

***Report on Inventory Analytics:  
Reducing Lost Revenue Due To Out Of Stock  
Inventory***

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# The Challenge

Not enough  
inventory

Too much  
inventory

Product/size mix  
not optimal

**Lost Revenue**

# Problem Definition

A chain of stores sell various products.

Ideally	Real world
There always are the right products in the right quantities at every store.	Products can be out of stock (OOS). After that moment a seller has <i>Lost Sales</i> .

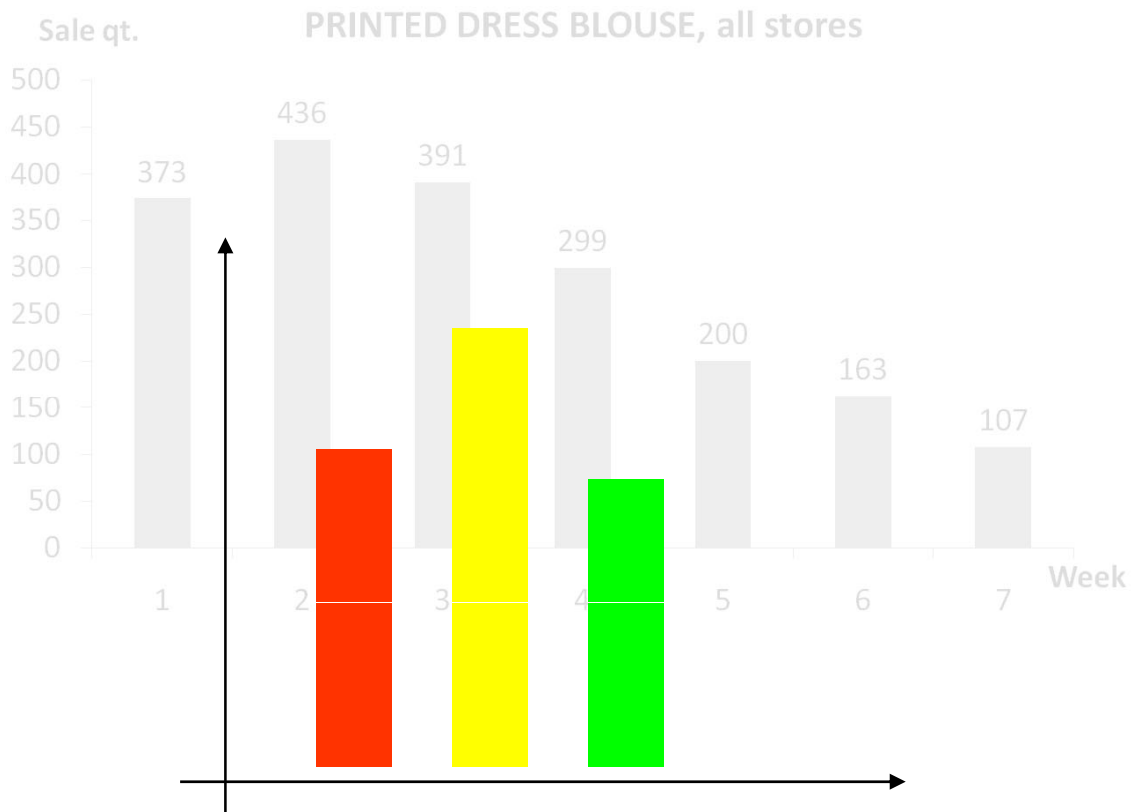
*Lost Sales* are the potential sales after an item goes OOS that could be made if there were be enough units in stock.

For the seller, the following business questions arise:

- *What is the amount of sales that were lost?*
- *Is there a better distribution of products between stores and items?*

# The Benefits

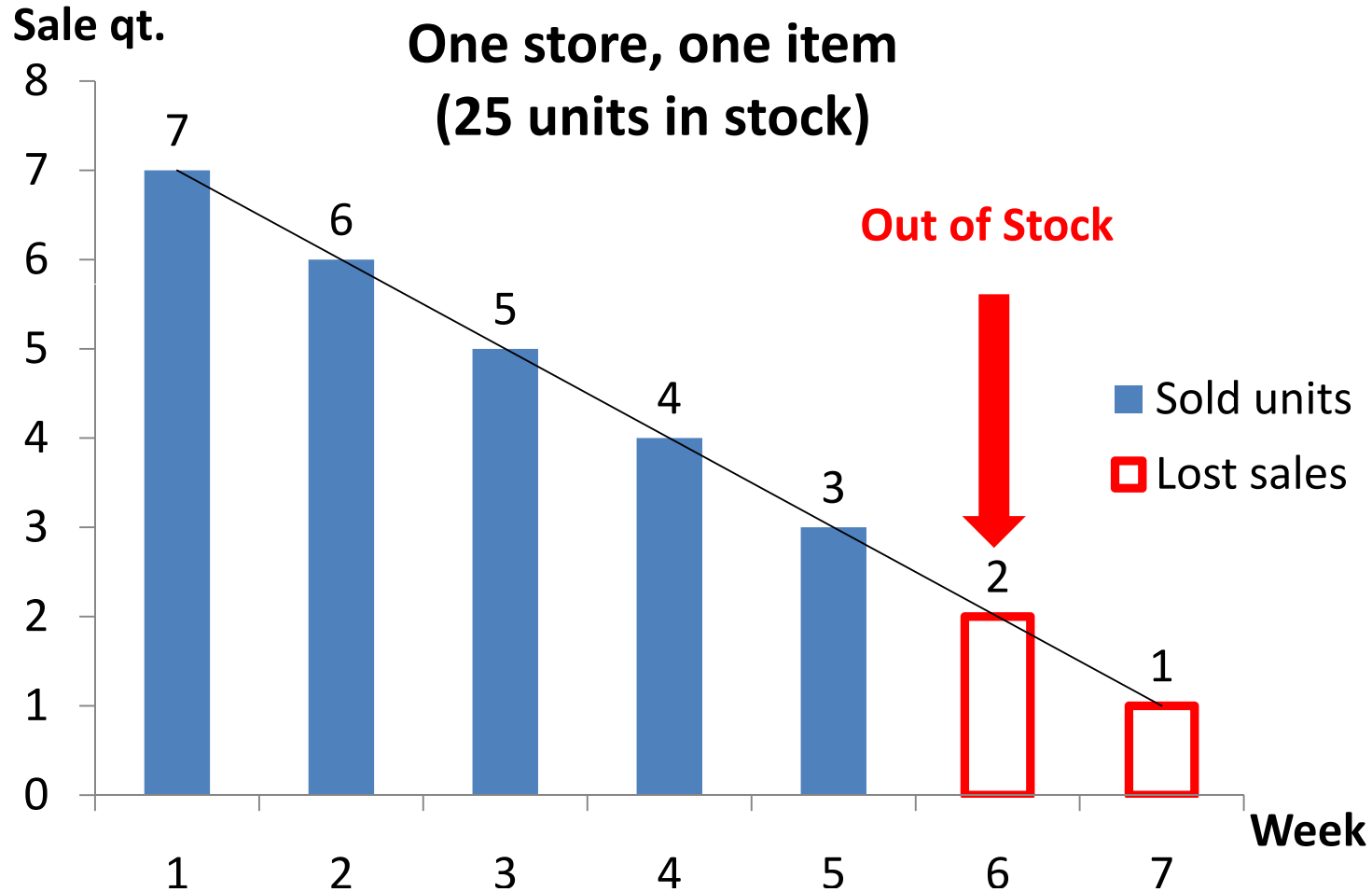
- Lost Sales estimation;
- Size curves tied to local demand;
- Proper distribution between stores;
- Increase in sales (4% - 22%);
- Universal model.



