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Target: Using Analytics to Improve Asset Protection

Saurabh Bodas, Lin Chen, Jake Hill, Shelby Watson

Acknowledgements

- **Ed Tonkon**, Zebra Technologies
- **Jess Pena**, Target
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- **Dr. Tej Anand**, MSBA Faculty

ZEBRA

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The University of Texas at Austin
Texas McCombs
MS Business Analytics
McCombs School of Business

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Master of Science in Business Analytics (MSBA)

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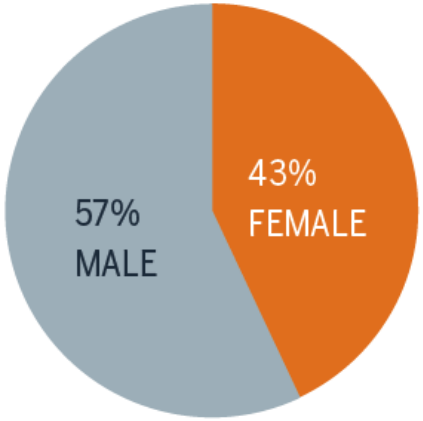
ACADEMIC BACKGROUND

40%	ENGINEERING
19%	BUSINESS
15%	MATHEMATICS
14%	ECONOMICS
9%	COMPUTER SCIENCE
3%	OTHER

- Ranked #3 in Business Analytics worldwide
- 10-month intensive STEM-certified program

GENDER



AVERAGE TEST SCORES

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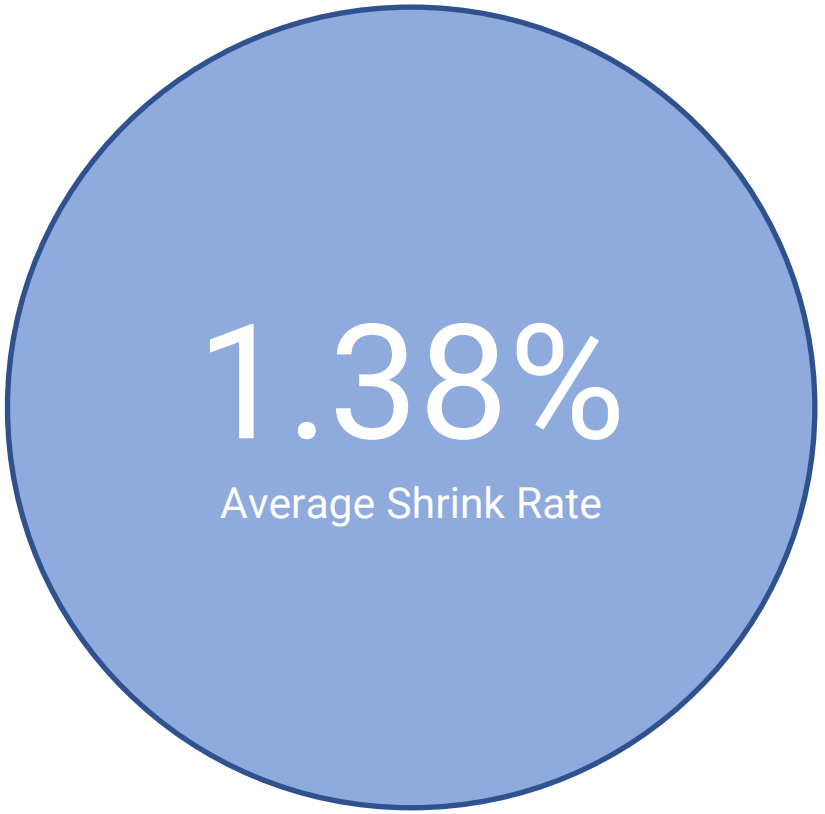
Asset Protection: Countering Theft



National Retail Security Survey

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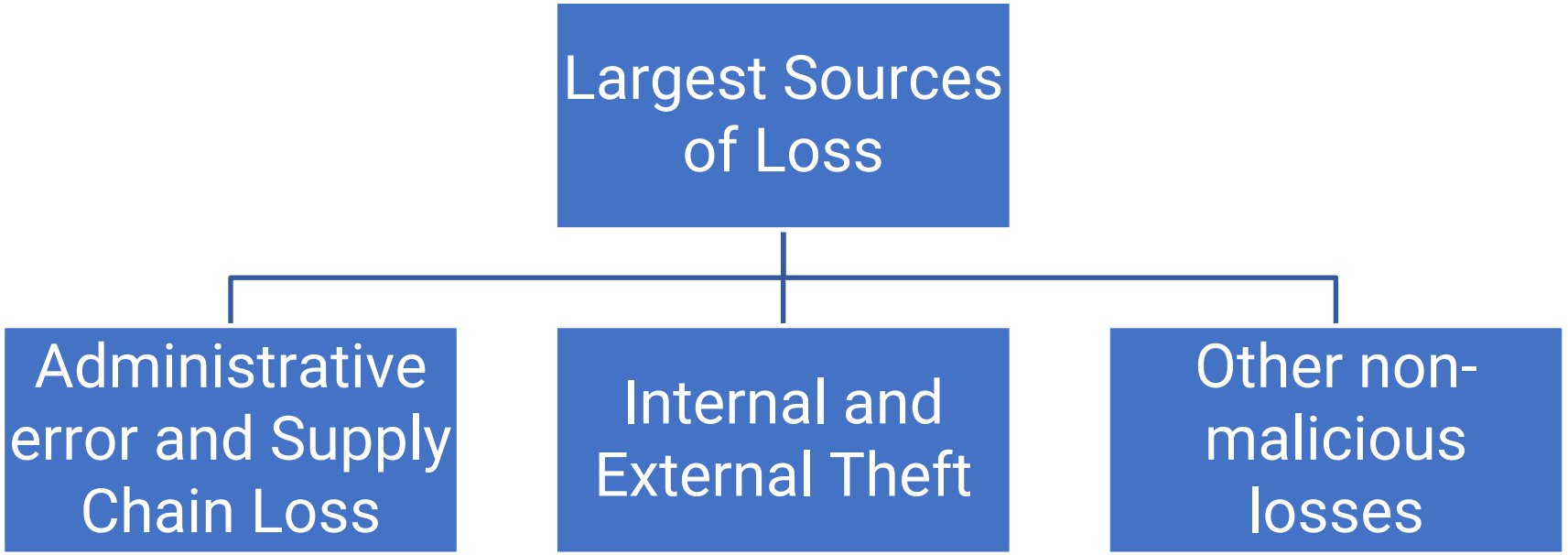
Largest Sources of Loss
Administrative error and Supply Chain Loss
Internal and External Theft
Other non-malicious losses

Background and General Observations

Our Main Objectives

1. Track performance of AP teams
2. Optimize resources to prevent the most theft

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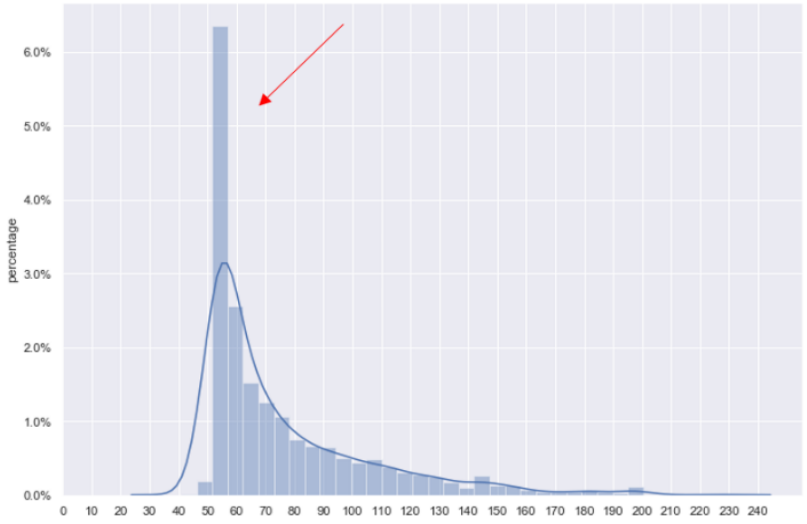
Understanding the Data

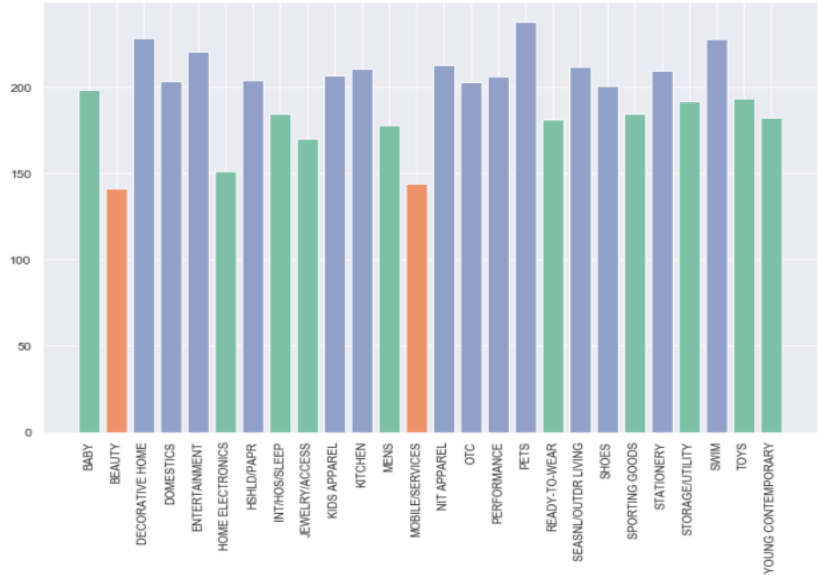
- 1,800+ stores
- 2015-2019
- Broken down into two main segments:
  - Annual Store Data (annual sales, shortage, store attributes, etc.)
  - Weekly Department Data (weekly theft statistics)
- Weekly data is collected as records from individual AP teams
- Annual data is collected from aggregate store records

Exploratory Data Analysis

- Granular Data
- Missing Values
- Addressed through clustering



Missing Week Distribution Across Stores



Missing Week Distribution Across Merch Division

Addressing Objective 1

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Measure an AP Team's performance against itself

- Trend Extraction

Measure an AP Team's performance against other similar stores

- Store segmentation
- Assess performance through theft prevention within groups

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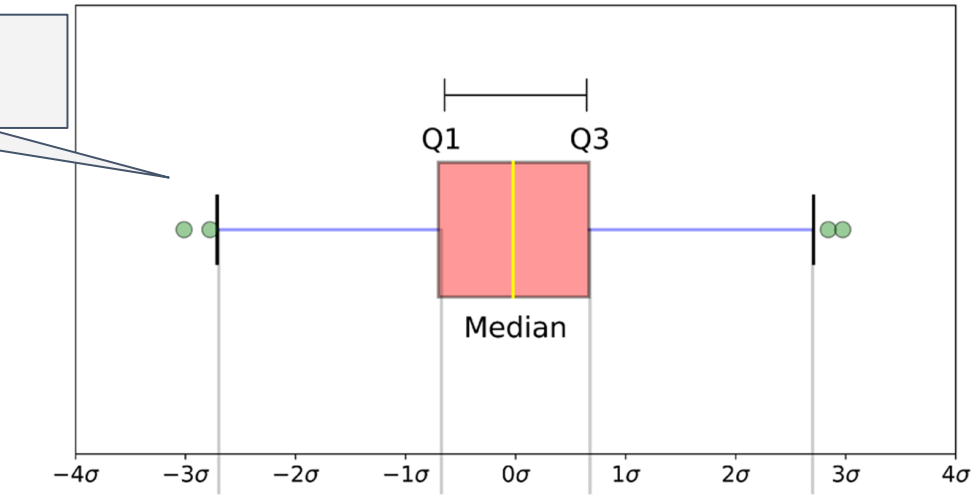
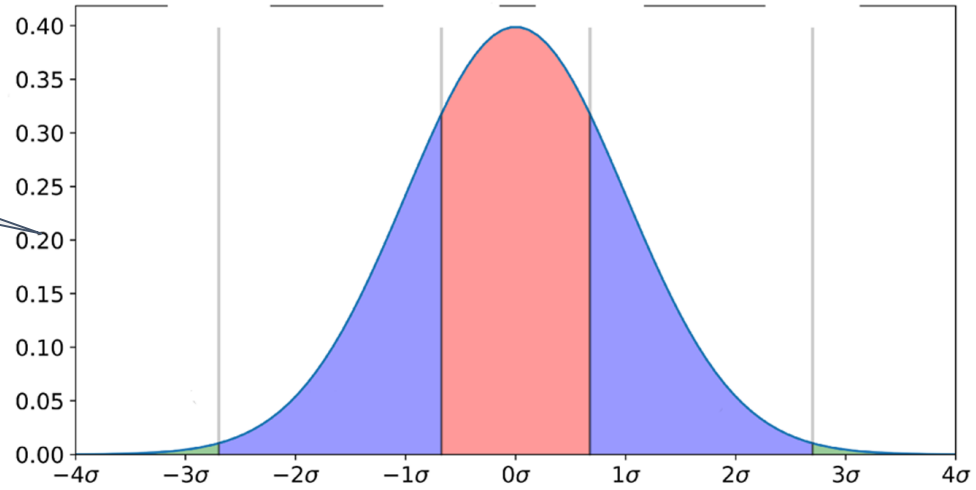
How to easily interpret a boxplot

Data from above



Side view



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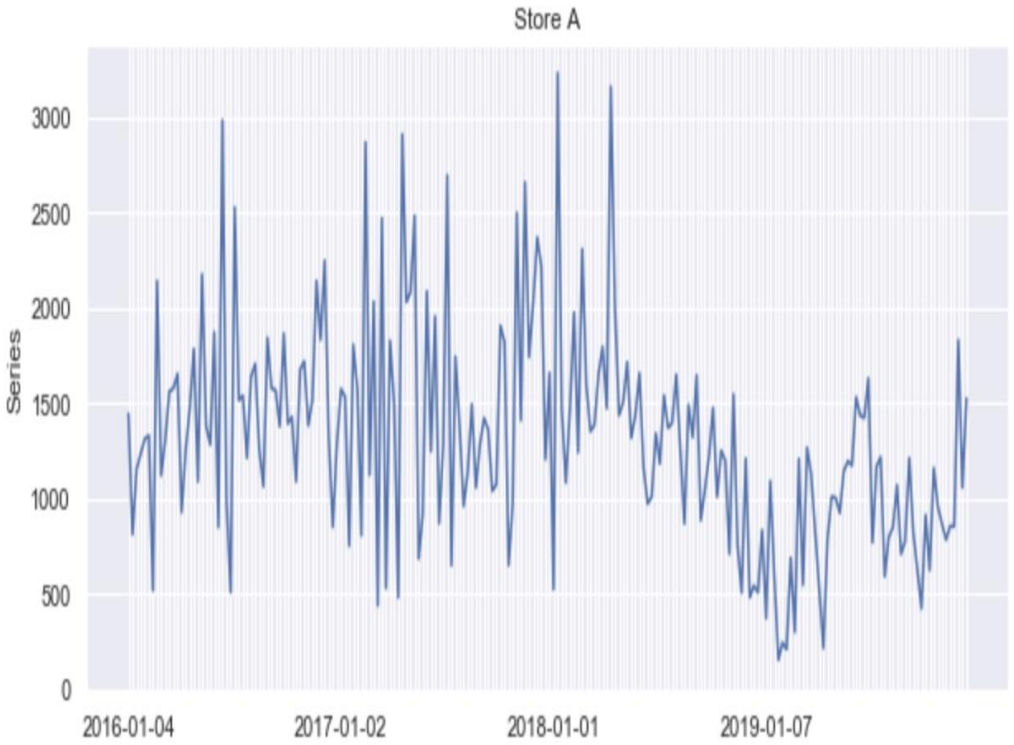
Measuring AP Team Performance: Trend Extraction

