



What **WEAR** *When?*

Demand Forecasting for Future Fashion Products

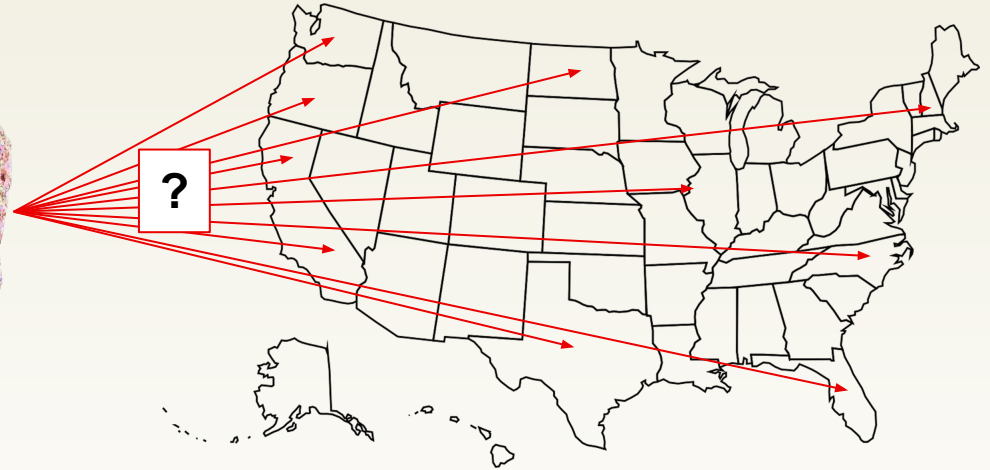
Alex Birch
Vincent Lao

Iris Singhanian
Jingjing Ni

*"Pink top, long slv
ruched floral style
blouse spring, weekend
retreat, drawstring front
elasticized details
sleeves Kit & Sky..."*



*“Pink top, long slv
ruched floral style
blouse spring, weekend
retreat, drawstring front
elasticized details
sleeves Kit & Sky...”*



