ZARA
What Products Should be Displayed?
Double Assortment Optimization

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Problem Statement

Zara is the largest global apparel retailer specializing in fashion products, especially the 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:

- 💰 Maximize total retail revenue
- 💡 Re-display which Backroom Items
- 💡 Remove which Existing Items
- 🏠 Personalized store-wise decision
- 🕐 Run twice a week

Business Impact:

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

Business Context

New Product Arrives

Store

Existing Product

Removed / Re-displayed

Backroom Product
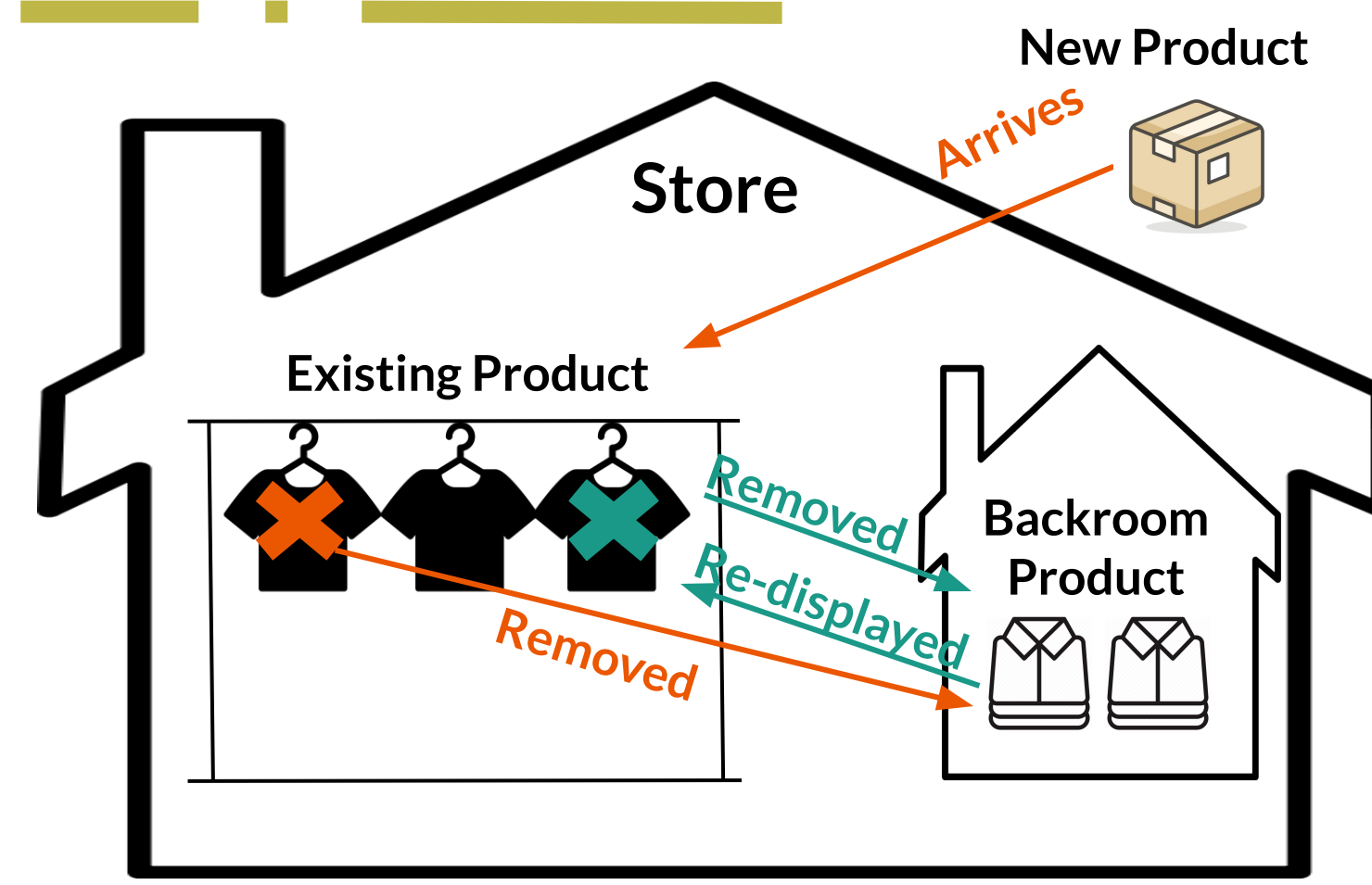
Removed

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

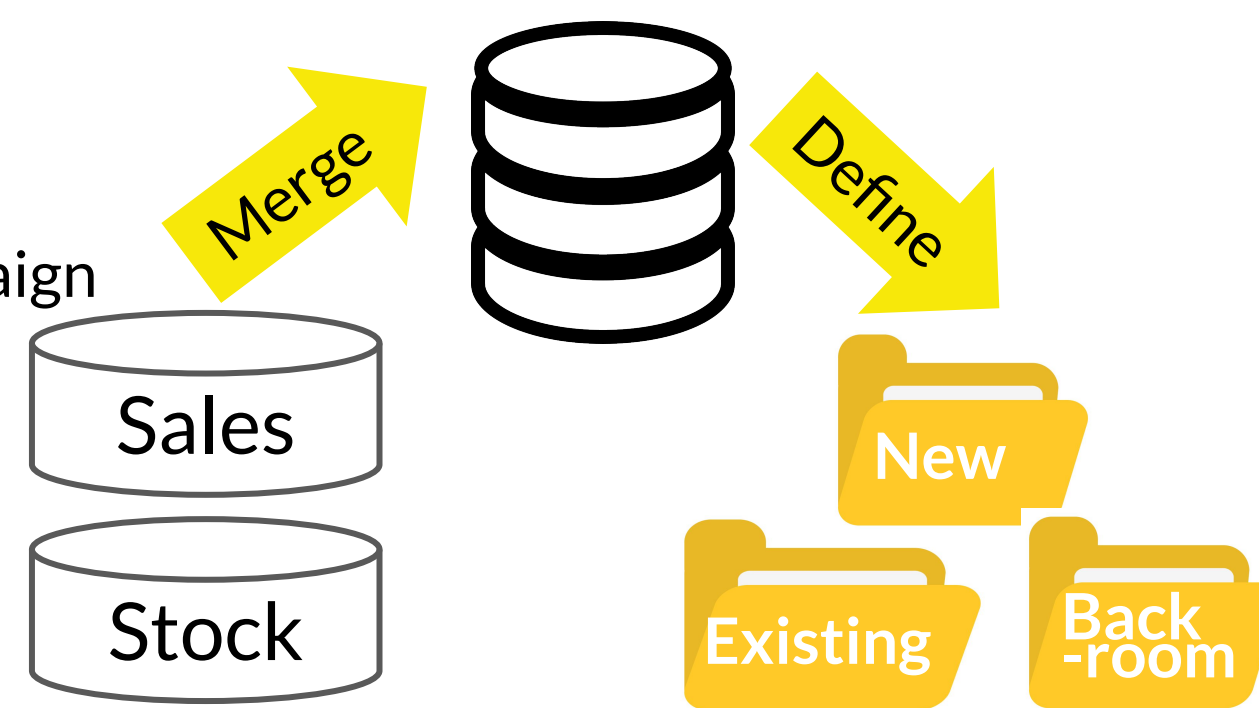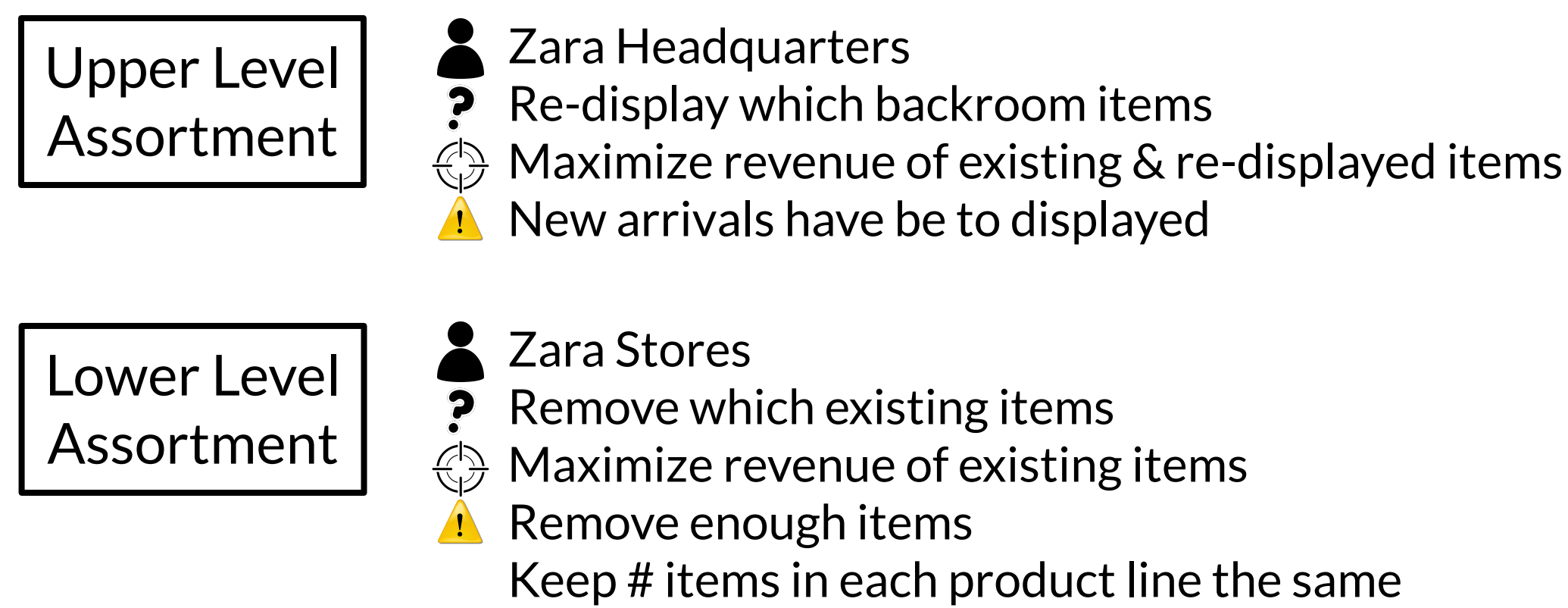| Problem Definition	Data Acquisition & Preprocessing	Demand Prediction Model	Bi-level Optimization Framework
April	May	June	June - Aug