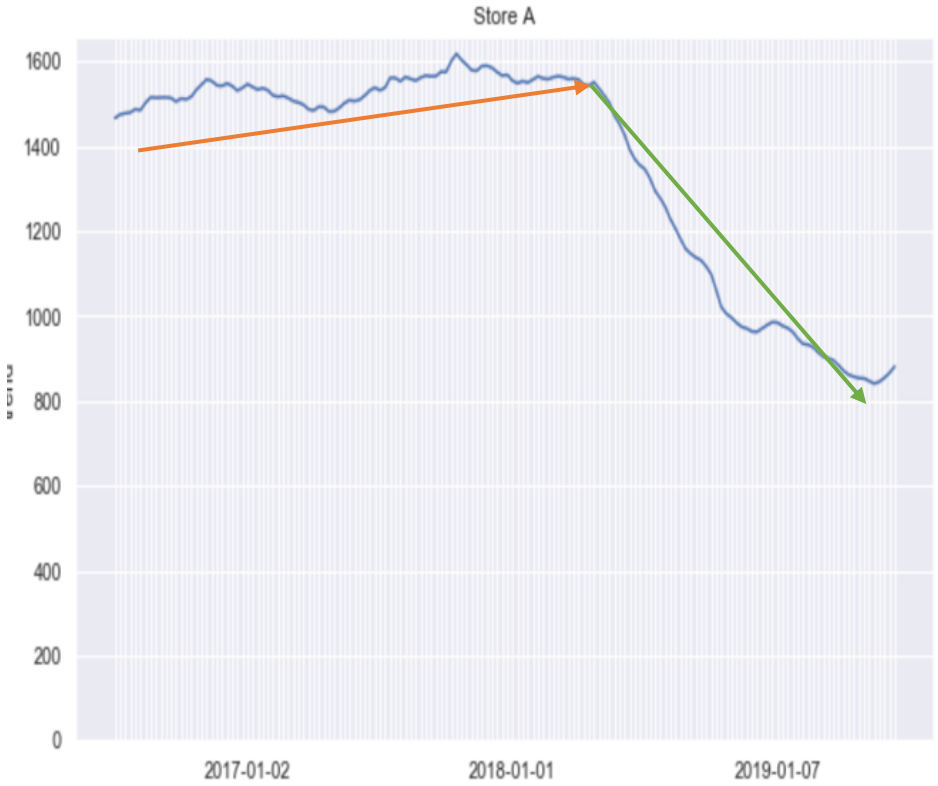
- Trend is a general direction for the theft time series and could be a good proxy for measuring the performance of Asset Protection team against itself
  - Taking empty package as an example
  - If the trend is always going down with a good amount, performance is improving
  - Otherwise it stays constant or worsens
- Time series is often affected by seasonality and trend need to be extracted first.

Measuring AP Team Performance: Trend Extraction

Original Data



Trend



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Measuring AP Team Performance: Trend Extraction

- On average, the value of recorded emptypackage in 2018 decreased by 15 dollars on a weekly basis.

	Store	ep_2016	ep_2017	ep_2018	ep_2019
0	A	3.1079	1.8402	-14.7292	-6.0514

- **Implication:** Give a quantitative measure of reduced dollar amount
- **Elasticity:** This method can check quarter, semi-annual and annual performance of Asset Protection team.
- **Limitation:** It requires high-quality and streamlined data collection for at least 2 years in order to get rid of seasonality effect.

Tracking AP Team Performance

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Evaluating AP team performance is tricky:

Occurrence of crime can be erratic

Cannot set target theft metrics to be achieved

Best approach: compare each store's relative performance against all other stores

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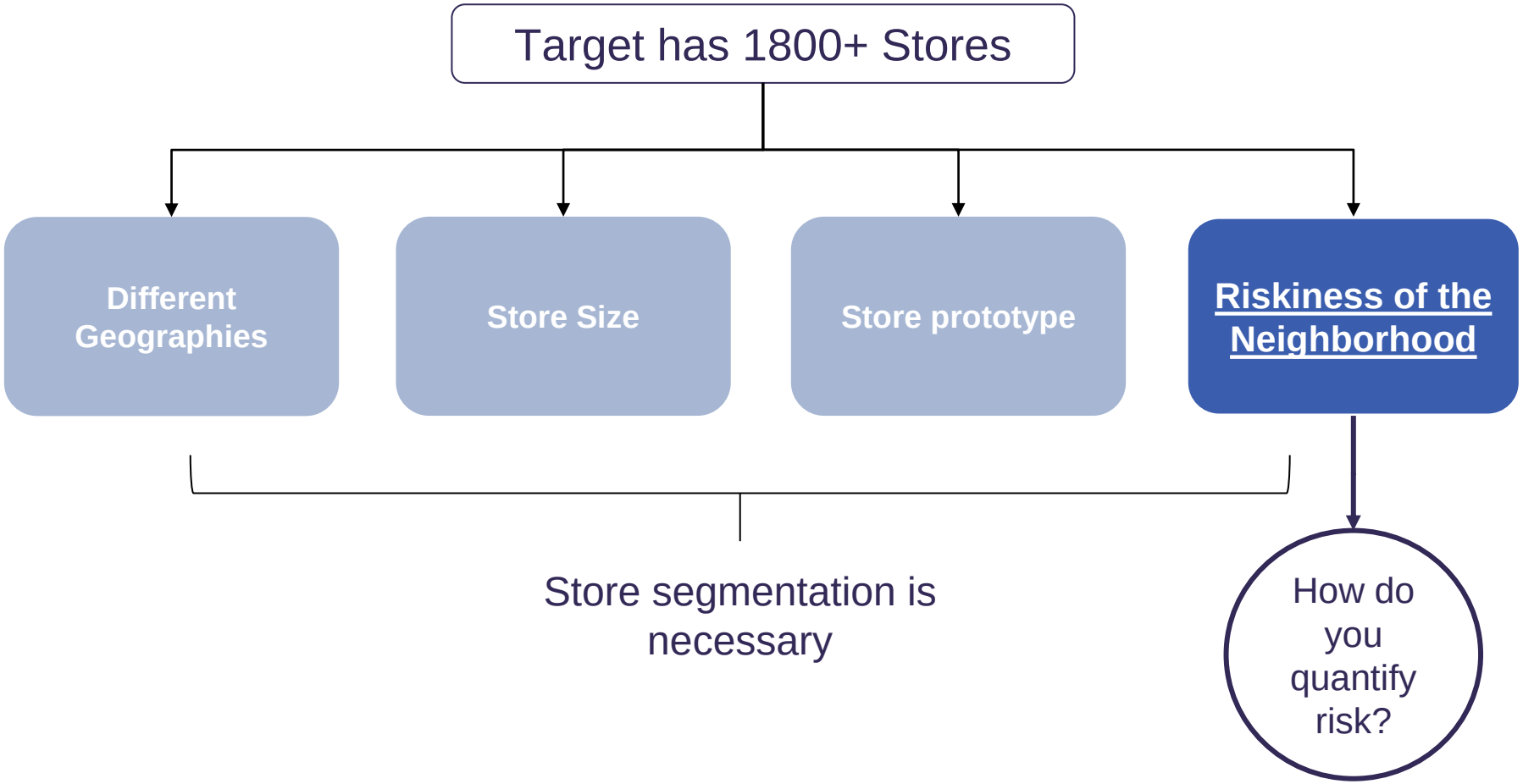
Tracking AP Team Performance



Tracking AP Performance

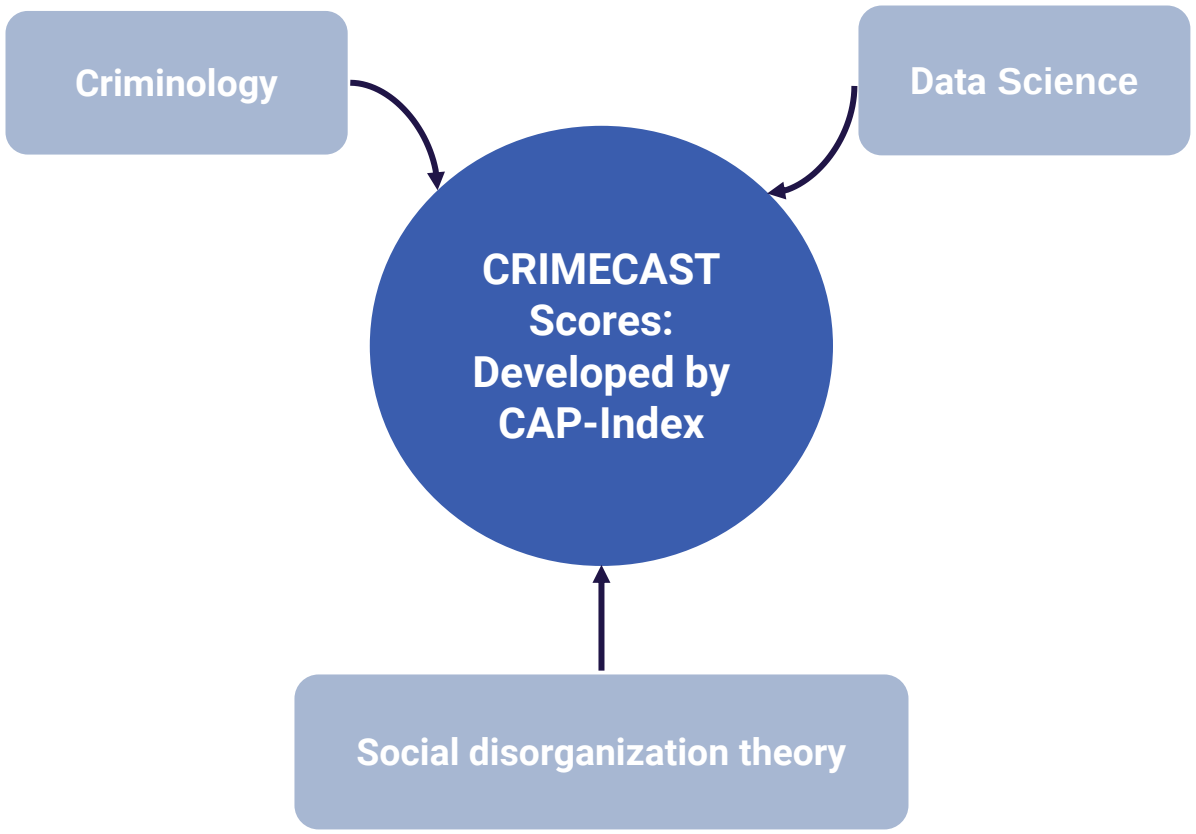
Why does a particular store prevent more theft than another store?