Project Context - Macy's

446

Macy's department stores

4.3B+

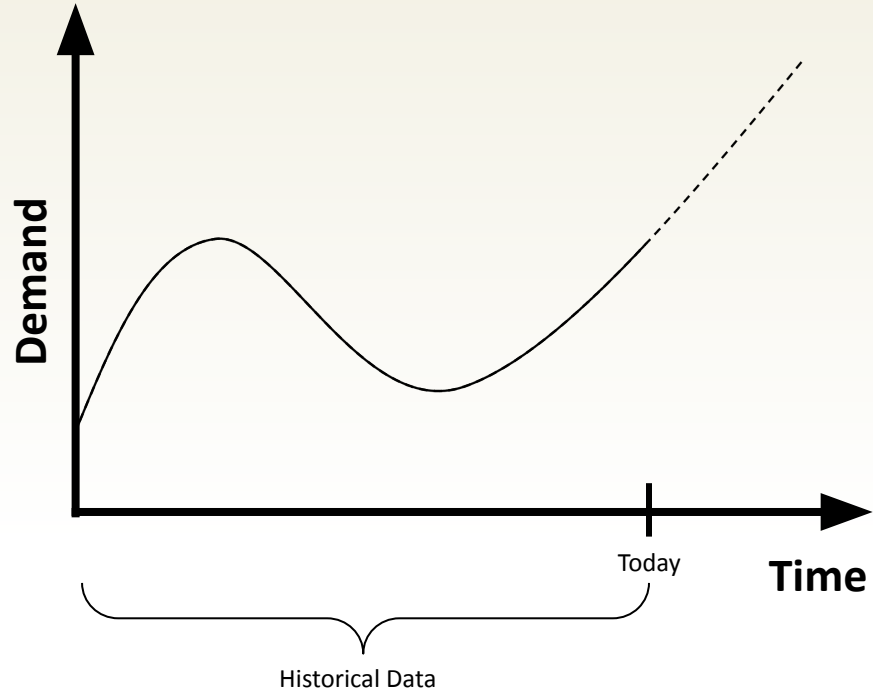
women's apparel revenue

24B+

total annual revenue

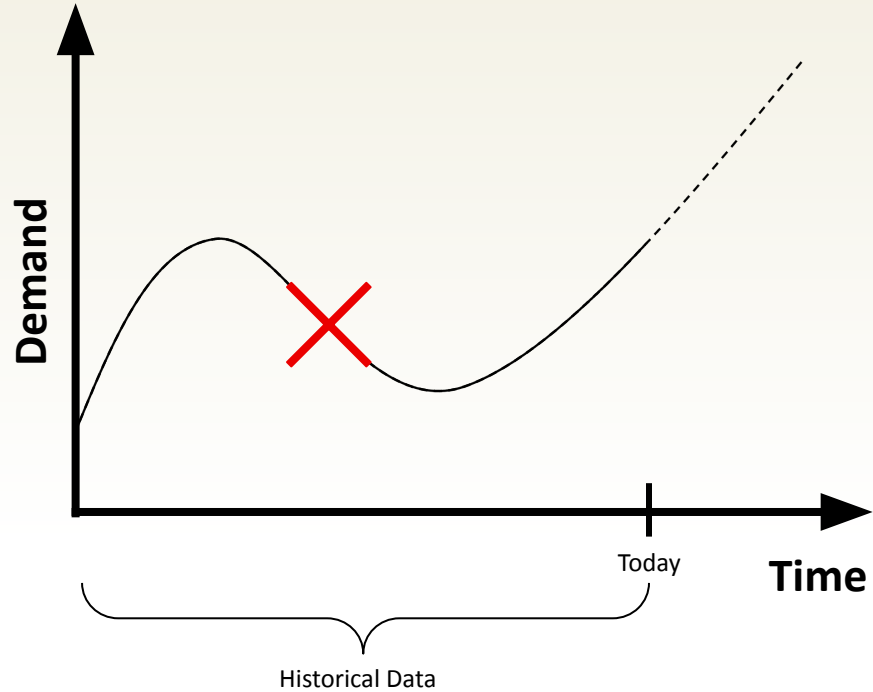
Project Context - Forecasting

Traditionally:



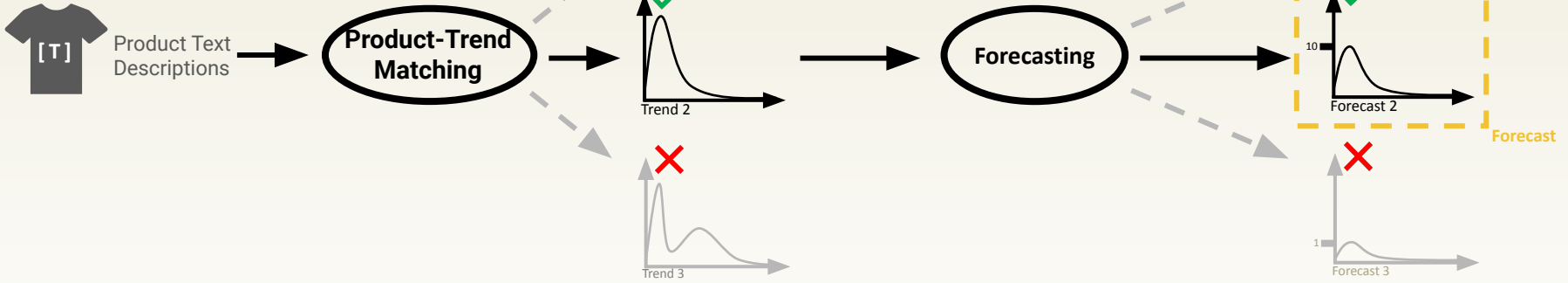
Project Context - Forecasting

Our Project:

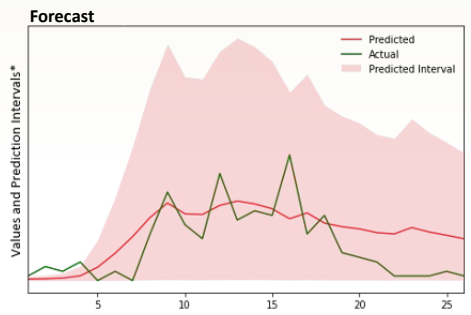


How do we do it?

Model Framework



"Pink top, long slv ruched floral style blouse spring, weekend retreat, drawstring front elasticized details sleeves Kit & Sky..."