# Challenges

# Example 1.

## Simple Linear Demand



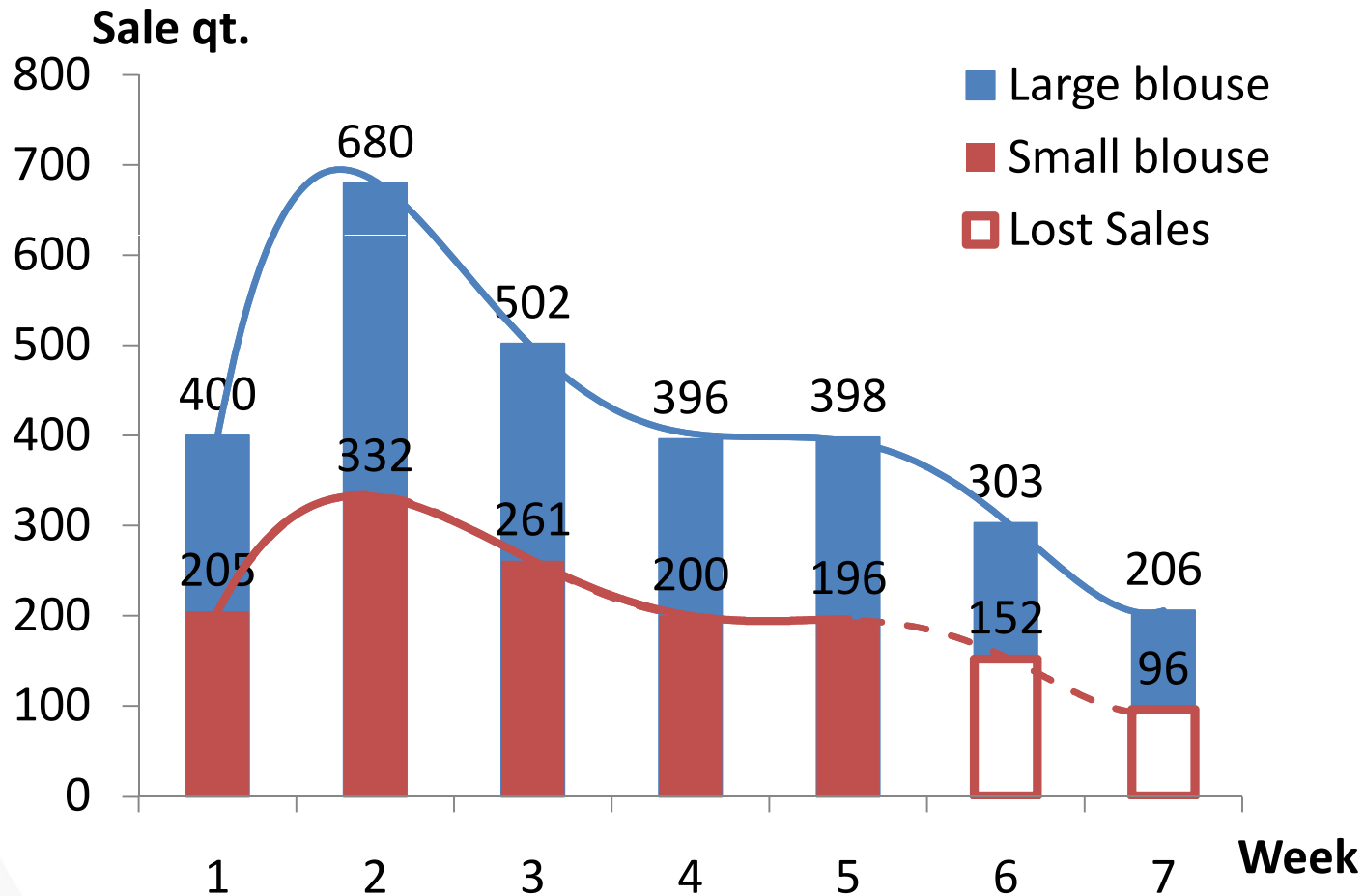
# Example 2.