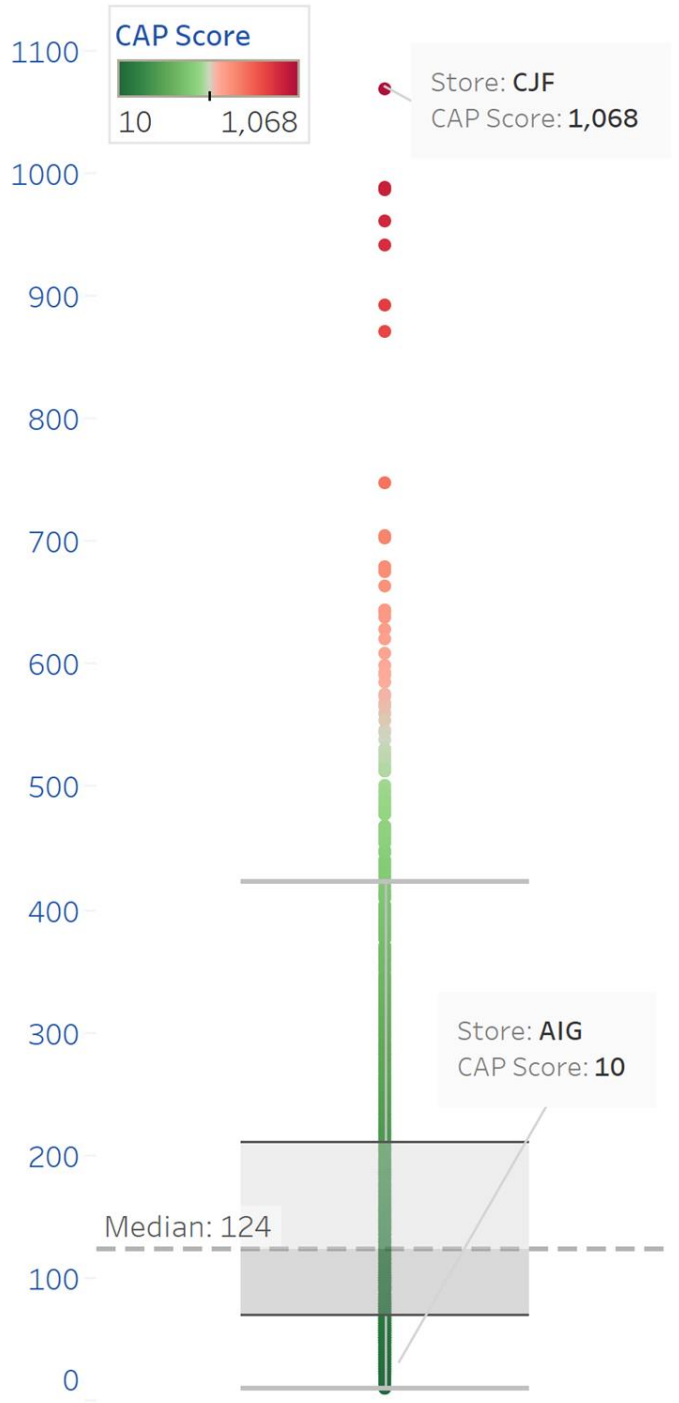
~~More Square Footage~~

~~Riskier Neighborhood~~

AP team performs well

Explaining CAP Scores





Each store receives a custom score between **0 - 2000**

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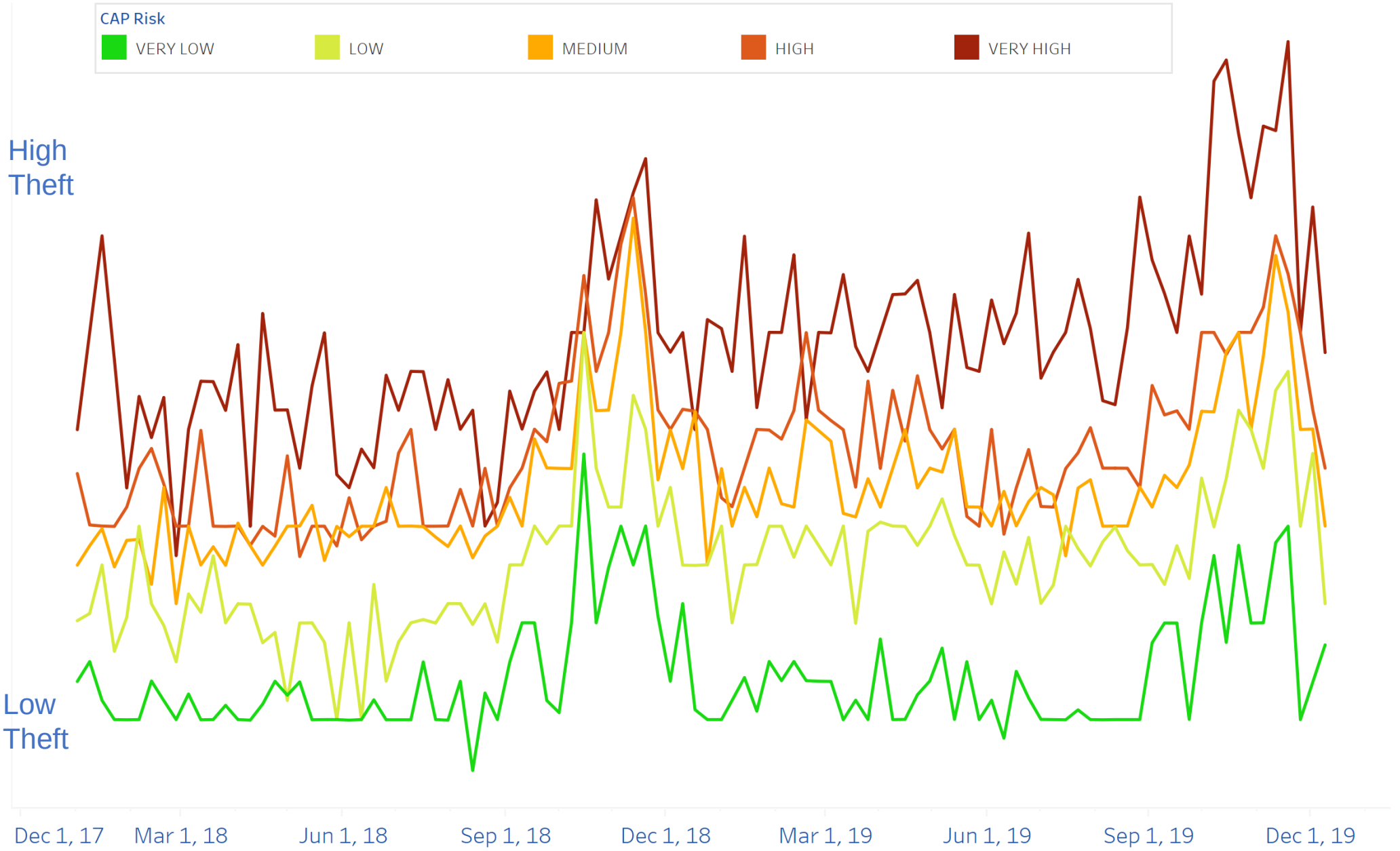
Average Prevented Theft (across different CAP scores)



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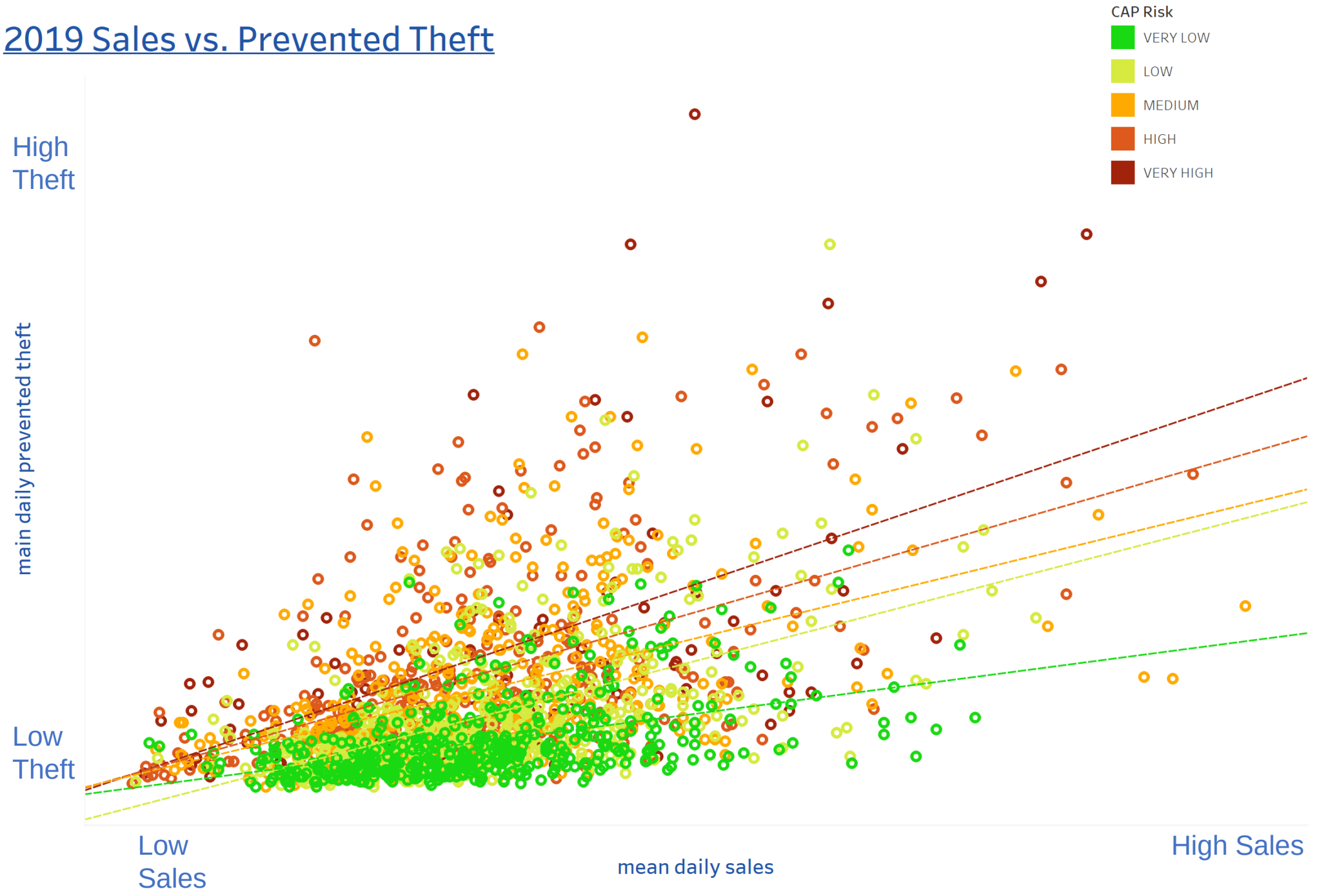
2019 Sales vs. Prevented Theft



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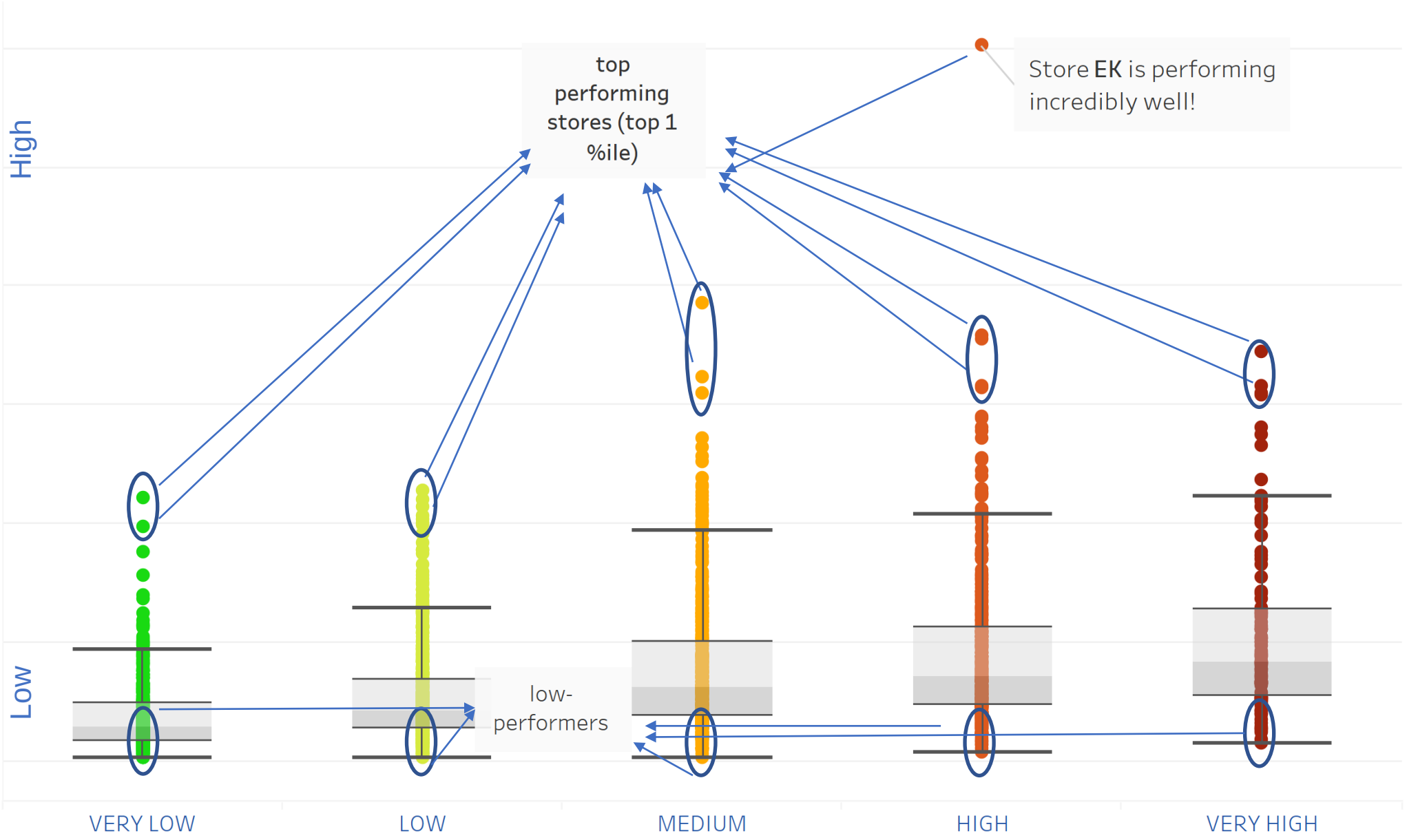
Prevented Theft as % of Sales



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Stores Redistributed: *from 'excellent' to 'very poor'*

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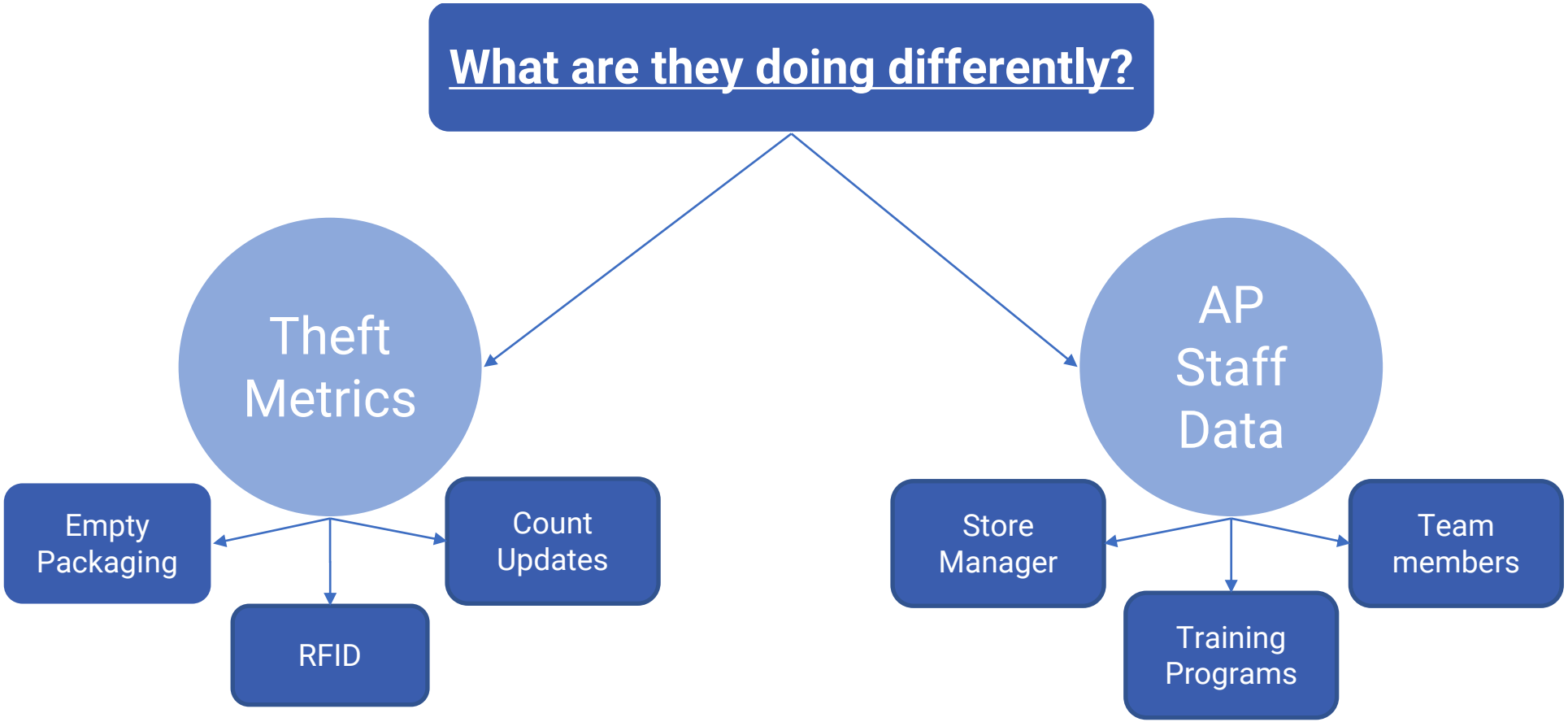
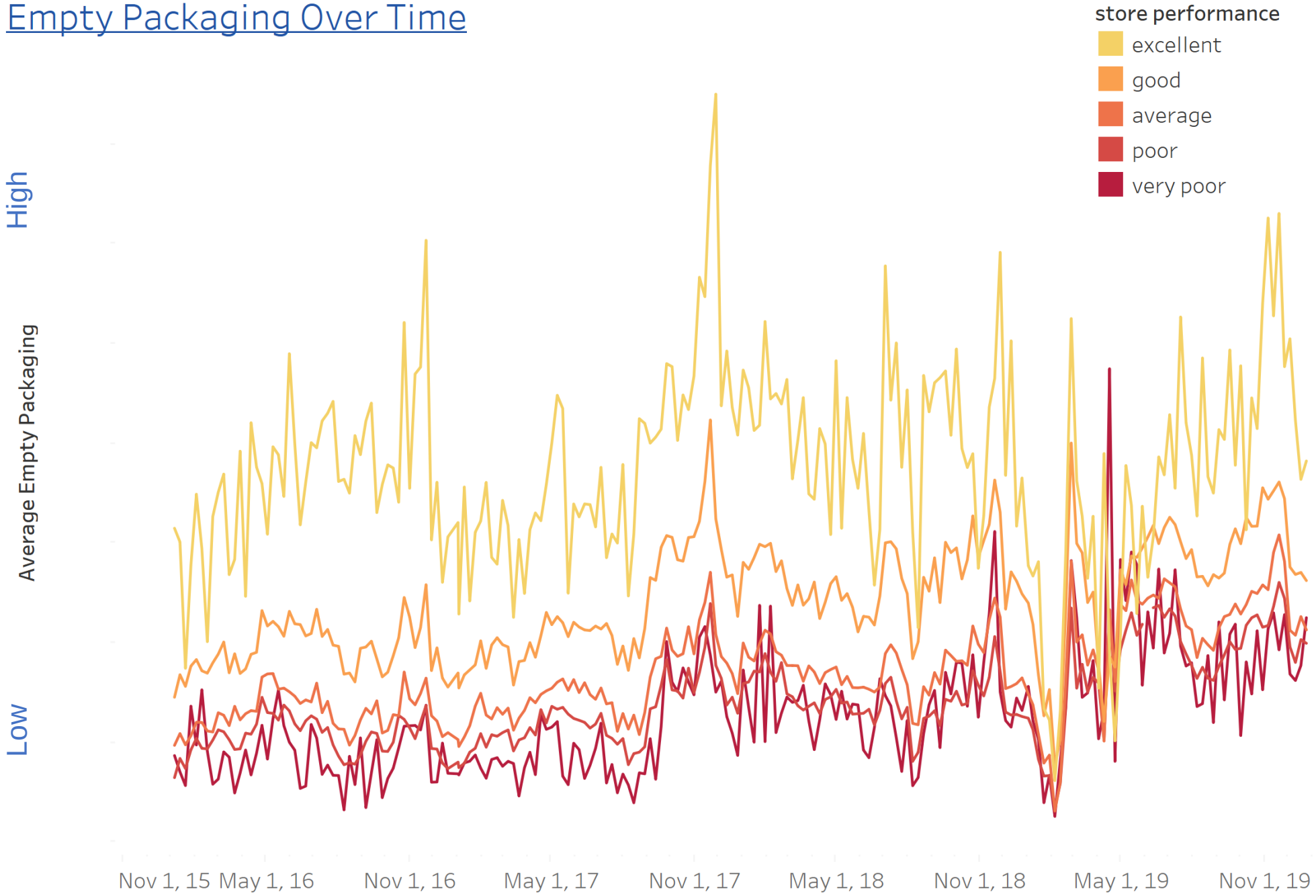
What Next?