Jan-Jun 2023

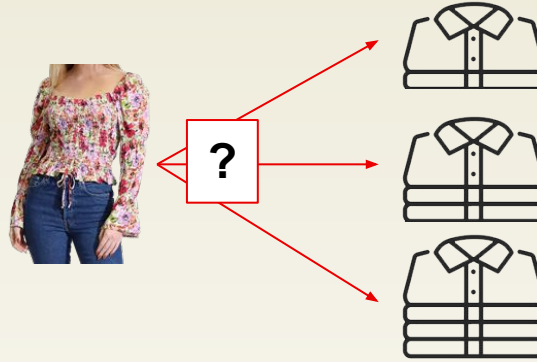


Herald Square, NYC

Results

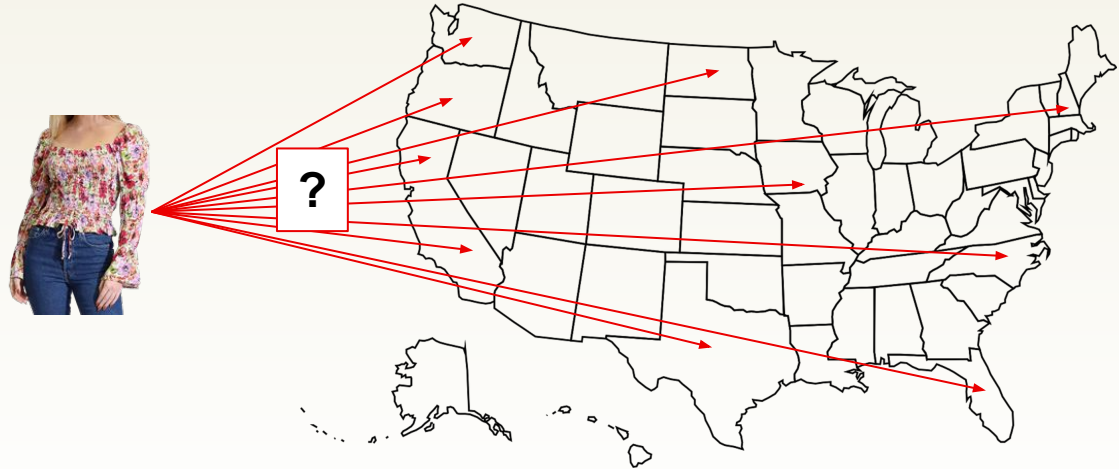
Use Case 1

Buy Forecast

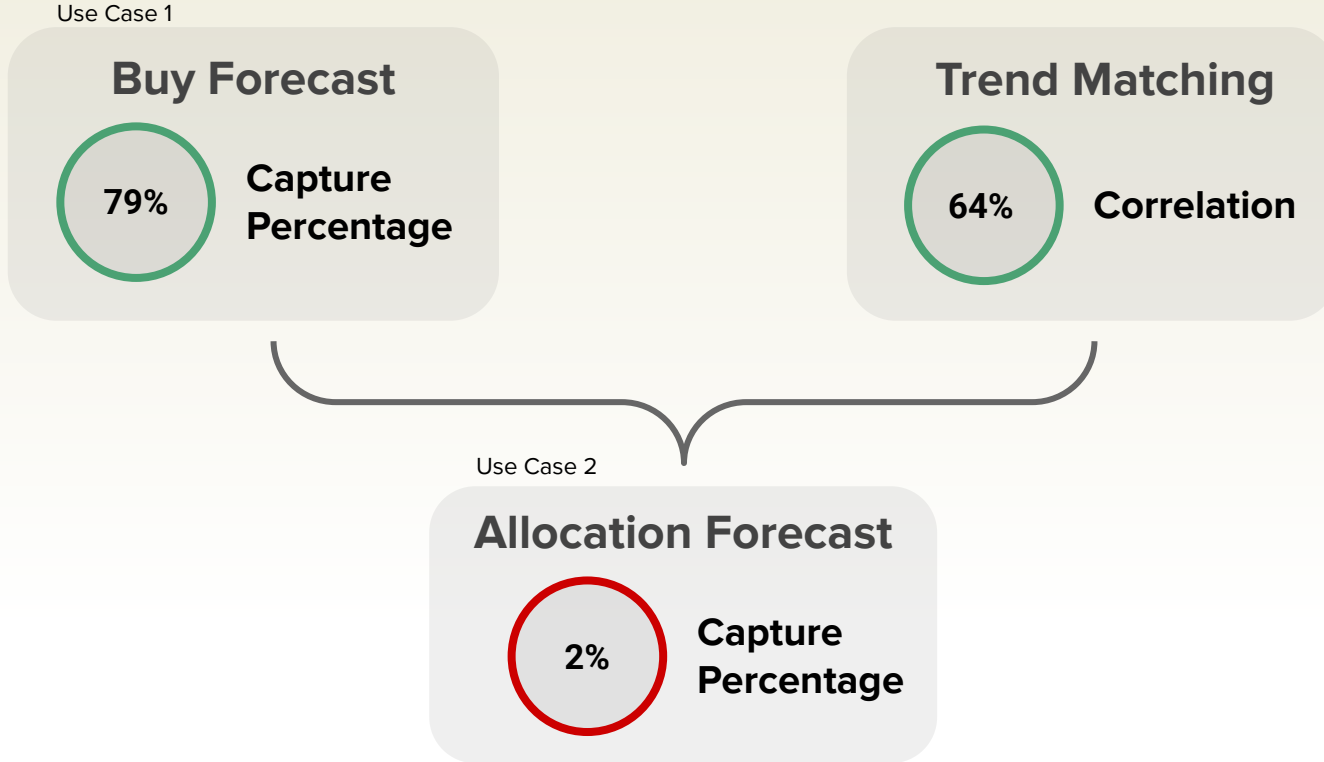


Use Case 2

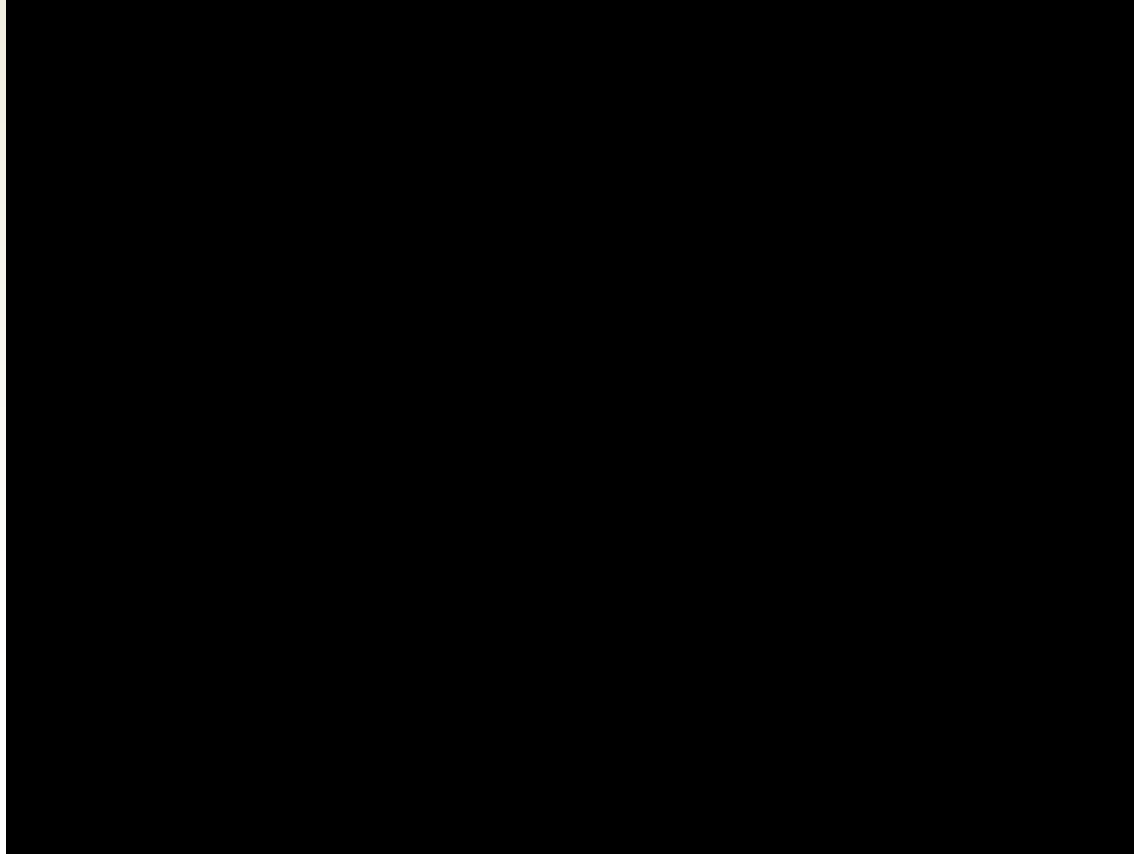
Allocation Forecast



Results



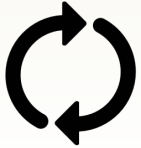
Dashboard Prototype



Impact



Innovated novel methodology for demand forecasting, pioneering a new class of forecasting at Macy's



Reinterpret Models for New Use Cases

Product Popularity Estimator

Product Matching Tool

Acknowledgements



Thank you to:

- Macy's Analytics Team
- Sandra, Iris, Jingjing, Akhil, and many others
- Prof. Fazel
- MIT MBAn Program

Thank you! Any questions are welcome!

vlao@mit.edu bircha@mit.edu

Appendix

Future Work



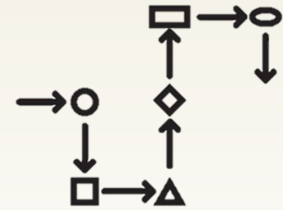
New Data Sources

- Predicted fashion trends
- Better inventory data



New Forecast Scopes

- Partition locations into regions
- Partition products based on their intended life cycle