## Real World Demand



### Example 3.

## Large quantities. Size proportions

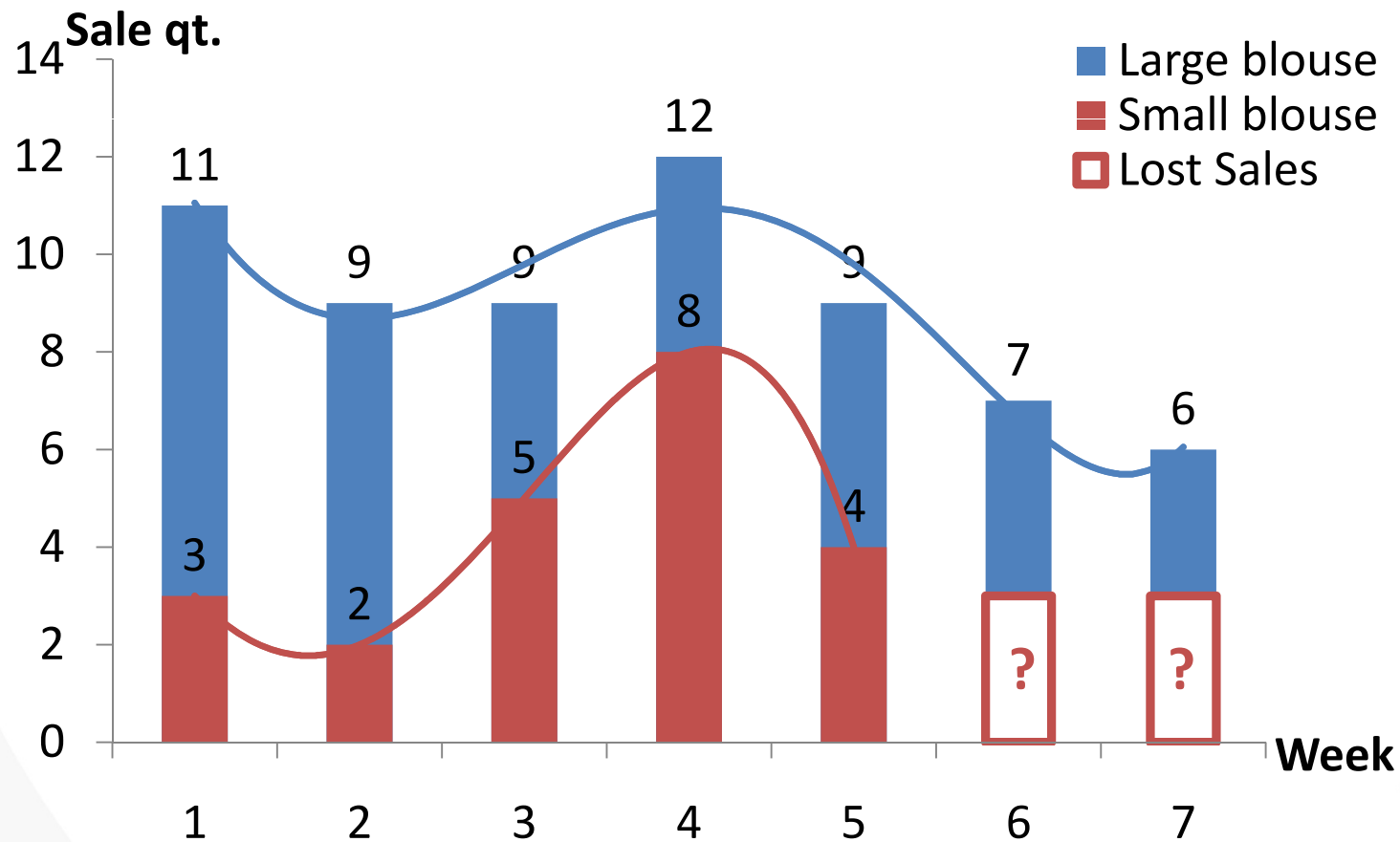




## Example 4.

# Real world. Size proportions

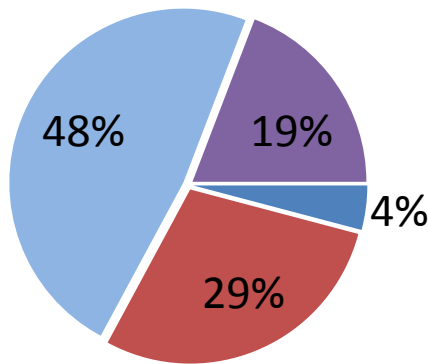
Real sales in an individual store display large variances that do not allow for direct proportional relationship.



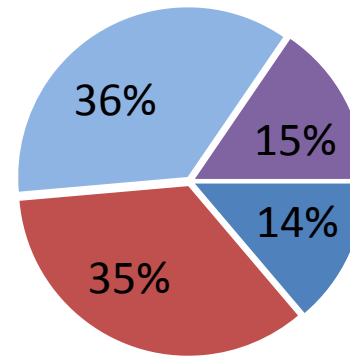
# Aggregating by Stores

Every store has its own size distribution.

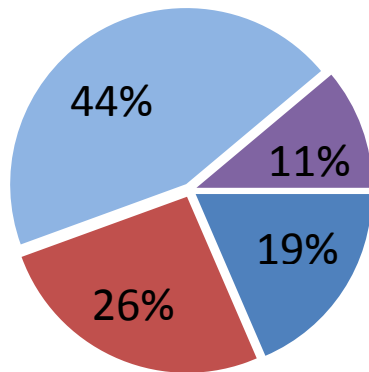
### Store 1



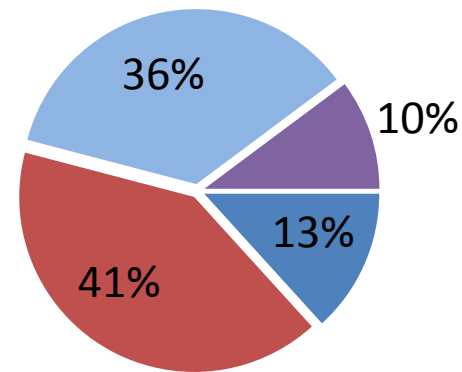
### Store 2



### Store 3



### Store 4

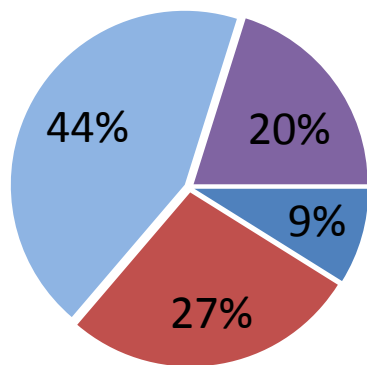


- L
- M
- S
- XS

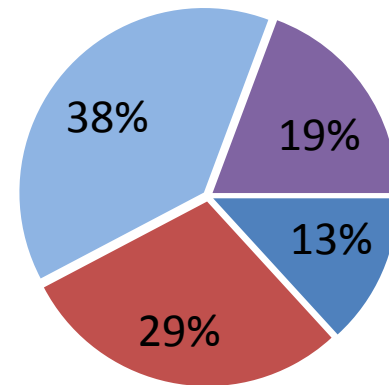
# Aggregating by Style

Every item has its own size distribution.