Study best-performing stores



Empty Packaging Over Time



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Tracking AP team performance

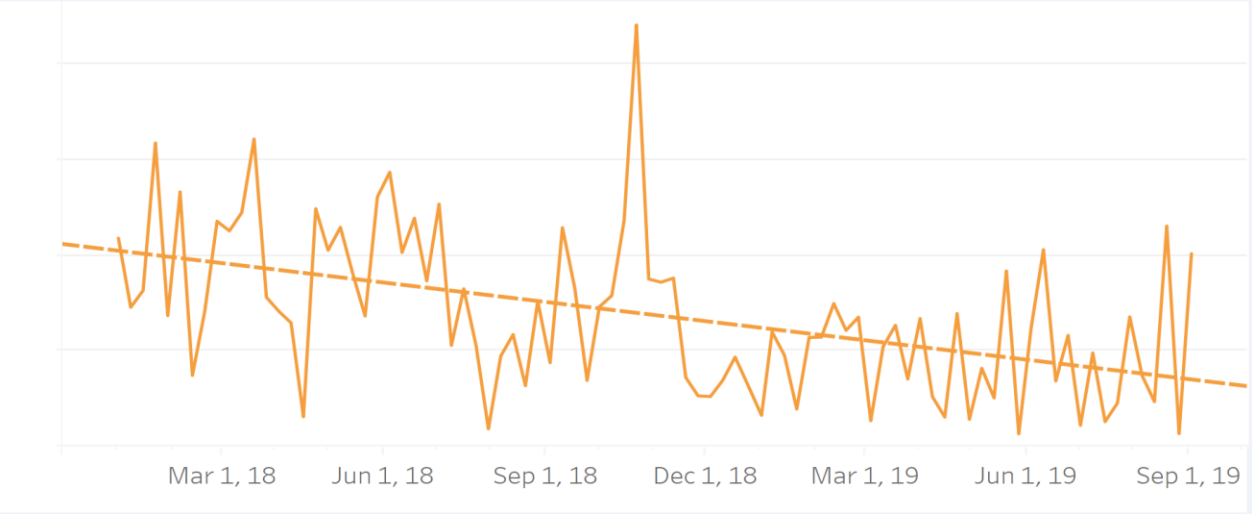
total prev. theft (str. 1): $$$ | total prev. theft (str. 2) : $$$ | % rel. diff.: %%

Select Store 1	Date Range 1 Begin	Date Range 1 End	Select Store 2	Date Range 2 Begin	Date Range 2 End
FY	1/1/2018	9/8/2019	KH	1/1/2018	12/9/2019

Prevented theft: Store 1

CAP Risk: HIGH

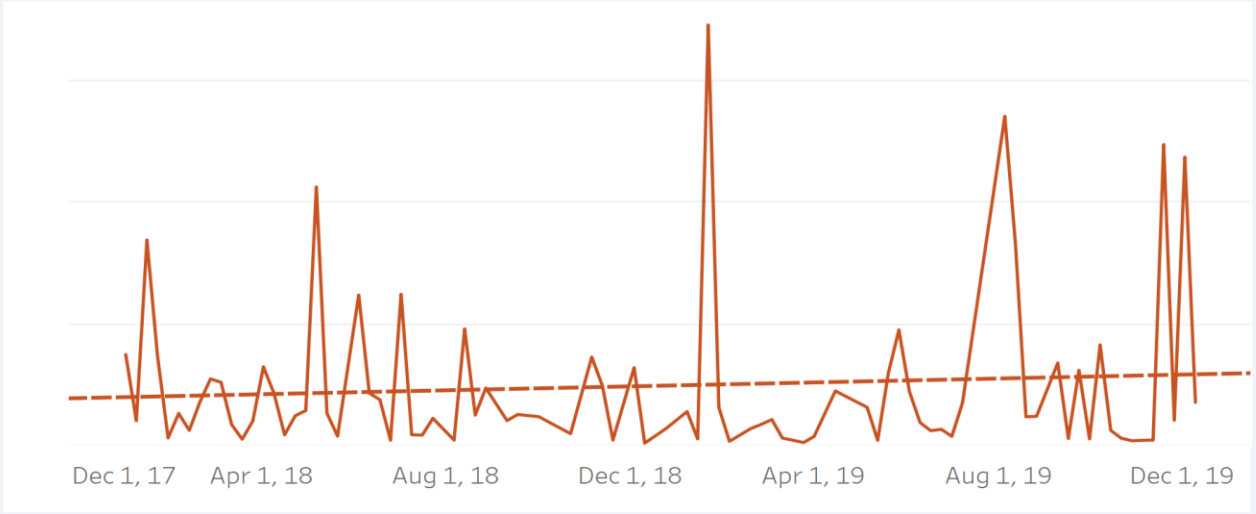
store status: good



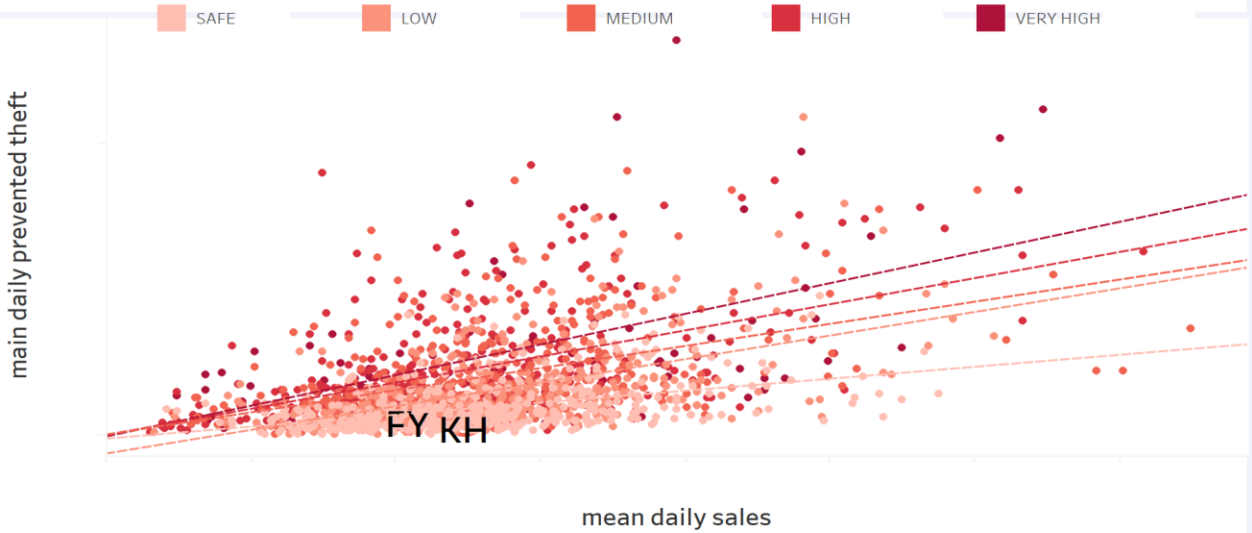
Prevented theft: Store 2

CAP Risk: MEDIUM

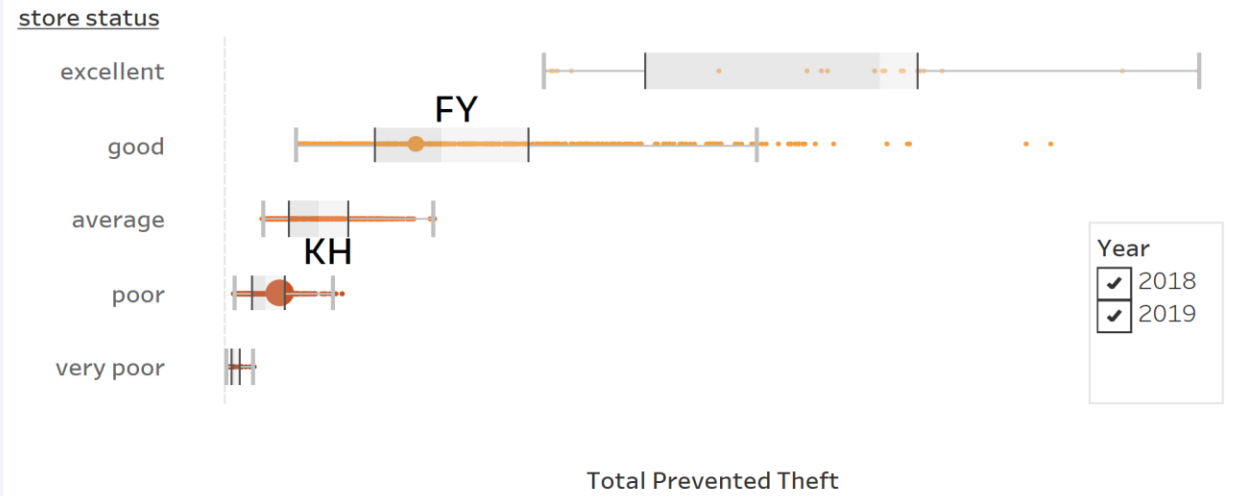
store status: poor



The Big Picture: 2019 Sales vs. Prevented Theft *(selected stores are highlighted)*