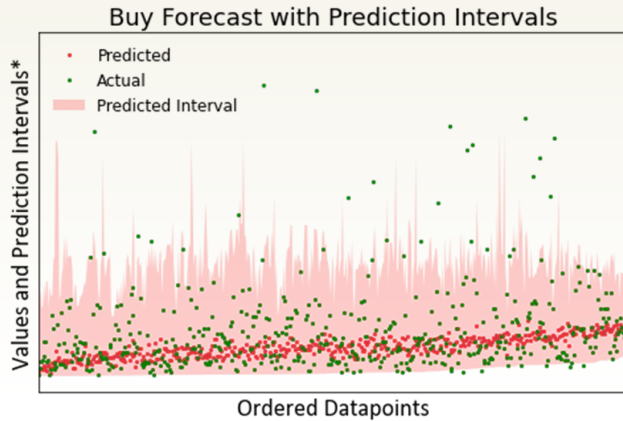
New Methodologies

- Tensor Completion
- Time-series Approaches

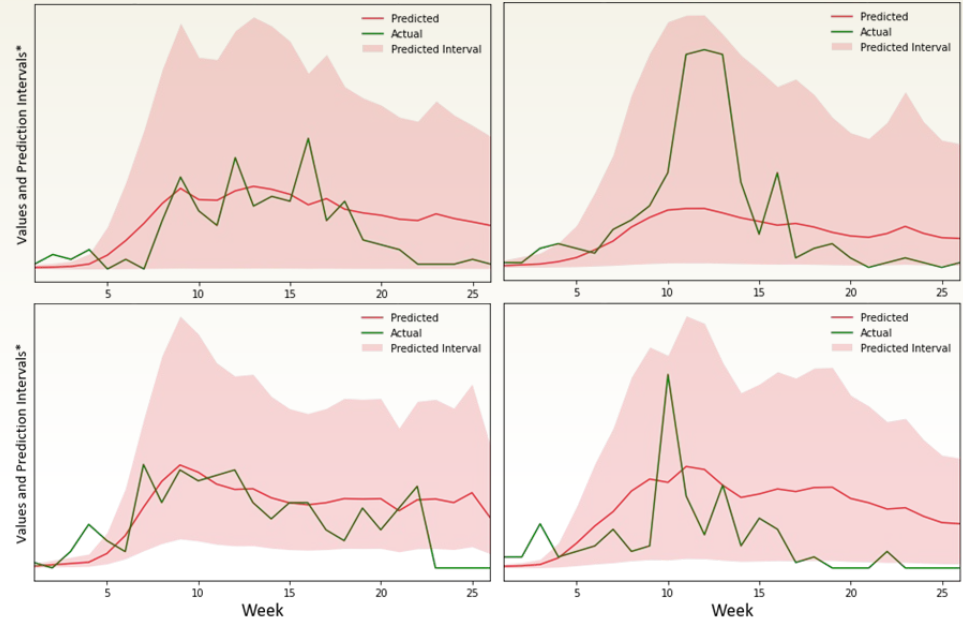
Use Cases



Buy Forecast



Allocation Forecast

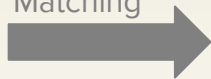


*Data censored at request of Macy's

Product Matching Tool

"soft ecru pants striped tie waist tapere, fabric pattern stripe, pant length ankle, style straight, cotton, Striped Tie-Waist Pants..."

Product Matching



8 most similar products in Millennial Sportswear



*12 digit upc code

Product Matching Tool

"lavender top, long slv
ruched floral style
blouse spring, weekend
retreat, drawstring front;
elasticized details
sleeves Kit & Sky ..."



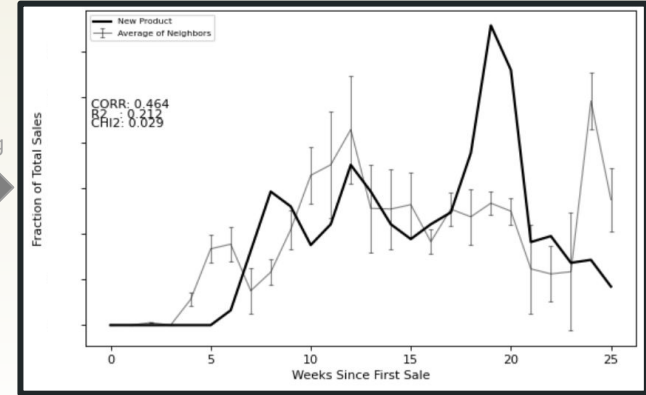
768594596674*

Product
Matching
➔

8 most similar products in Millennial Sportswear



Demand
Forecasting
➔



*12 digit upc code

Top-Down Trend Matching - Overview

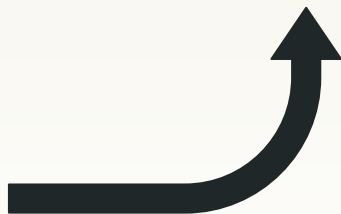
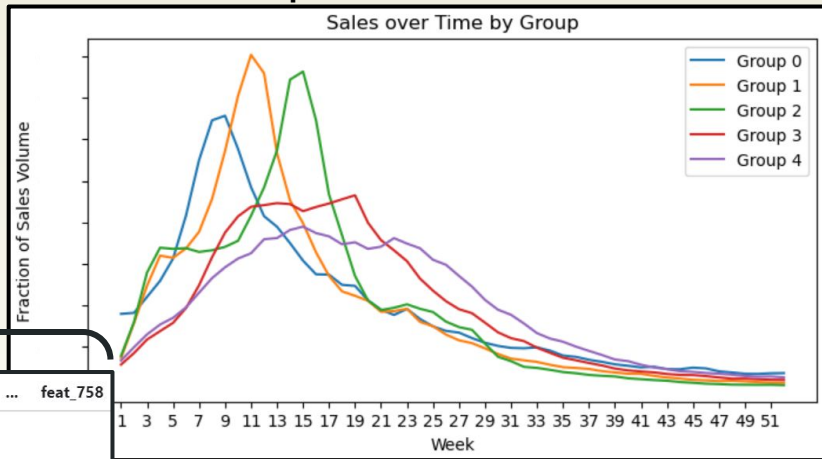
X - NLP embeddings from text data
y - Clusters found from pure demand clustering (n=5, weighted)