### V NECK TOP

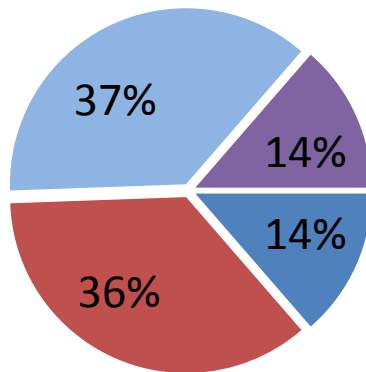


### PRINTED DRESS BLOUSE

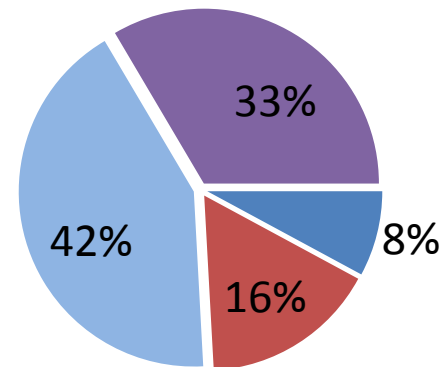


- L
- M
- S
- XS

### LACE BACK CAMI



### BEADED TANK TOP



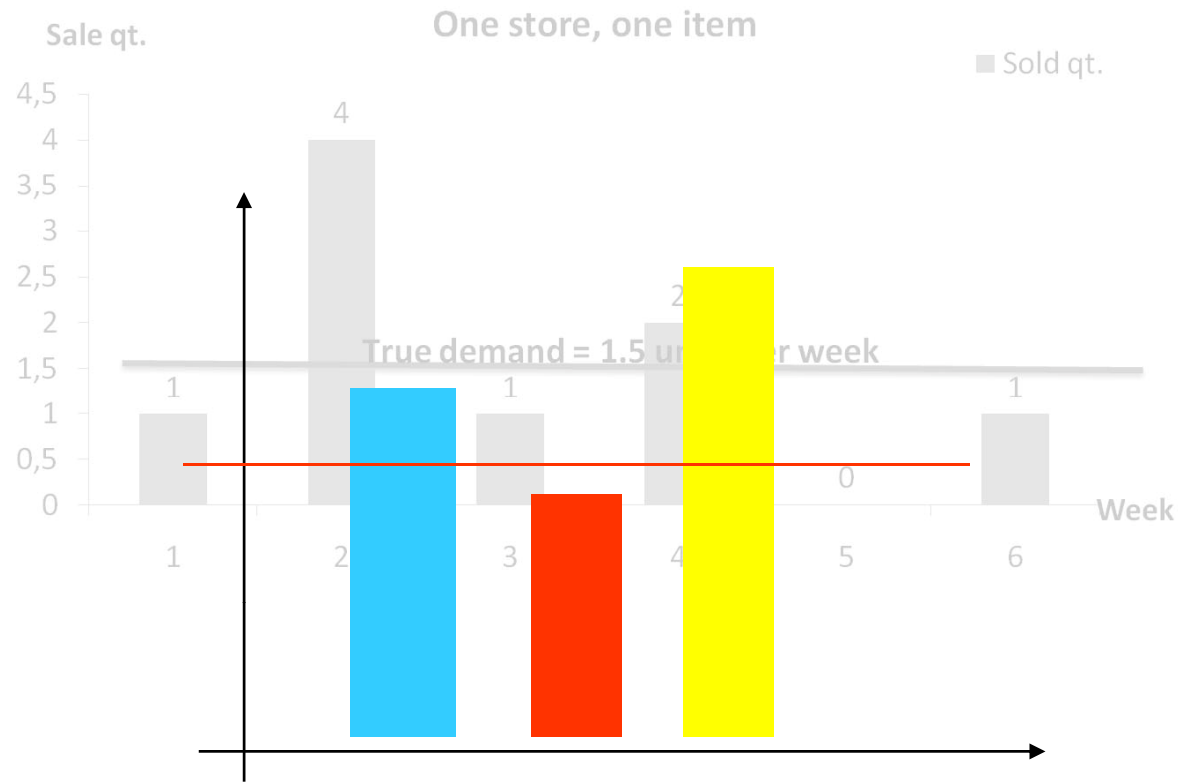
# Sales by Week

Due to seasonality, sales change significantly from week to week.



# Challenges of Lost Sales Analysis

- Small quantity of weekly sales per store, size and style. Hence week to week deviation of the real sales is significant ;
- Demand is time dependent;
- Different demand for various locations and styles;
- Different size proportions for different stores and styles.



# Solution

# Problem Formulation

There is a network of stores selling a product (e.g. T shirts) of various styles and sizes in different locations. For every valid combination of Style, Location, Size and Week we have sales data in the following forms:

*X units sold* or *X units sold and OOS position was reached*

After OOS there is no sales or demand information available. The problem is to find demand as a function of style, size and location for every week of the considered period. Once this function has been found, it provides an estimation of the Lost Sales for those weeks in which the store was OOS.