The Big Picture: Distribution of Stores *(selected stores are highlighted)*



Addressing Objective 2

Developing a way to optimize resources for AP Teams

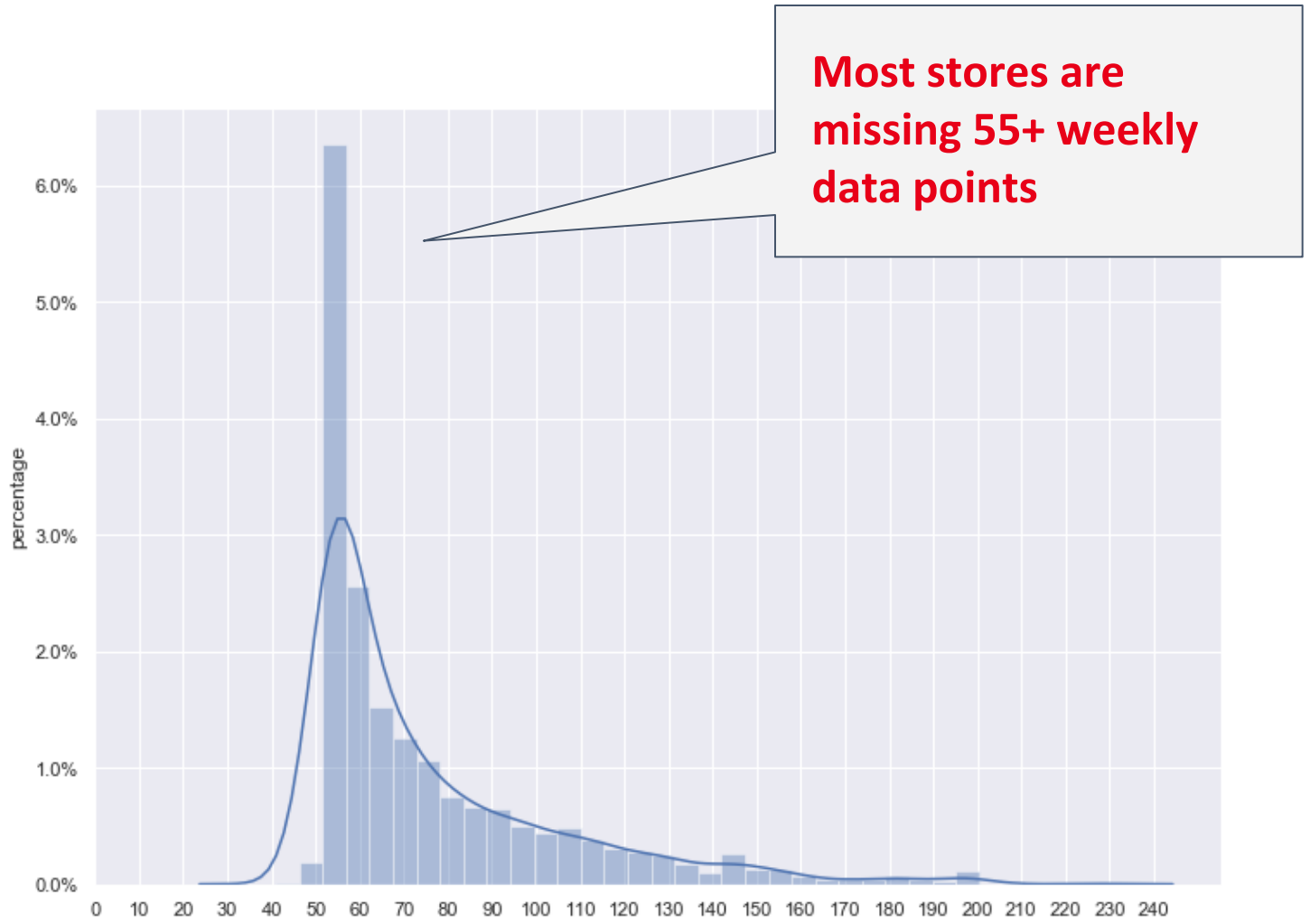
- Data-driven approach

3 Main Steps

- Clustering
- Time Series Forecasting
- Dashboards and Business Optimization

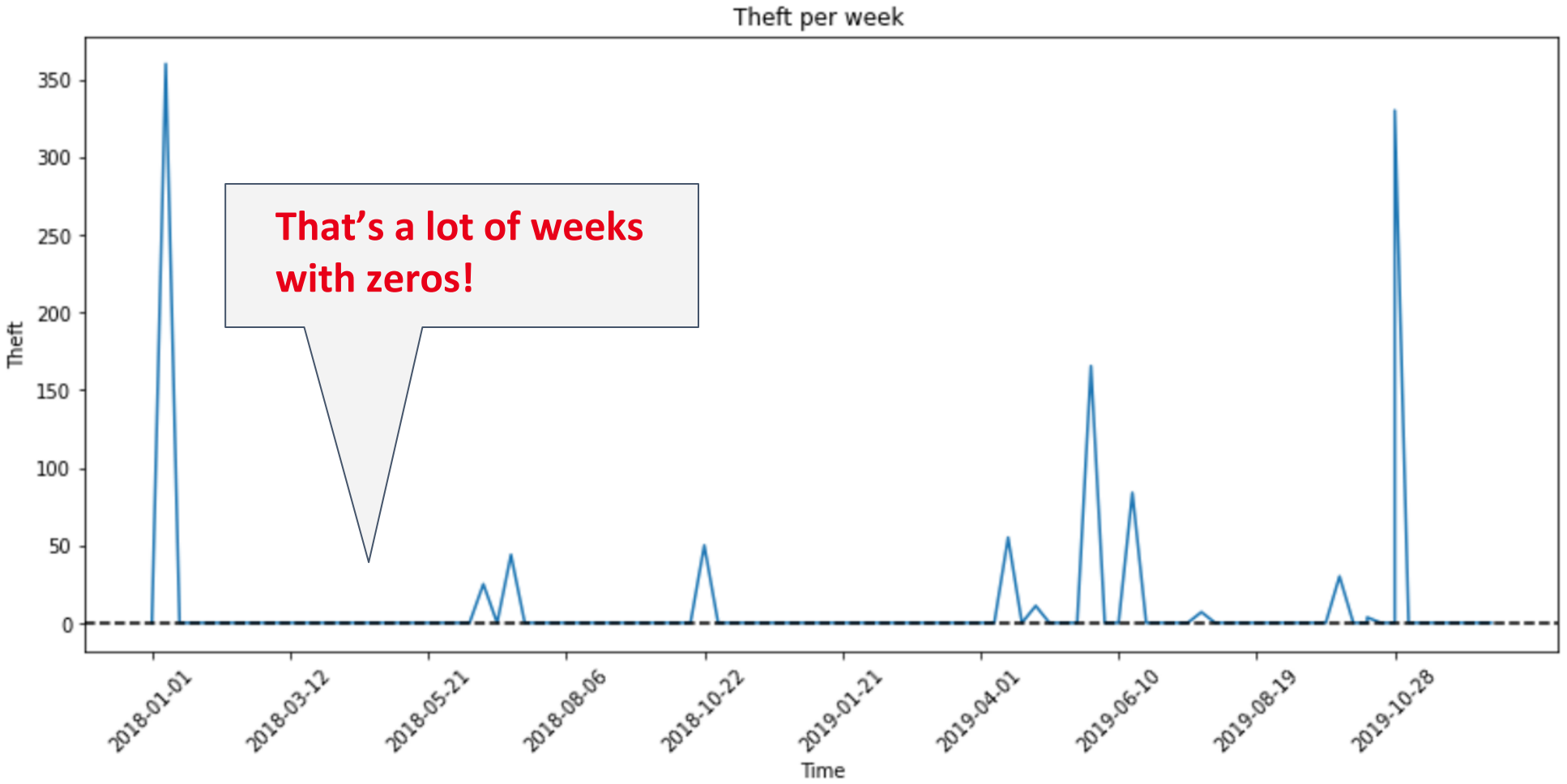

Clustering
Department
Ex. toys
Year
Ex. 2018
Week
Ex. 6
Theft Metric
Ex. Known loss
Store
Ex. ABX

Why Cluster?



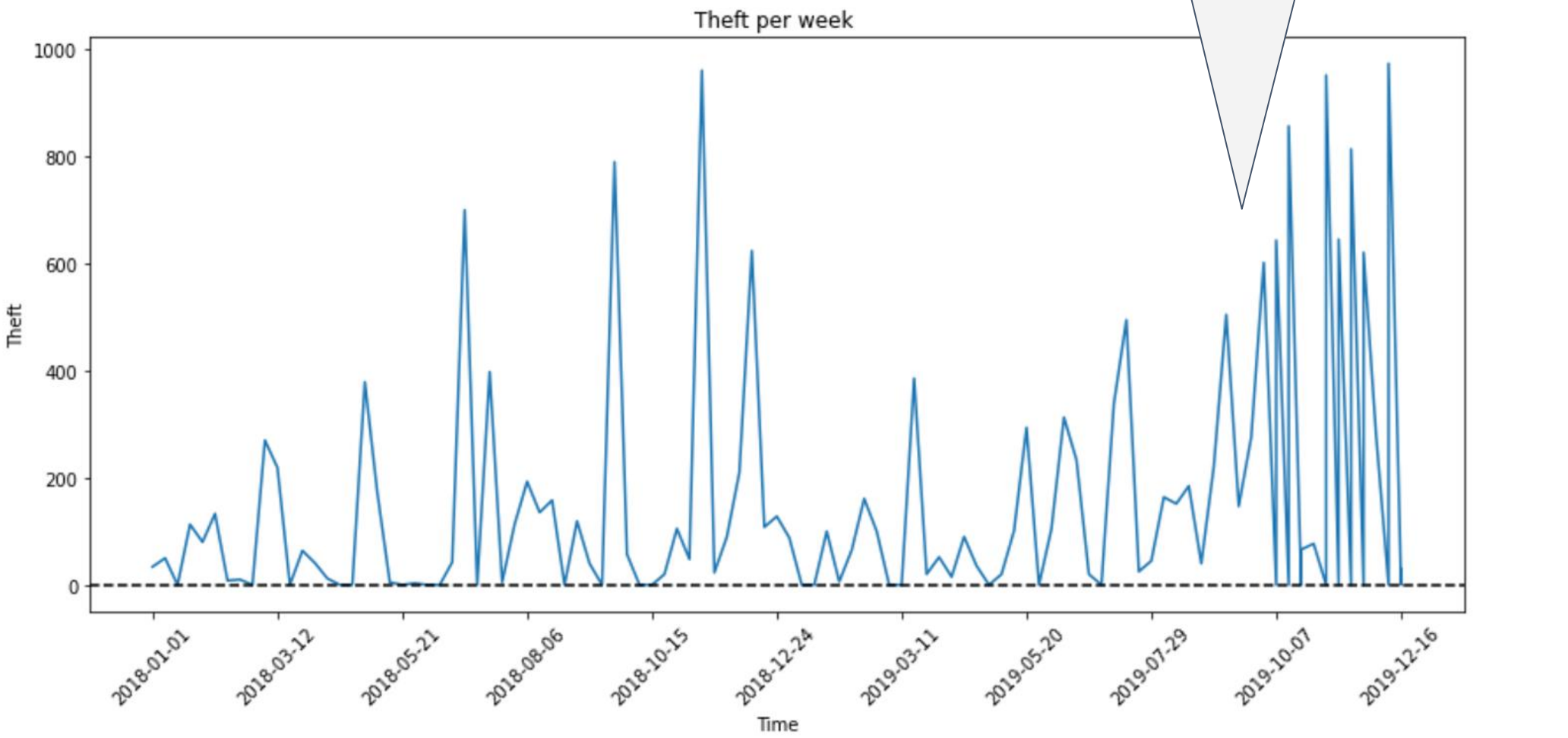
Worst Case Scenario

Store: BSS
Department: 1



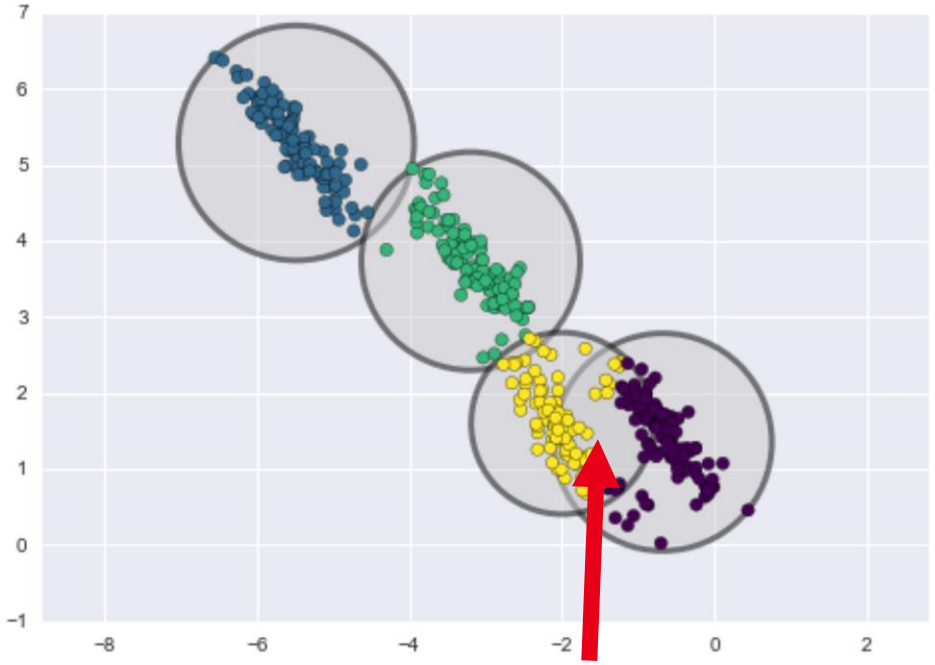
Best Case Scenario

Store: AHM
Department: 1

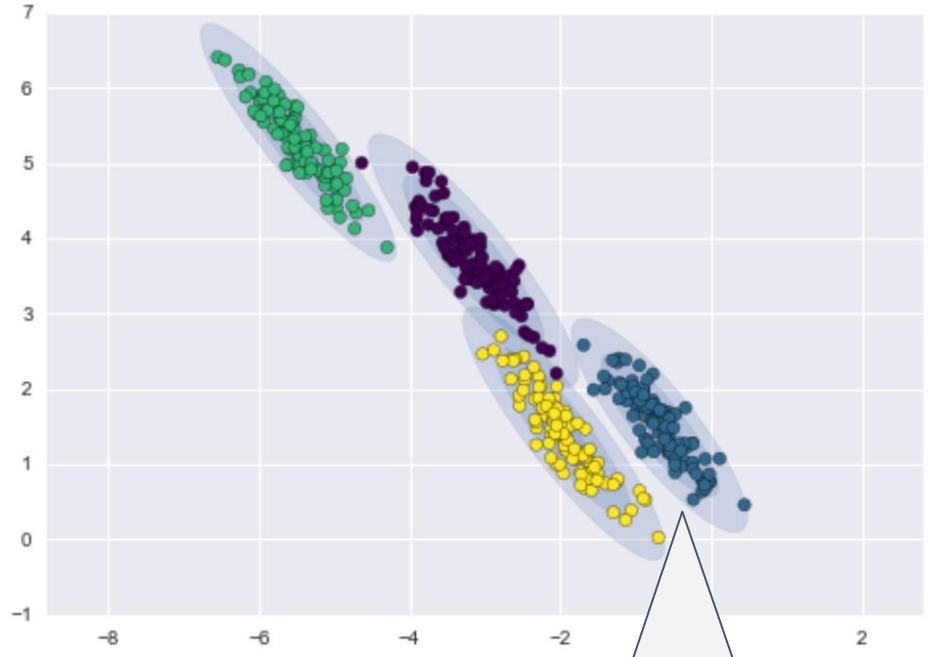


Clustering Method Used: Gaussian Mixture Models

K-means (most common)



GMM (most optimal)



It's just a different shape.

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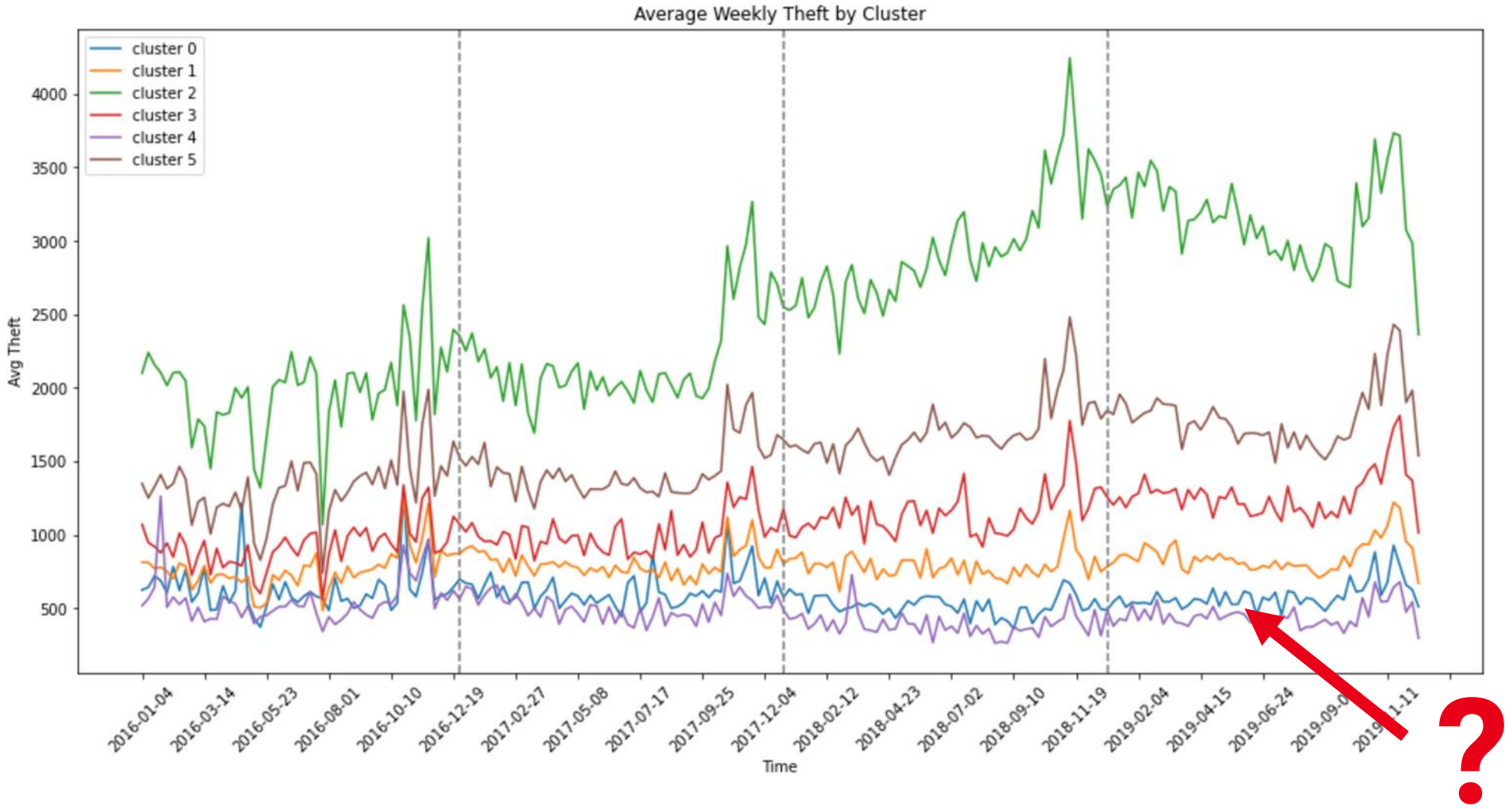
Attributes used for clustering