y
↓

X

| upc_color | description | cluster | feat_0 | feat_1 | feat_2 | feat_3 | feat_4 | feat_5 | feat_6 | ... | feat_758 |
|------------------|--|---------|-----------|-----------|-----------|----------|-----------|----------|----------|-----|-----------|
| 9356362461364_1 | divn_12, dept_266, black top crop cardigan ca... | 4 | -0.308989 | -0.160591 | -0.113058 | 0.008550 | -0.058915 | 0.306593 | 0.414051 | ... | -0.136239 |
| 193290724012_1 | divn_12, dept_211, black top cold shoulder ru... | 4 | -0.202188 | -0.278623 | 0.065765 | 0.140476 | -0.031005 | 0.448973 | 0.560005 | ... | -0.046427 |
| 196202002055_810 | divn_12, dept_211, brandy por top cap slv hoo... | 1 | -0.342582 | -0.167049 | 0.139372 | 0.029764 | -0.323340 | 0.408113 | 0.723457 | ... | -0.077014 |

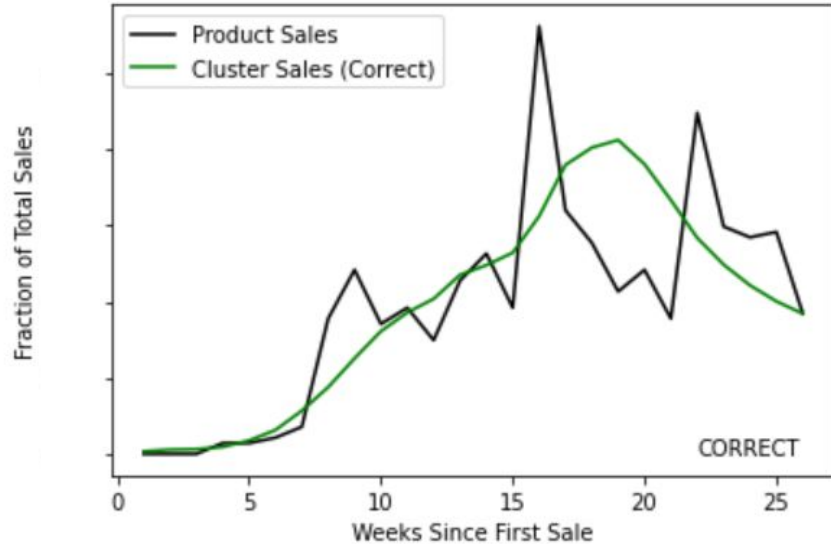
Found Distinct Groups of Products Based on Sales Trend



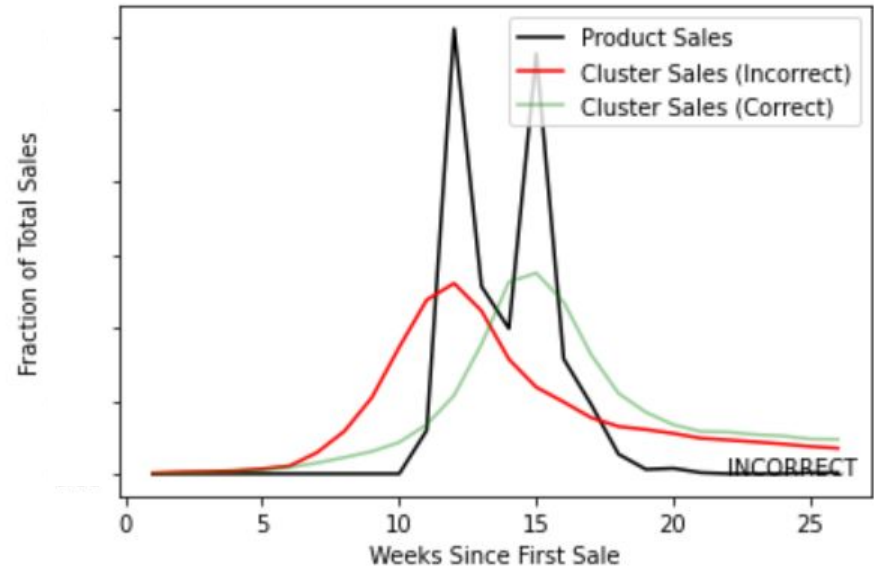
XGBoost
RandomForest
Decision Tree
etc.