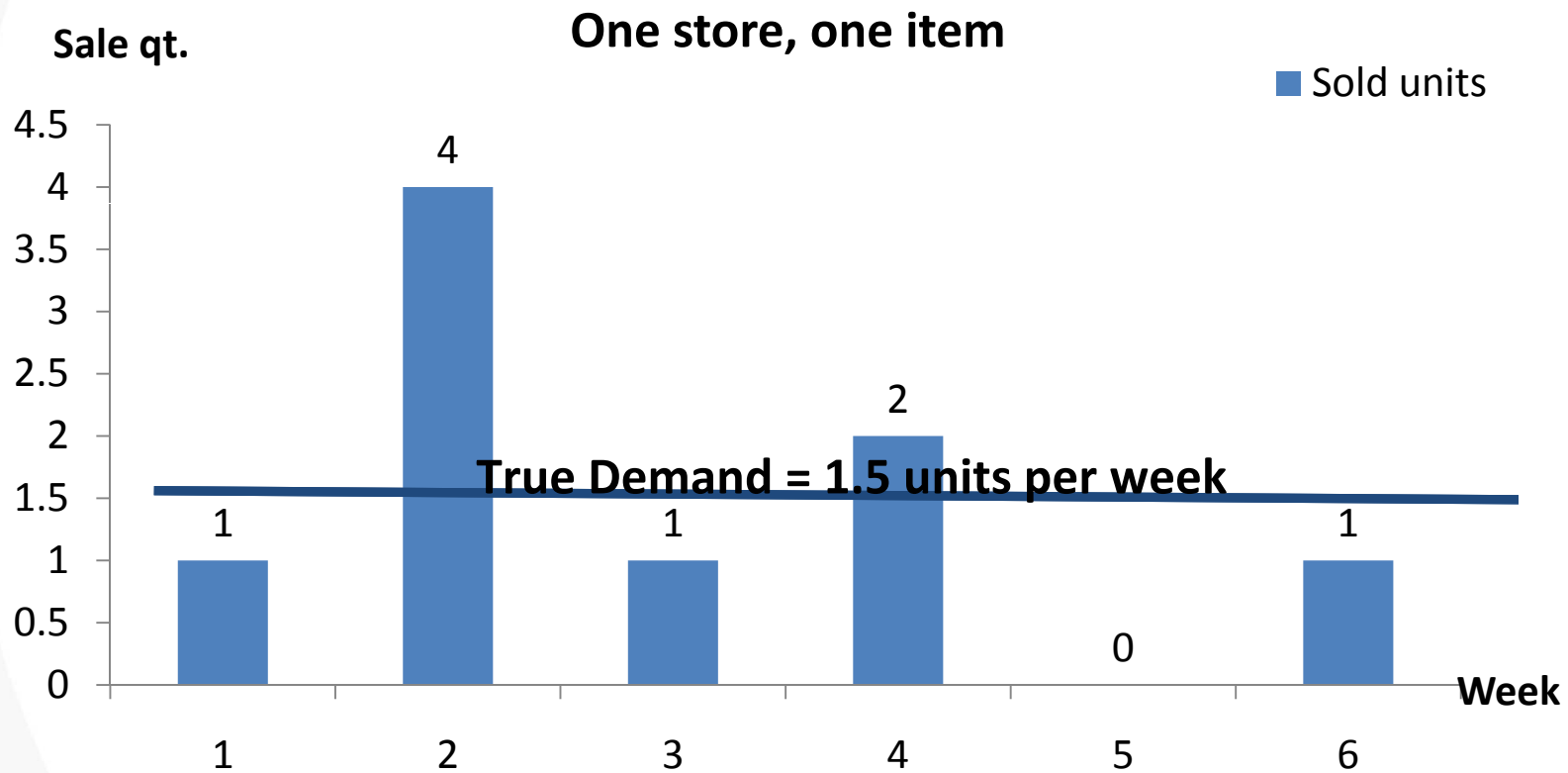
# Sales Data vs. True Demand

- The number of units sold in a store cannot be considered the True Demand especially in the case where the number of weekly sales is small.
- It is impossible to accurately predict that 1 unit will be sold during week 1, 4 units during week 2, 1 unit during week 3, etc.
- True Demand is a function (possibly fractional) of Style, Size, Location and Week  
with a high degree of variance!