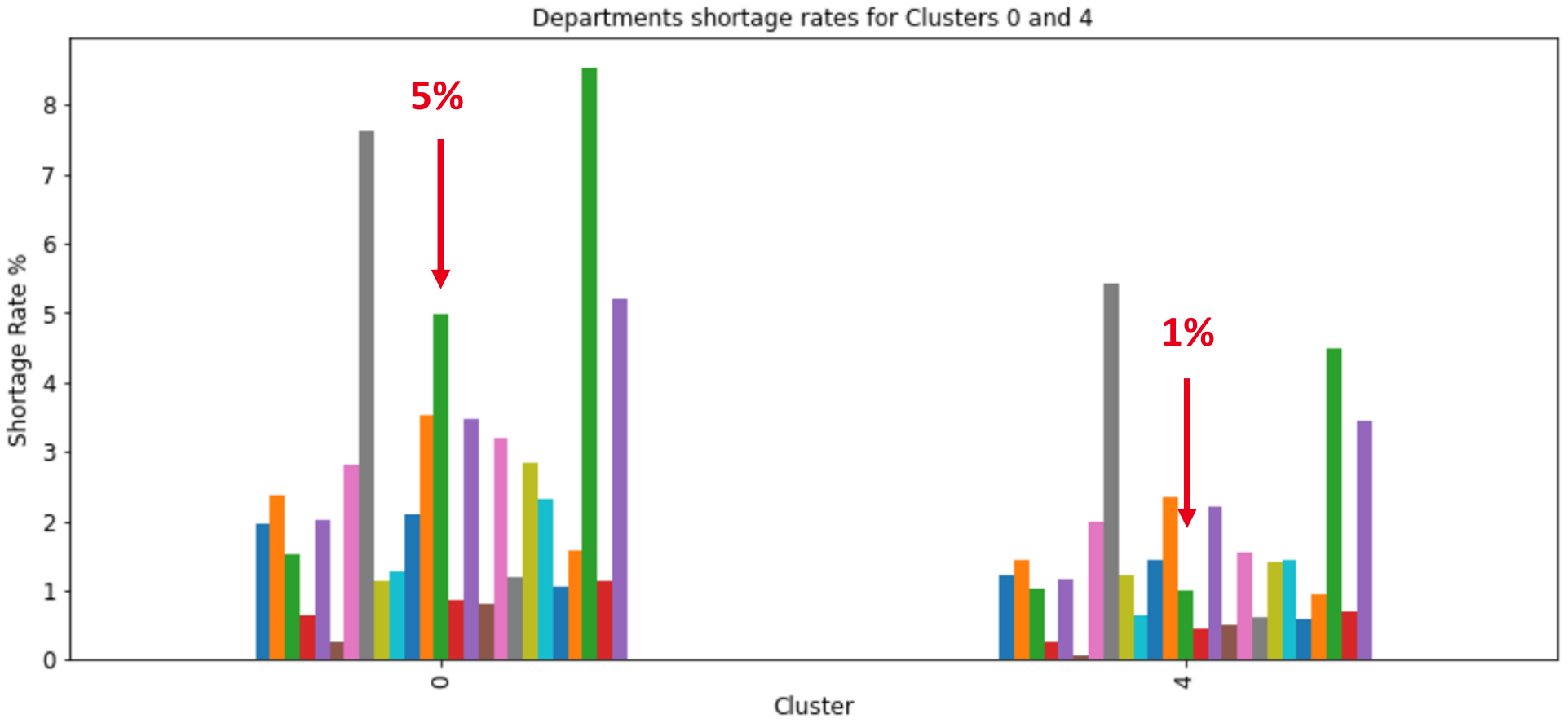
- **Quarterly theft figures**
  - 13 quarters used

- **Department shortage rates**
  - 26 departments

Clustering stores with similar theft patterns solves the missing data problem



Although clusters 0 and 4 have similar theft figures, their shortage rates differ across departments



Forecasting Theft: Predicting Future Trends

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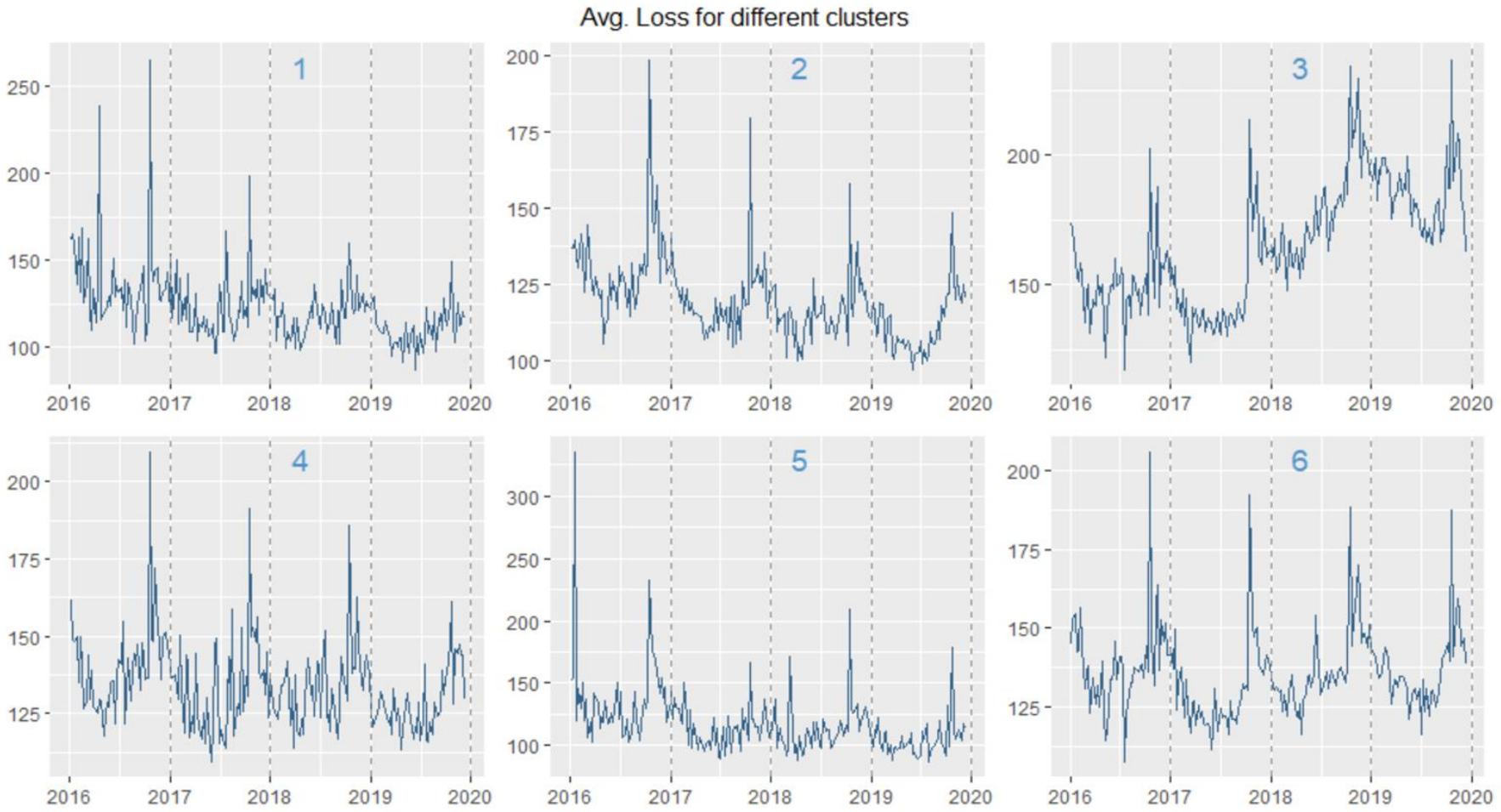
Optimizing Resource Allocation: Forecasting Theft



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Optimizing Resource Allocation: Forecasting Theft

700

Time Series Models:
automated the forecasting process

5

Different Model Families:
ARIMA, TBATS, hybrid, fourier terms, ensemble

3

Benchmark Metrics:
mean, naïve, seasonal naïve

Purpose: Update AP hours allocated to each department every week

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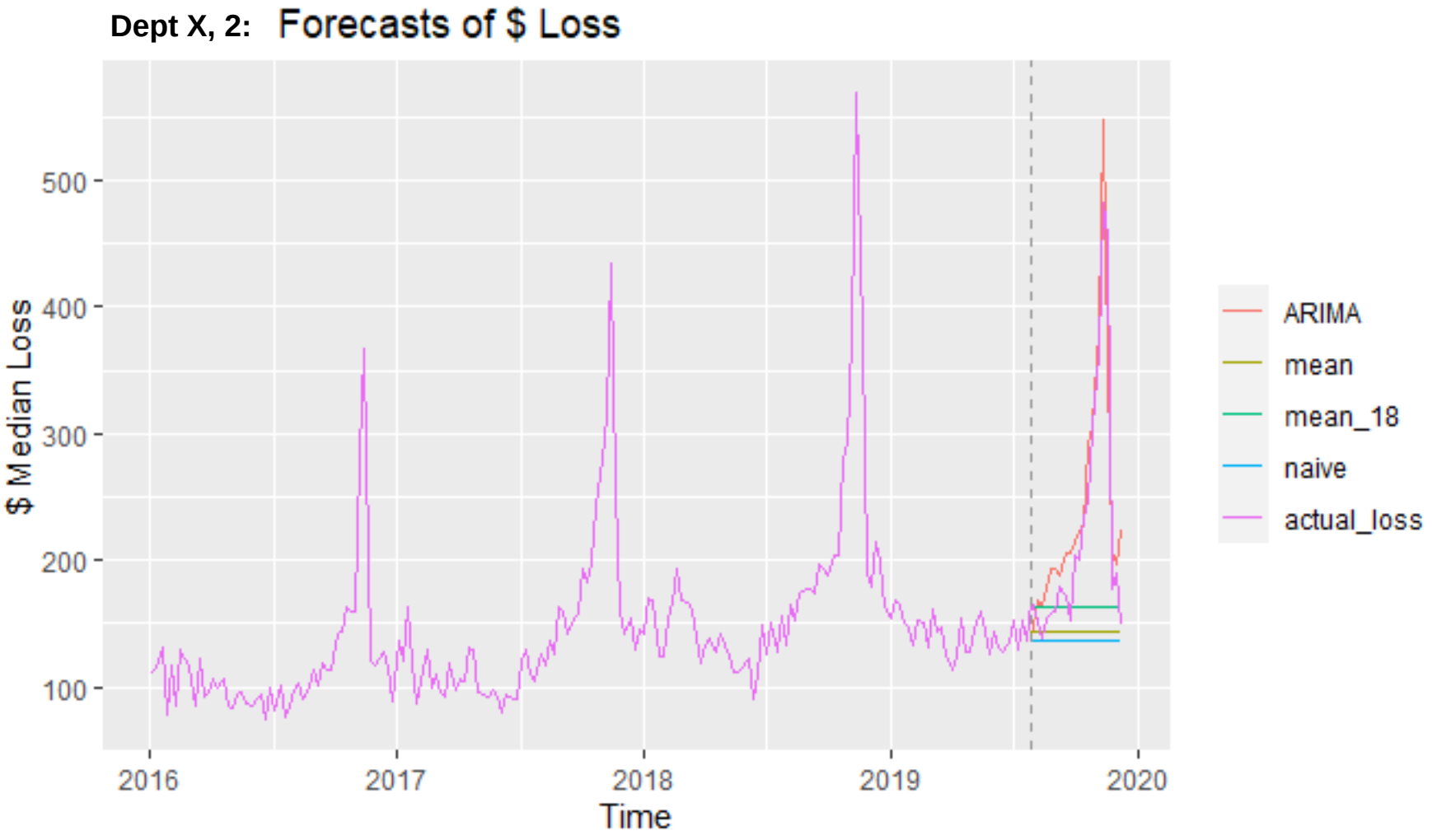
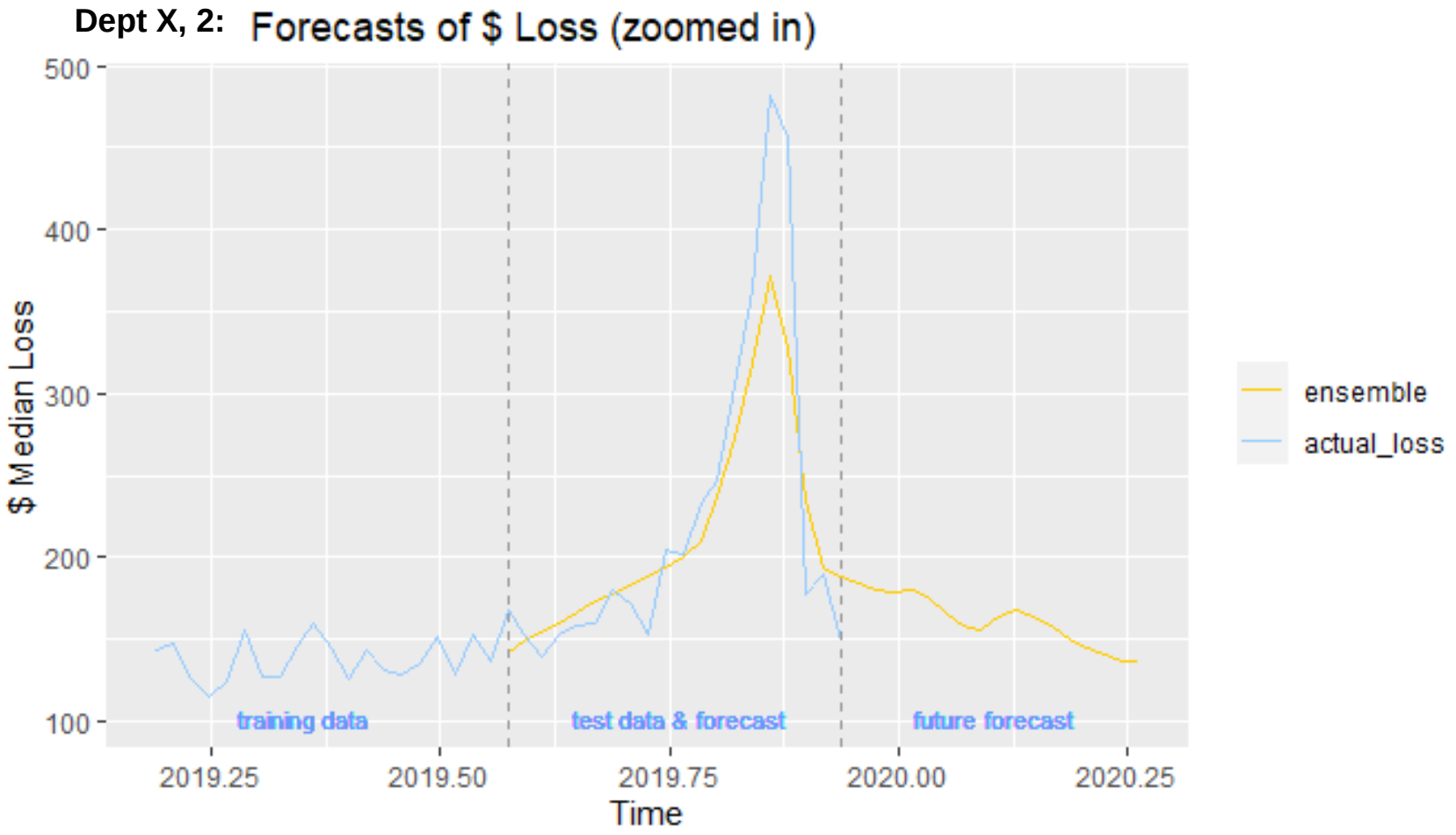
Good Forecastability