Top-Down Trend Matching - Example

Predicted Cluster: 0
Actual Cluster: 0

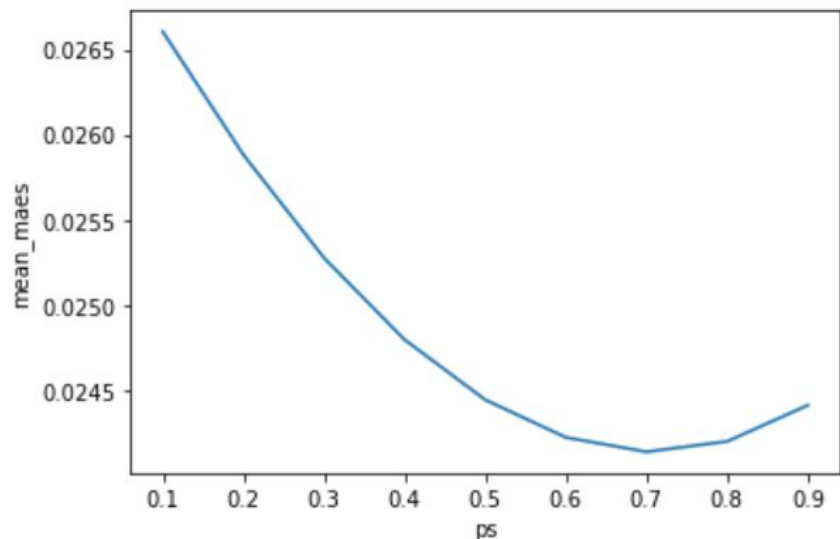
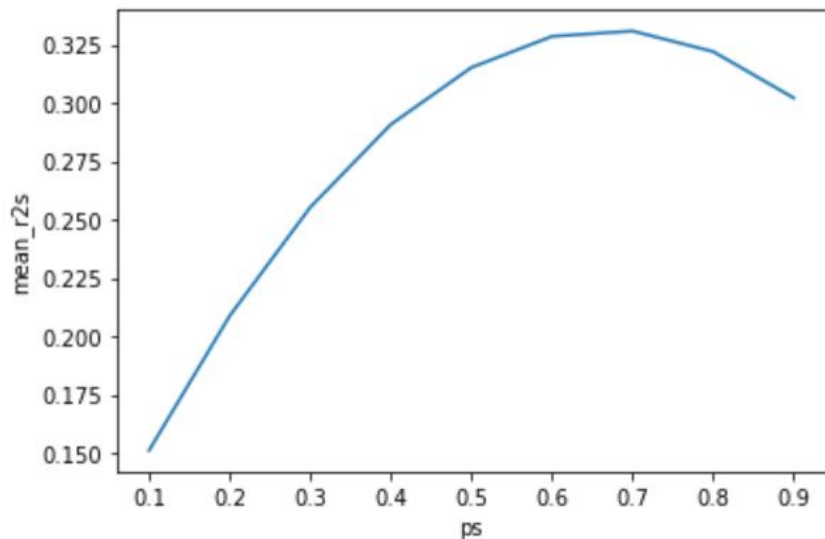


Predicted Cluster: 1
Actual Cluster: 4



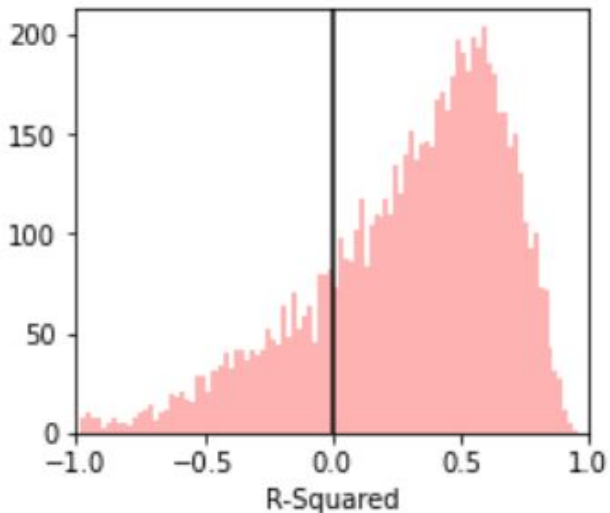
Product-Trend Matching - Ensemble Method