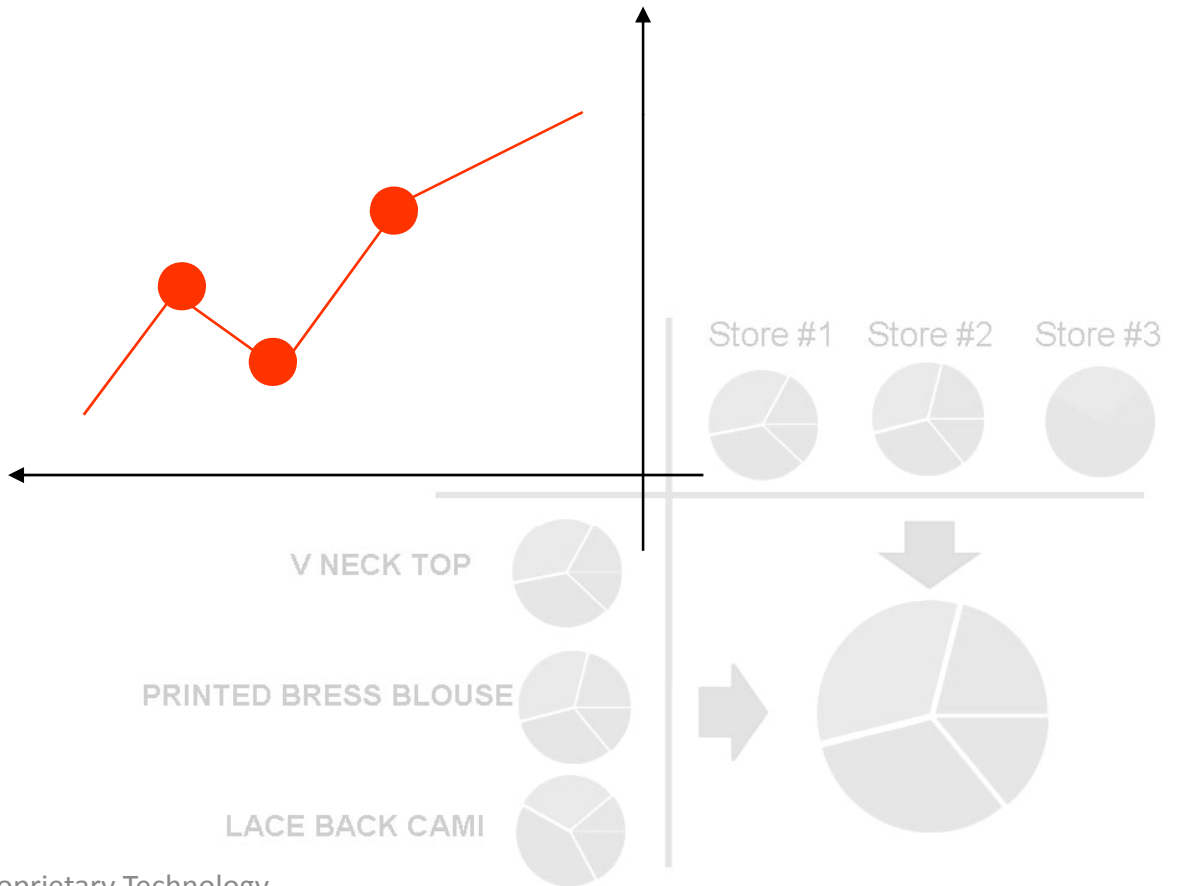


# Example 5.

## Sales Data vs. True Demand

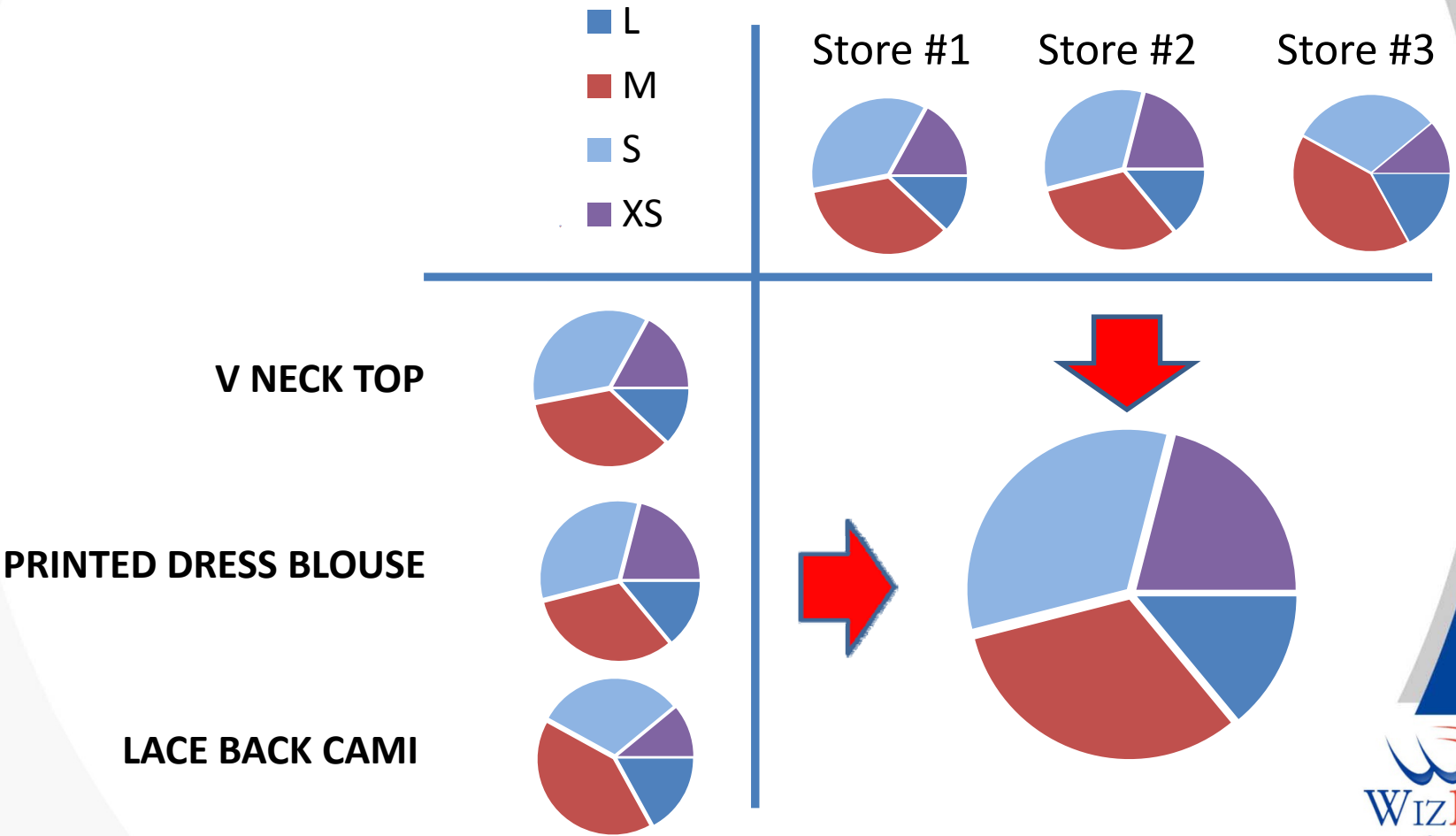


# Assumptions



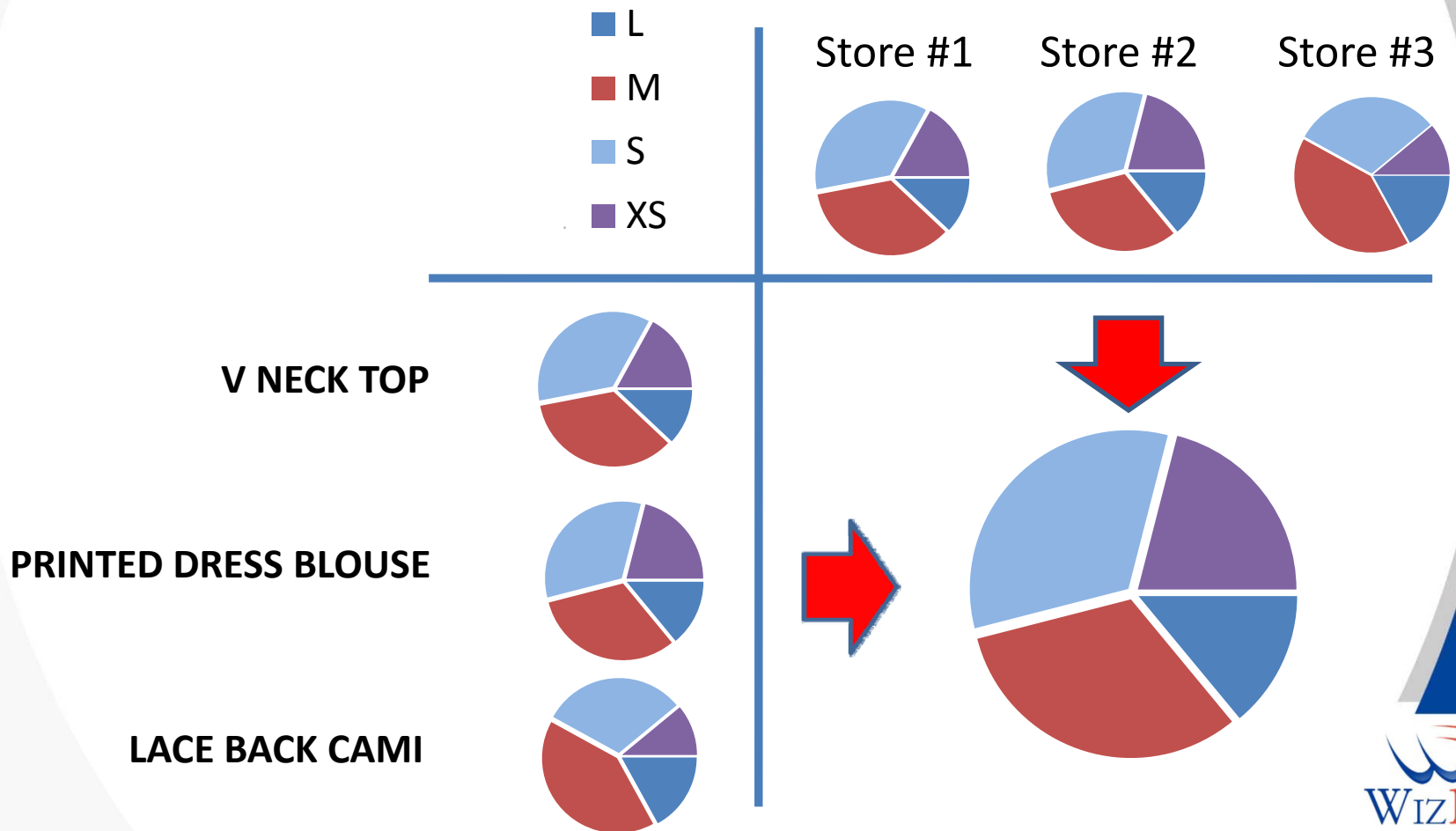
# Local Size Curve

Size distribution of a style is assumed to be a function of style design and location.