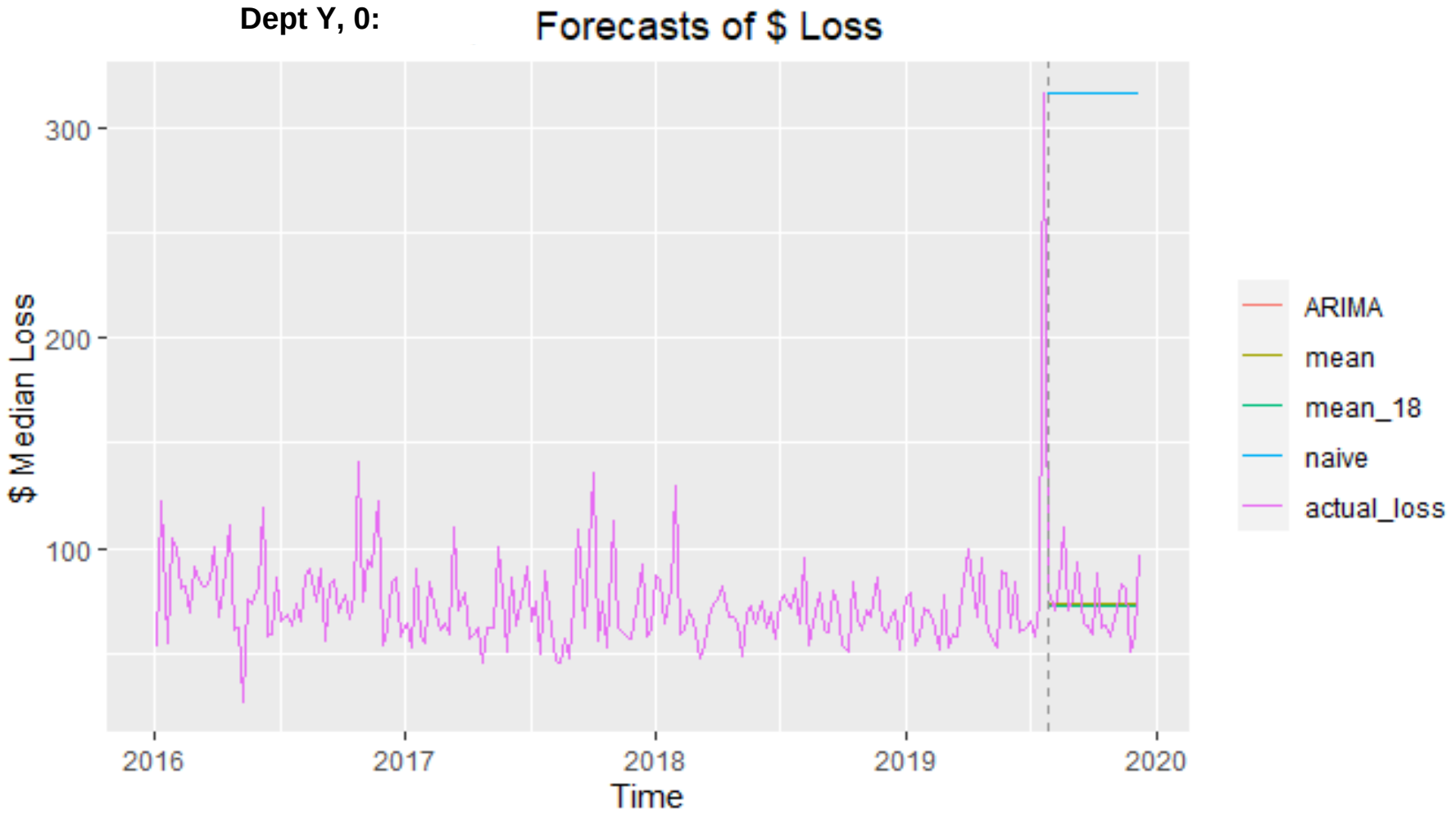


Good Forecastability



High Variation

Dept Y, 0:



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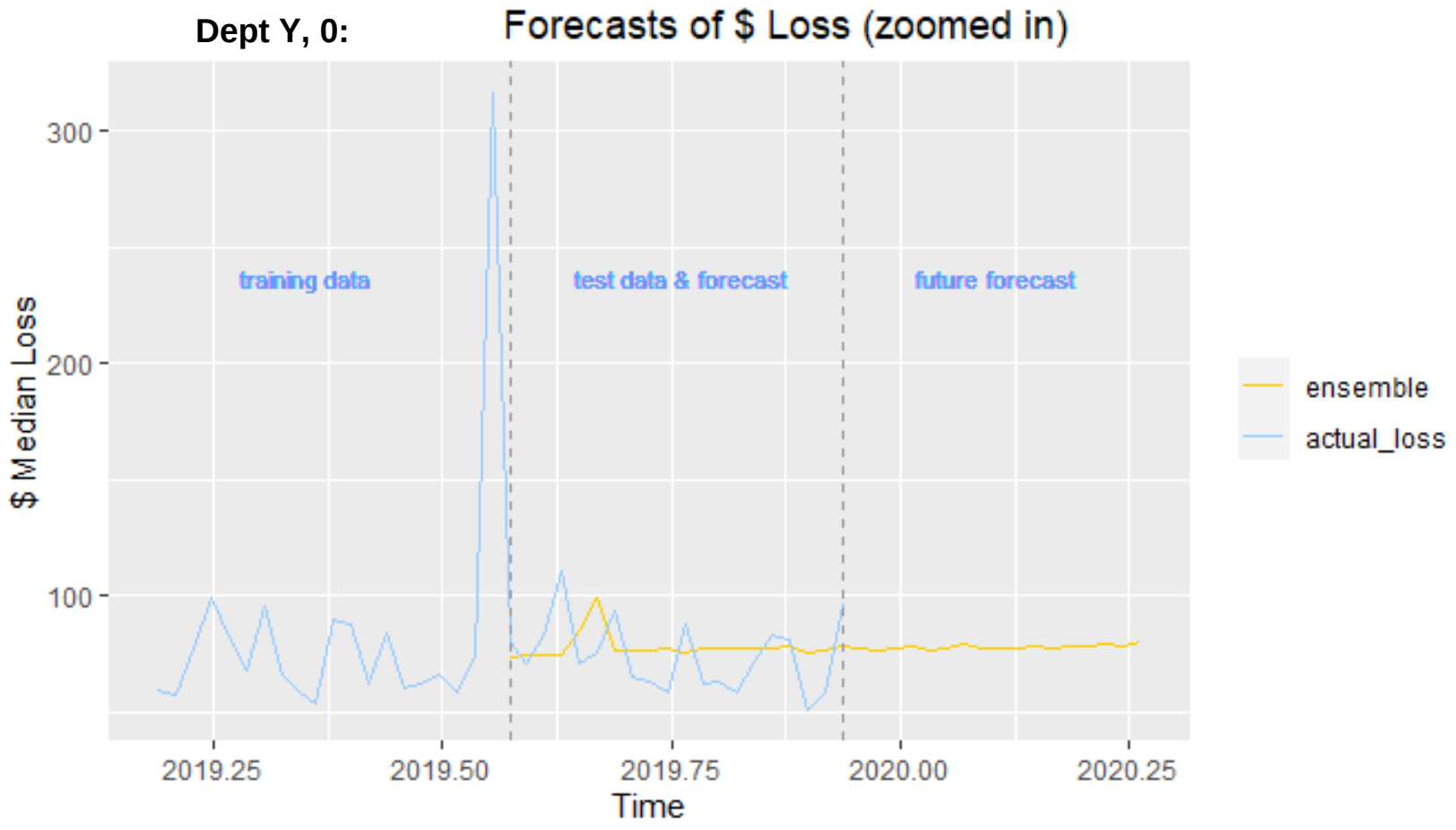
Noisy/Little Structure



How do we improve theft forecasts?

1. Prediction intervals for forecasts
2. Data on **special events** to explain sharp spikes/drops in $ loss
   - weekly promotions
   - anomalous store operations
   - holidays
   - weather forecasts
3. Recalibrate forecasts: COVID-19

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Optimizing Resource Allocation: Results and Dashboards

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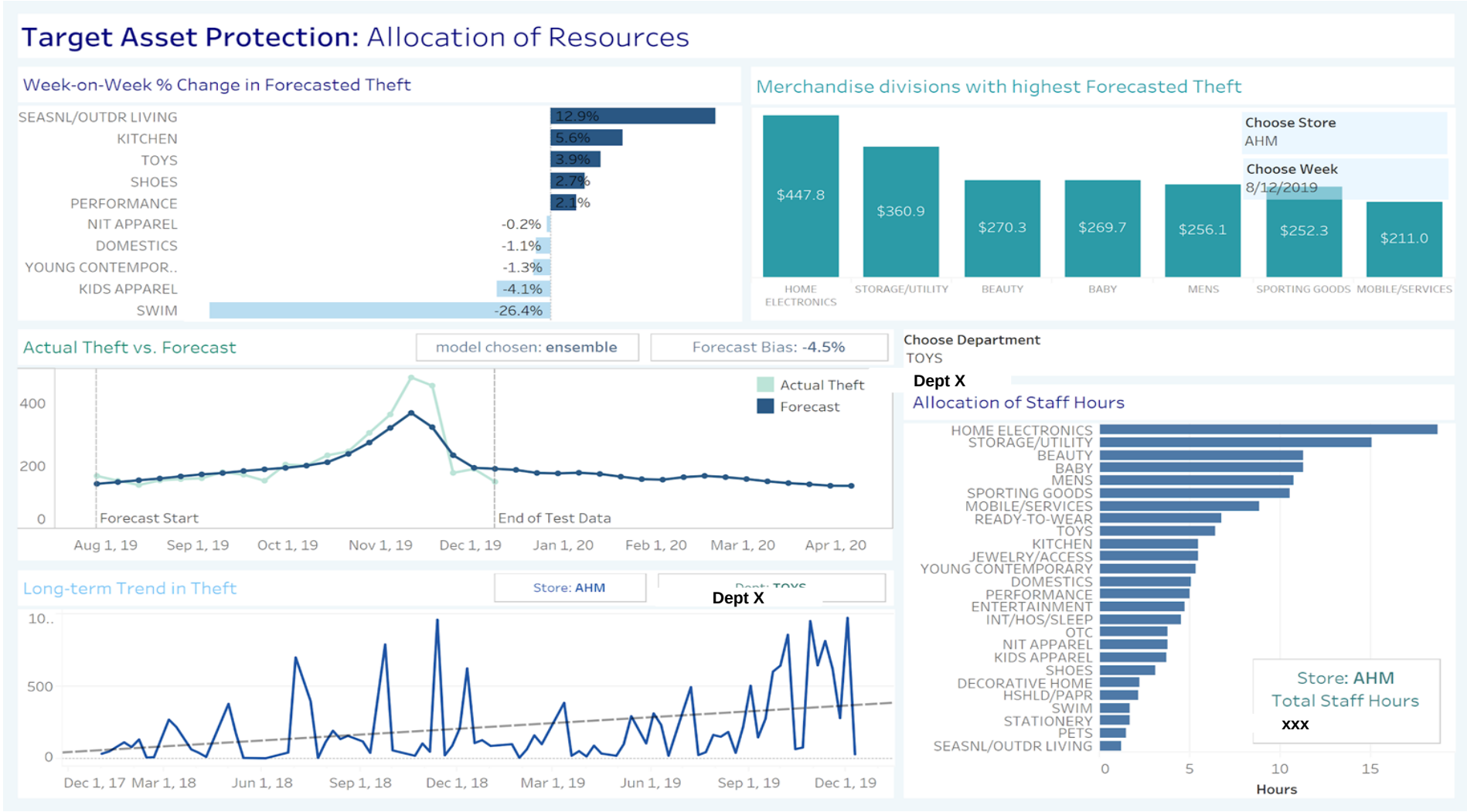
AHM Department X



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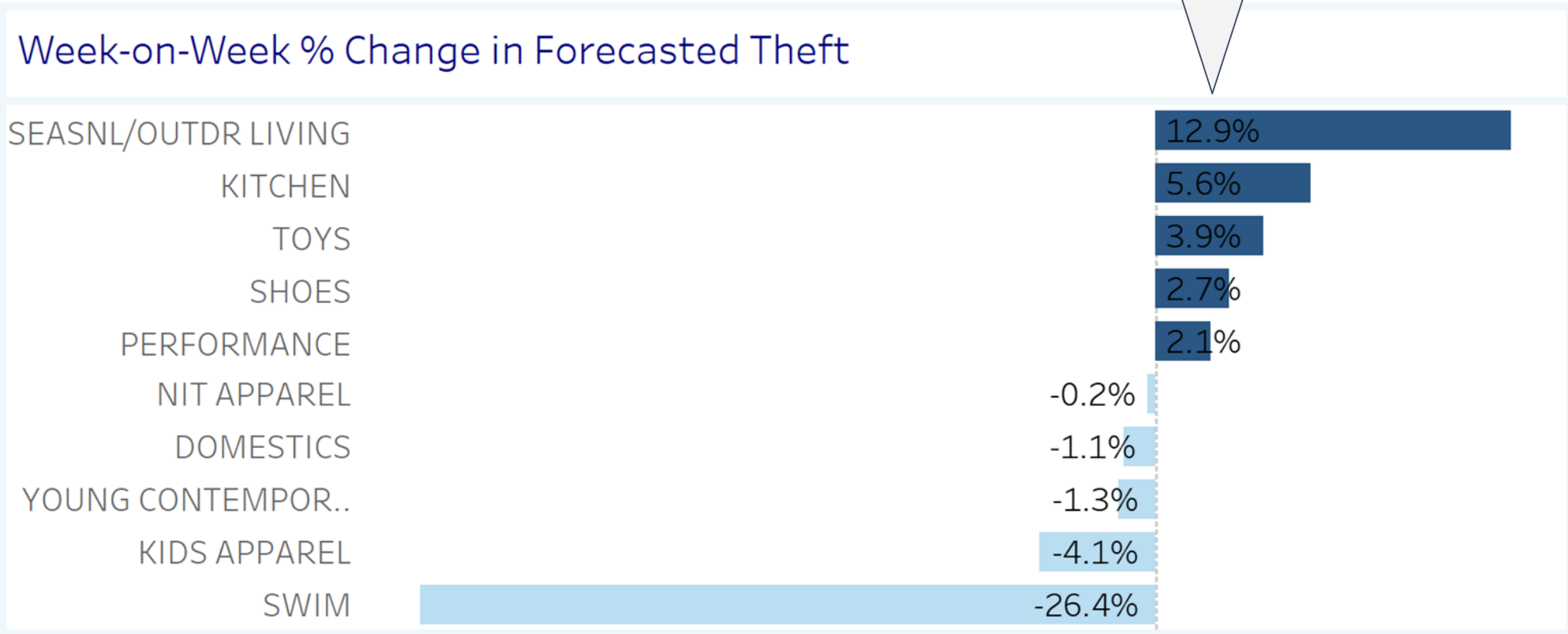
These 5 departments should experience a spike next week



