic Algorithm

- Minics Zara Stores' removal decisions given new arrivals & re-display orders
- Add Constraint in Lower Level of Optimization
- Existing Items with 'probability of being kept' greater than a threshold cannot be removed
- Initialize: Remove all existing Items
- Each Iteration: Display one existing item according to 'probability of being kept' (discrete random variable sampling)
- Terminate: Enough items are removed

Double assortment optimization & 3 scenarios of Implementation

Most Improvement +6.5%*

Zara Headquarters and Zara Stores both adopt optimization recommendation
1. Bi-level optimization without BR
   - Get optimized re-display decisions
2. Calculate total forecasted revenue

Medium Improvement +1.5%*

Zara Headquarters adopt recommendation knowing Zara Stores will not
1. Bi-level optimization with BR
   - Get optimized re-display decision
2. Plug in BR Myopic Algorithm
   - Get Zara Stores' "real" removal decisions
3. Calculate total forecasted revenue

Least Improvement +0.5%*

Zara Headquarters adopt recommendation assuming Zara Stores will adopt, but they do not
1. Bi-level optimization without BR
   - Get optimized re-display decision
2. Plug in BR Myopic Algorithm
   - Get Zara Stores' "real" removal decisions
3. Calculate total forecasted revenue

Future Work

1. Definition of Bounded Rationality
2. Demand Prediction
3. Bi-level Optimization

Takeaways

- Important to understand Zara Stores' actual behaviors when using the optimization in practice
1. Best to ensure Zara Stores follow removal recommendations strictly (+6.5%* in revenue)
2. Otherwise, should optimize re-display decisions with consideration of Zara Stores' suboptimal behaviors
   - More robust & brings higher revenue (+1.5%*)