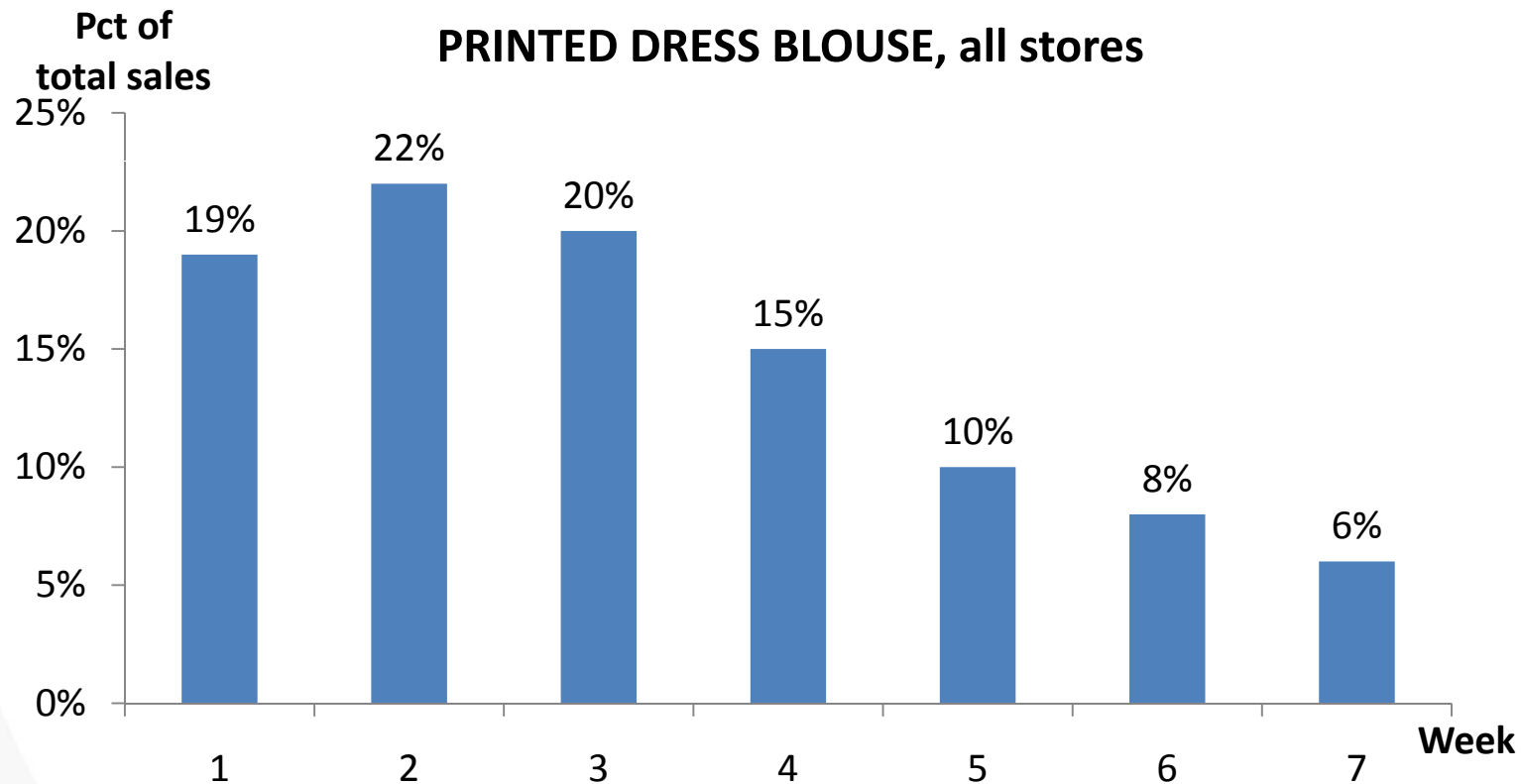
# Size Curve Does Not Change

Size curve of a style at a given location does not change in time.



# Weekly Sales

For every style the weekly fractions of a total demand during a considered period are the same for different locations.



# Results

As a result of the Lost Sales algorithm we calculated a **True Demand** function, which allows us to:

- Find the Lost Sales in context of styles, locations and sizes;
- Analyze the structure of sales during the period;
- Find the optimal product distribution between locations.