These 5 departments should experience a dip next week

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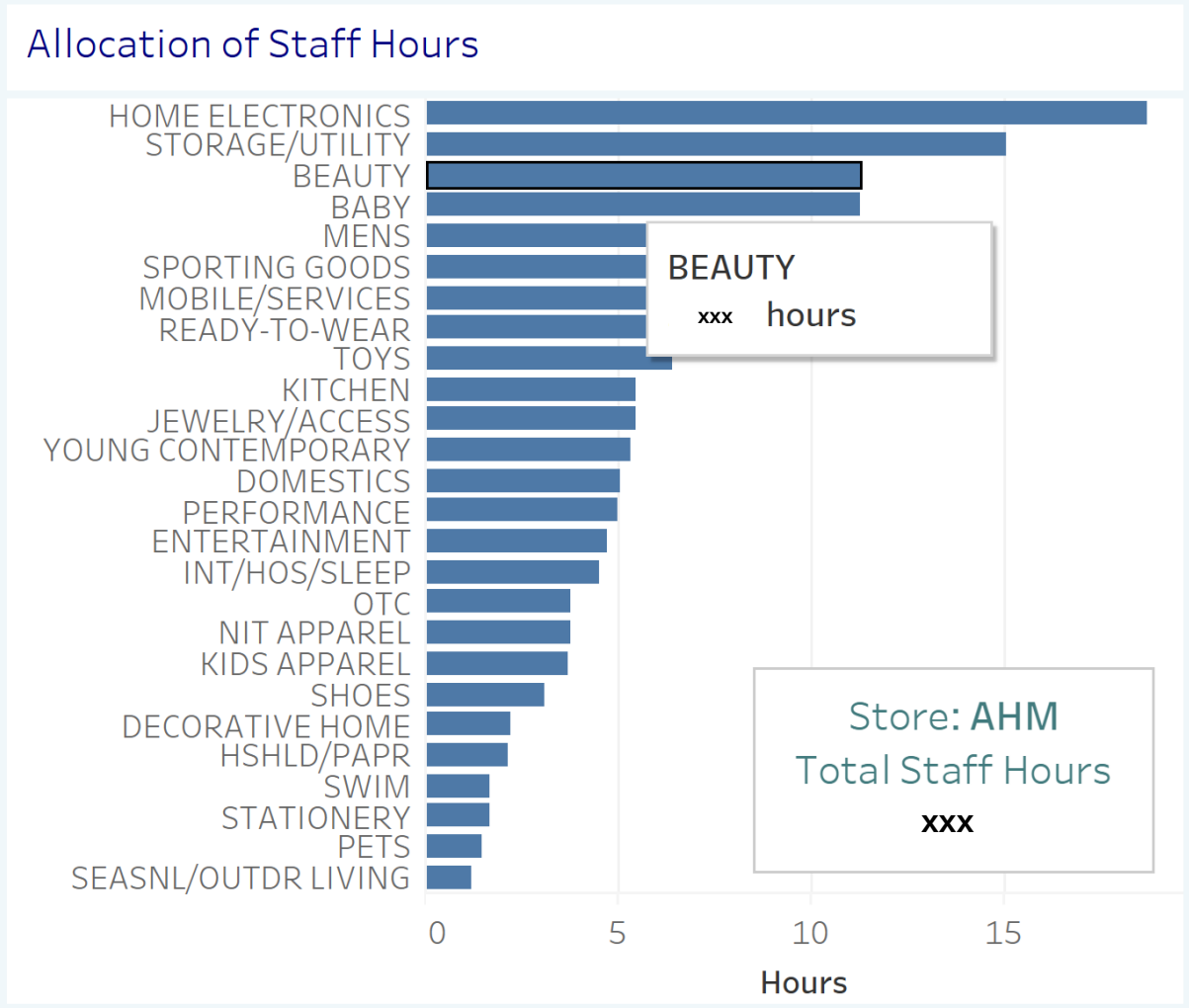
Allocate % of time in labor hours to areas that are predicted to experience that portion of theft



The week-on-week % change from the previous slide is reflected here

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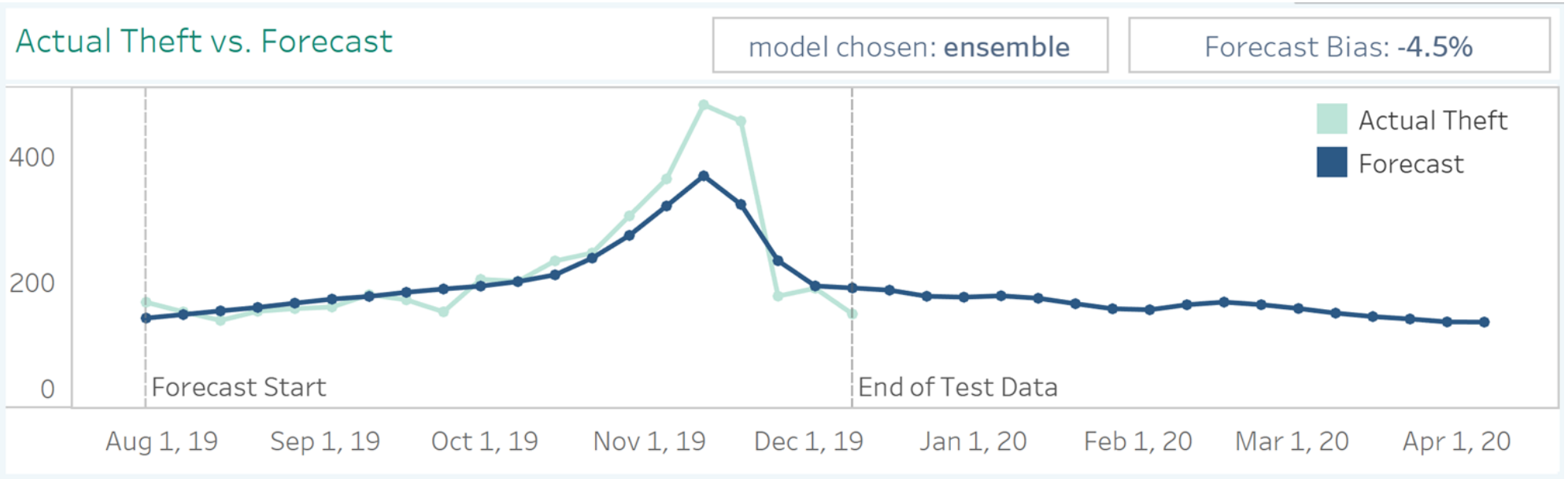
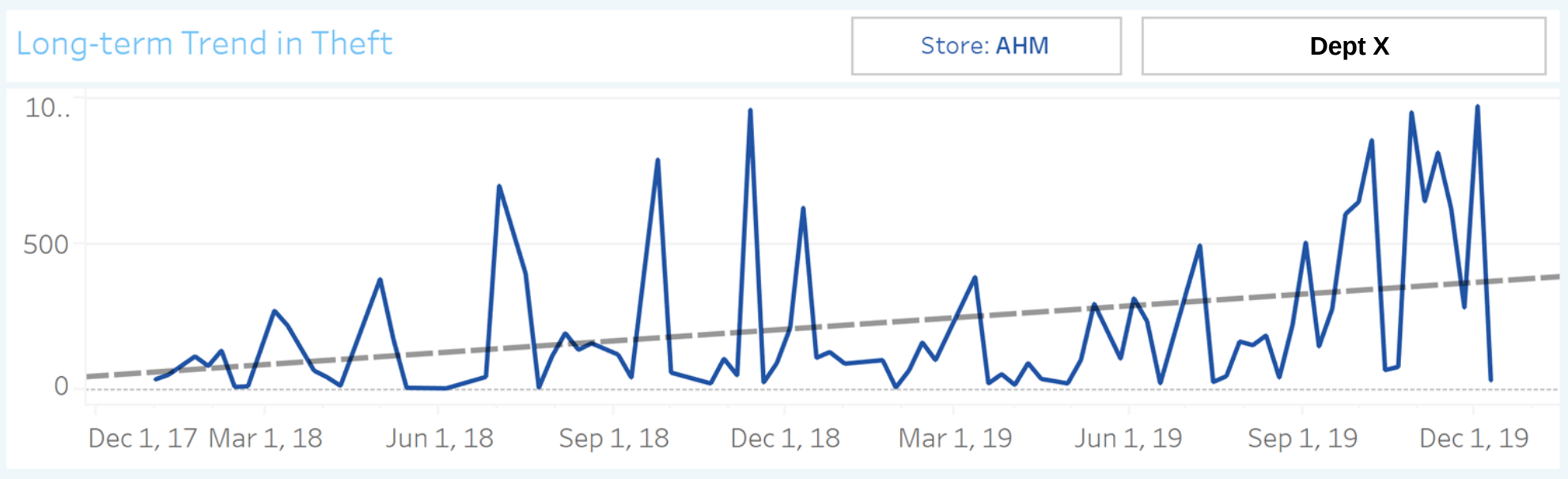
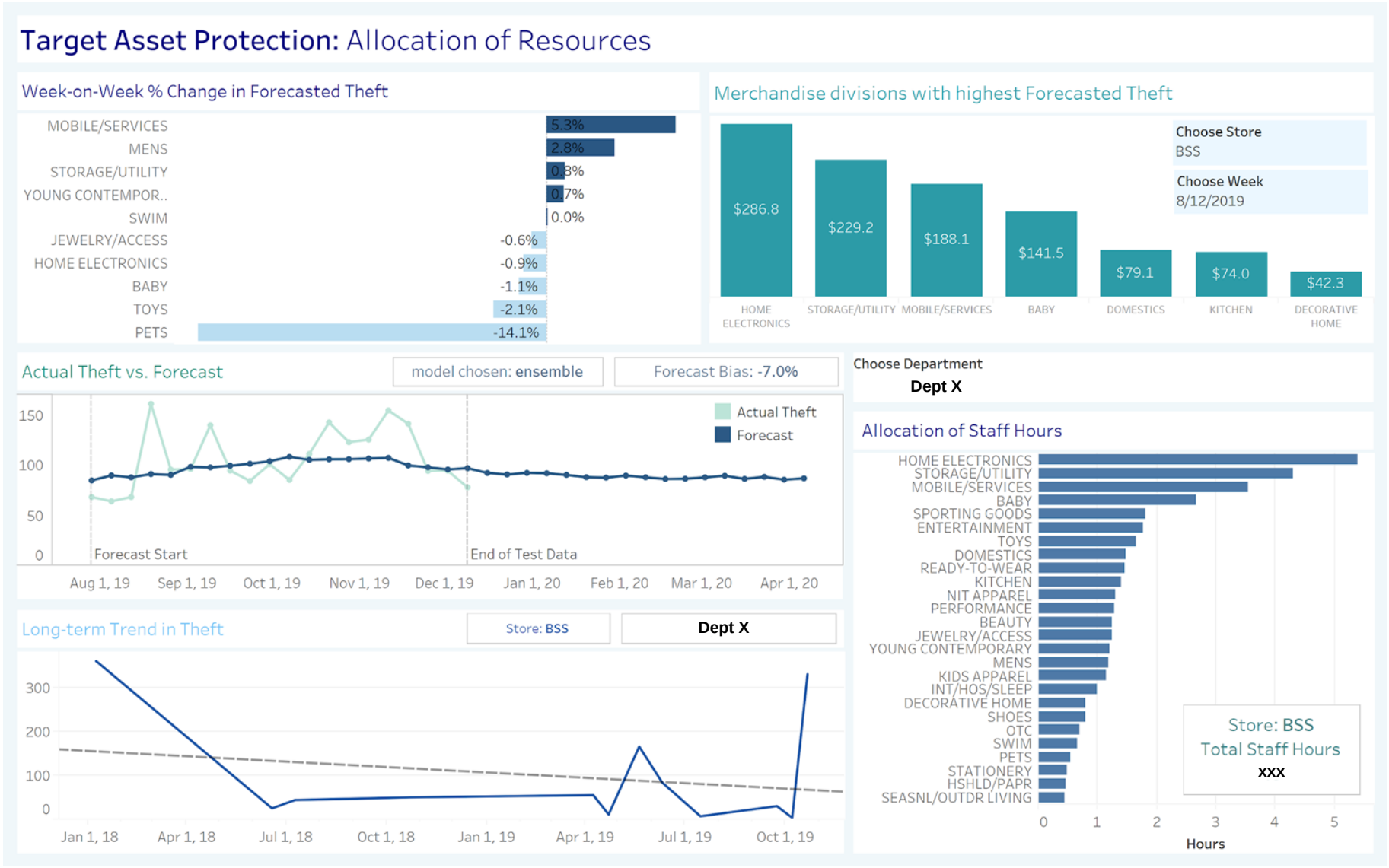
This cluster's forecast has a pretty good fit, only slightly under-estimating the actual theft



A positive long term trend may suggest [...]



BSS Department X



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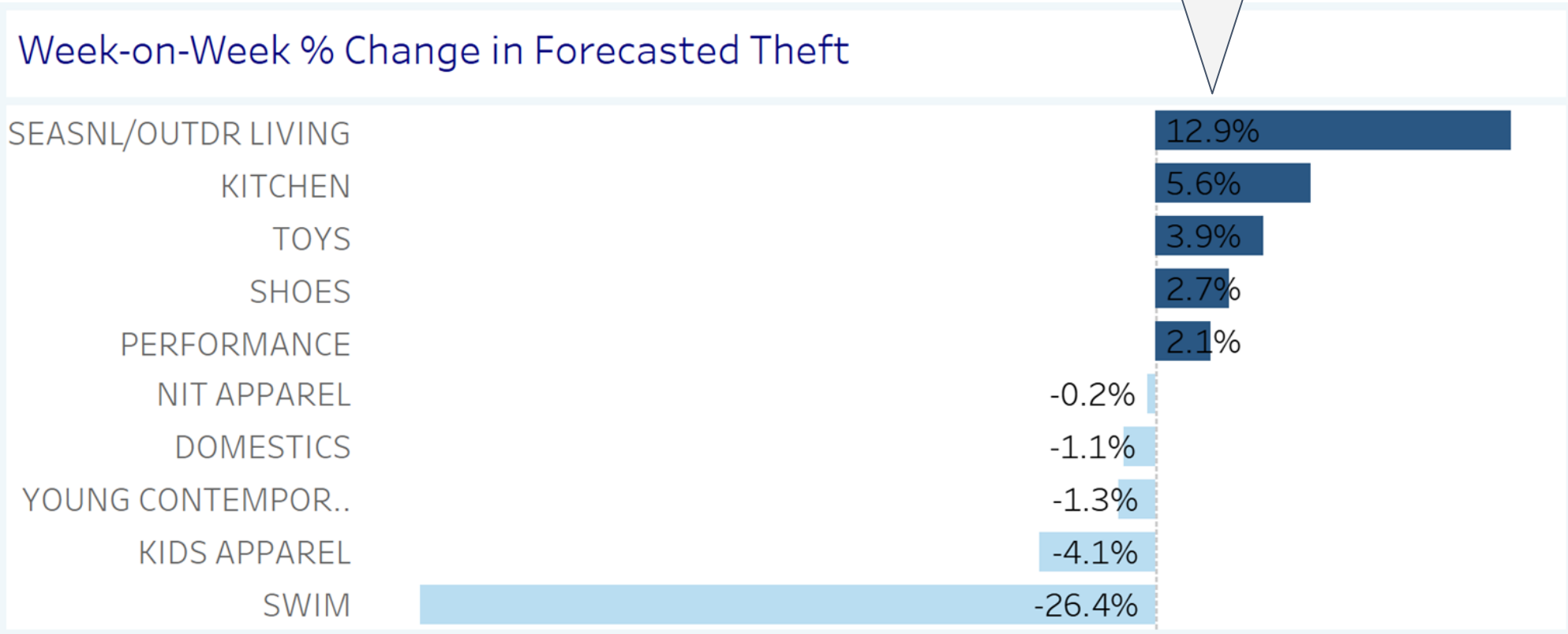
These 5 departments should experience a spike next week



These 5 departments should experience a dip next week

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Conclusions and Implementation

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Measuring AP Team Performance

- Trend Extraction
- CAP Score Segmentation

AP Team Resource Optimization

- Clustering
- Time Series Forecasting
- Resource Allocation Dashboard

Implementation

- Corporate level
- Trickle-down to store level

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