Data Pre-processing

🔍 **Data Scope**
- Women's fashion, 2018 winter campaign
- Worldwide Top 10 largest stores
- Half-week granularity

🔍 **Result Scope**
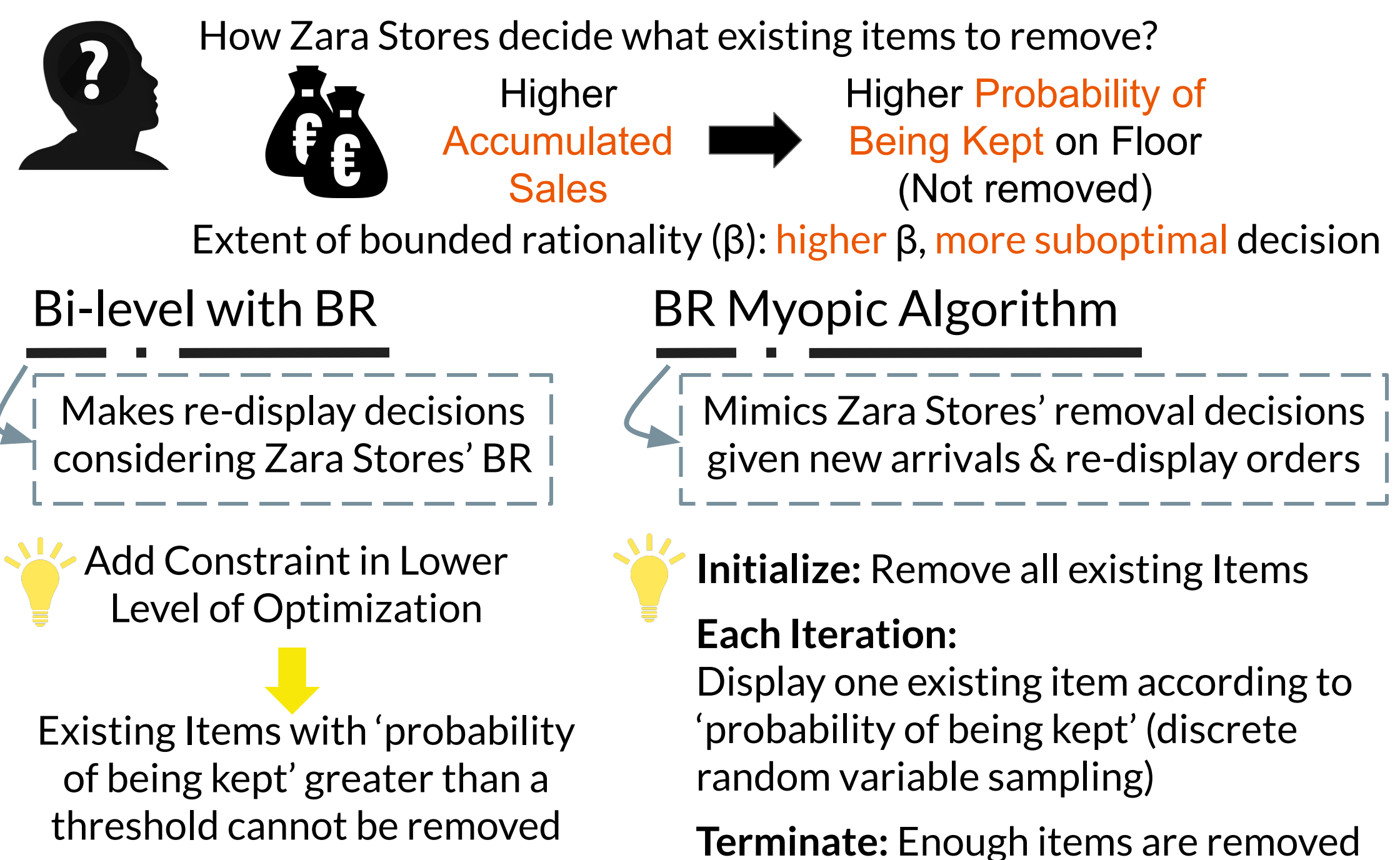- Two stores: one US, one German
- Time: Nov. 1, 2018 - Nov. 4, 2018

Merge → Sales / Stock → Define → New / Existing / Back-room

Demand Prediction

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

Random Forest

🎯 **Prediction**
- Demand for Existing and Backroom Items

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 be to 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

📥 **Inputs**
- Forecasted Sales
- Price
- Product Line

Bi-level Optimization

📤 **Outputs**
- Re-displayed Items
- Removed Items

Bounded Rationality (Suboptimal Zara Stores)

❓ How Zara Stores decide what existing items to remove?

Higher **Accumulated Sales** ➡ Higher **Probability of Being Kept** on Floor (Not removed)

Extent of bounded rationality (β): higher β, more suboptimal decision

Bi-level with BR

Makes re-display decisions considering Zara Stores' BR

💡 Add Constraint in Lower Level of Optimization

⬇

Existing Items with 'probability of being kept' greater than a threshold cannot be removed

BR Myopic Algorithm

Mimics Zara Stores' removal decisions given new arrivals & re-display orders

💡 **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
   -> Get optimized removal decisions
2. Calculate total forecasted revenue

Medium Improvement   +1.5%*

Zara Headquarters adopt recommendation knowing Zara Stores will not

1. Bilevel 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. Bilevel 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

*Based on 2 stores, Nov 1- Nov. 4, 2018

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%*)

Future Work

1. Definition of Bounded Rationality
   - Scale Personalized β for Each Zara Store
   - Other Metrics or Methods for BR

2. Demand Prediction
   - Improve Prediction Model Performance
   - Separate Prediction Model for Backroom Items

3. Bi-level Optimization
   - Expand Outlook to Multi-period