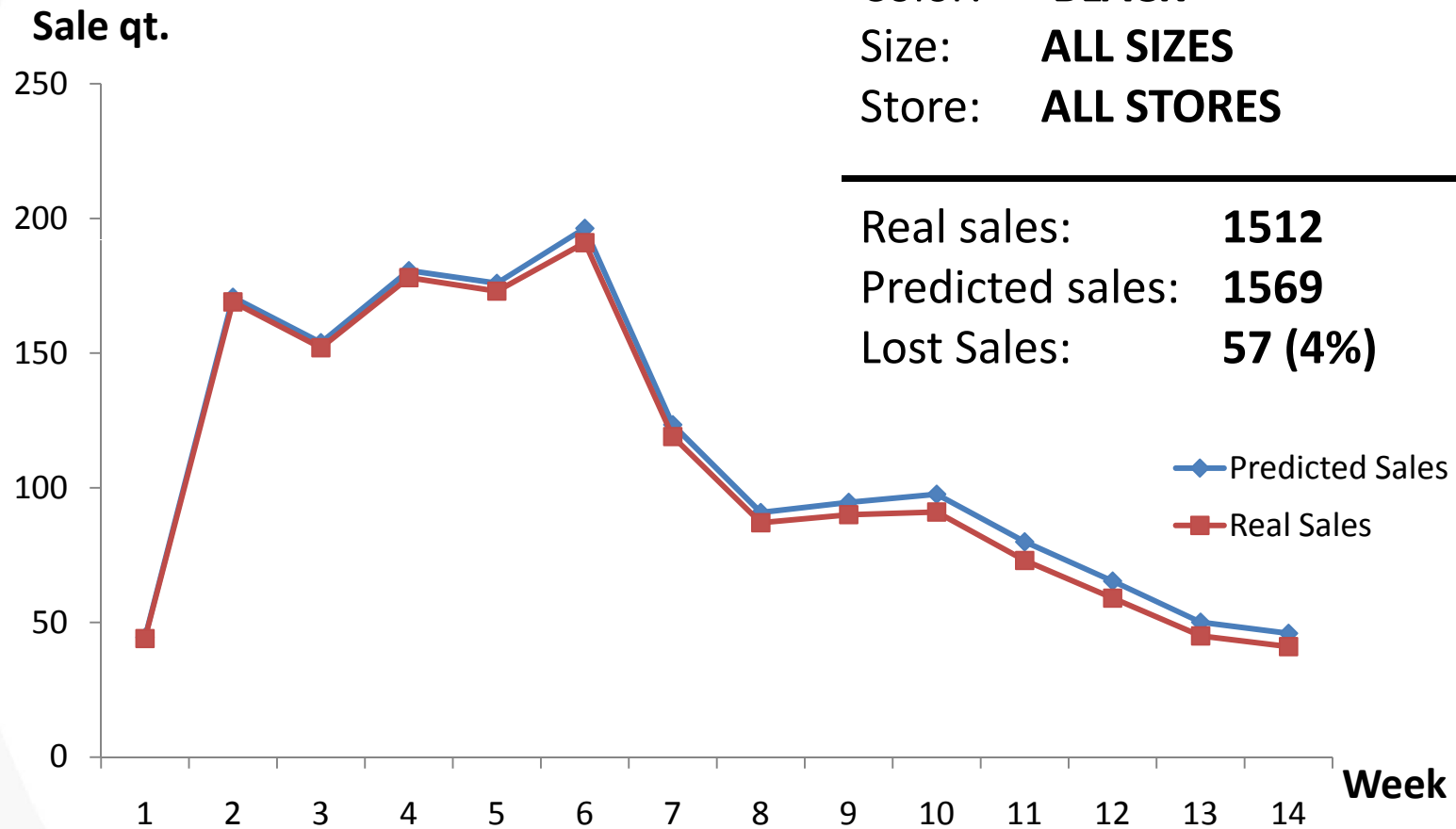
# Results – Blouse

Style: **PRINTED DRESS BLOUSE**

Color: **BLACK**

Size: **ALL SIZES**

Store: **ALL STORES**



Real sales: **1512**

Predicted sales: **1569**

Lost Sales: **57 (4%)**

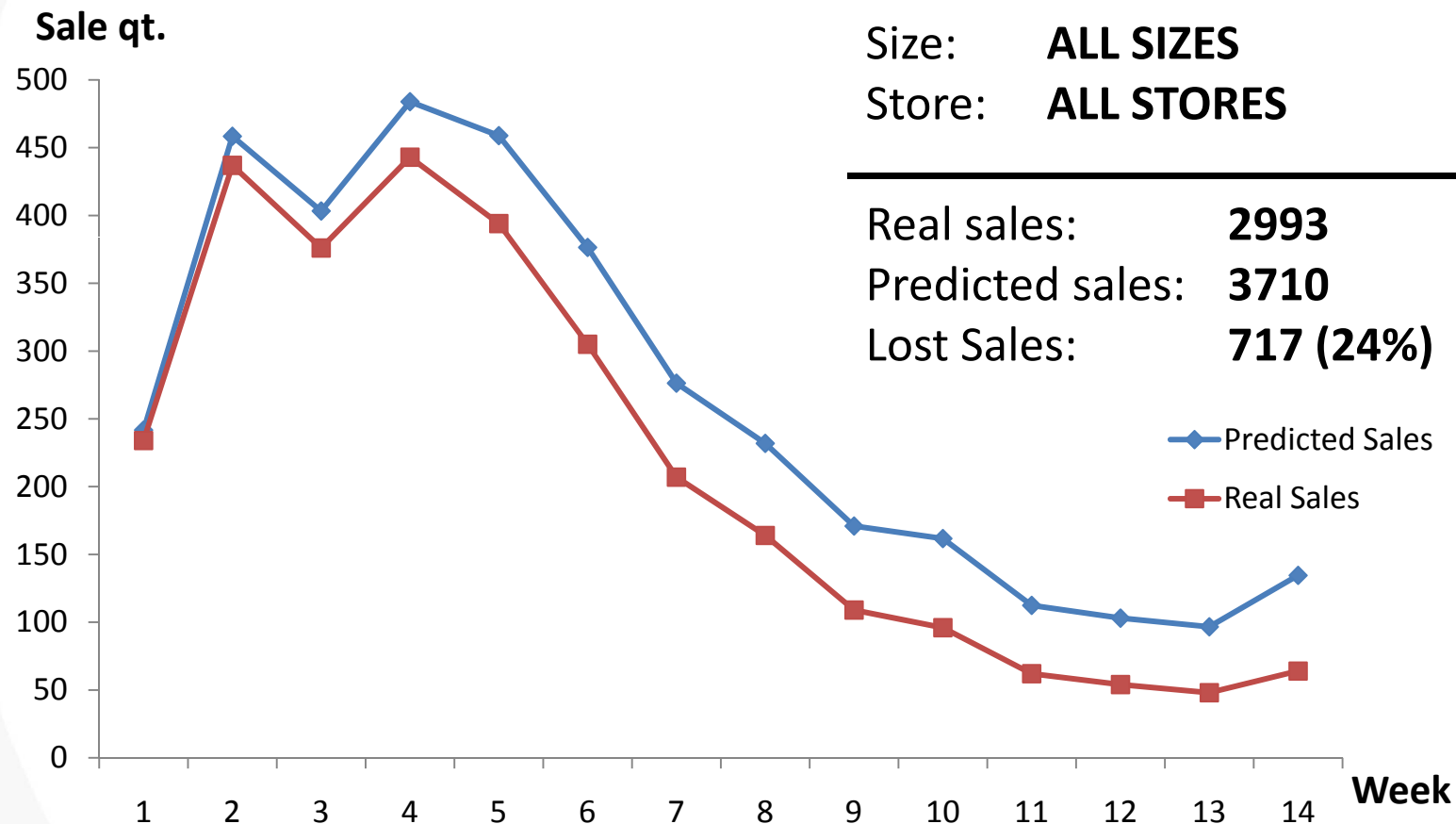
# Results – V Neck Top

Style: **V NECK TOP**

Color: **IVORY**

Size: **ALL SIZES**

Store: **ALL STORES**





# Results - V Neck Top

Style: **V NECK TOP**

Color: **IVORY**

Size: **ALL SIZES**

Store: **STORE #100**

Sale qt.



Real sales: **23**

Predicted sales: **30**

Lost Sales: **7 (30%)**

◆ Predicted Sales

■ Real Sales

# Conclusions

- Lost Sales analysis is very difficult due to the small number of items sold and the very high variance of the data;
- The proposed approach recognizes general regularities of the sales for different products and locations and provides the True Demand function;
- The amount of Lost Sales and the optimal distribution of products between stores can be estimated by means of the developed algorithm.

# Benefits

- Lost Sales estimation can be used for future planning
- Estimated Increase in sales (4% - 22%);
- Smaller amount of merchandise sold at clearance prices
- Immediate within the season response
- Our model can be used stand alone or integrated into existing systems

# Authors

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# Can we answer any questions?

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