Hyperparameter Tuning



Product-Trend Matching - R-Squared

classification

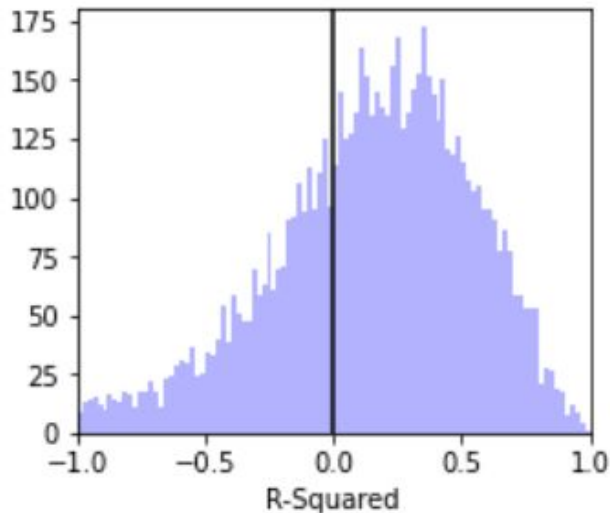


Classification

Mean R2: 0.2711333041601214

Median R2: 0.3717150403131663

knn

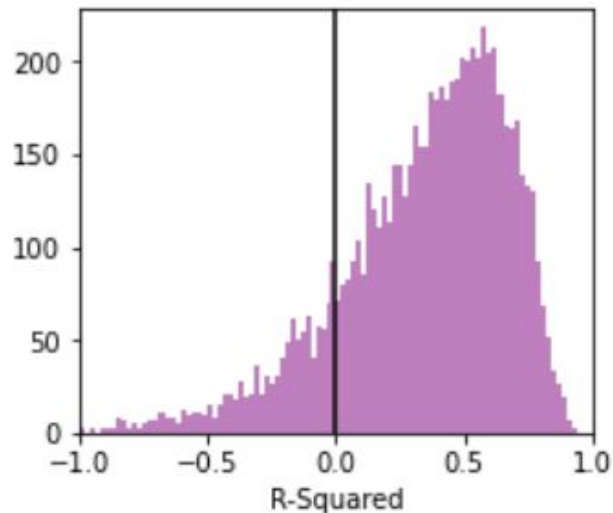


KNN

Mean R2: 0.08241844813950884

Median R2: 0.17189358004760624

ensemble



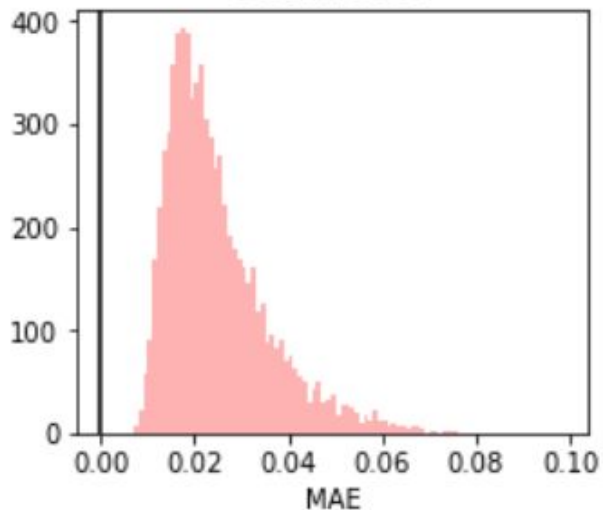
Ensemble

Mean R2: 0.3295331148712052

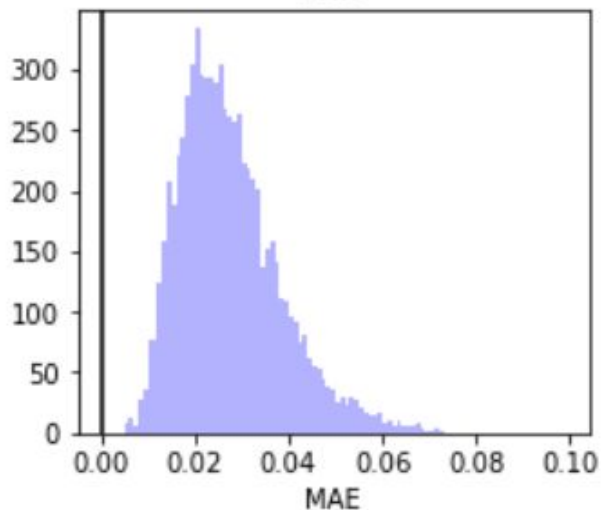
Median R2: 0.4054799609351912

Product-Trend Matching - Mean Absolute Error

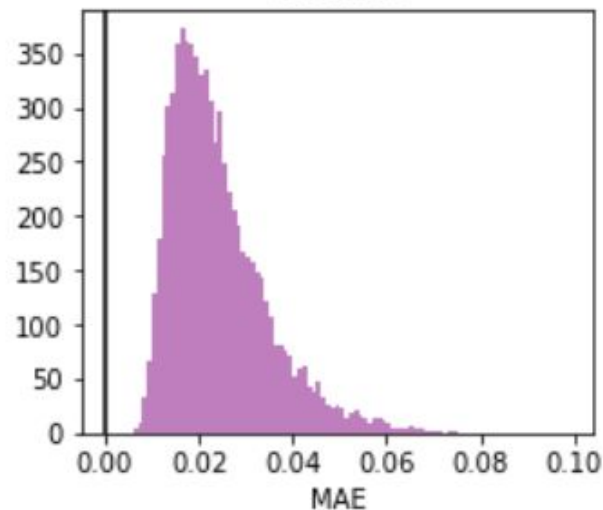
classification



knn



ensemble



Classification

Mean MAE: 0.024777997511992254
Median MAE: 0.02212645287870084

KNN

Mean MAE: 0.027436192264568646
Median MAE: 0.02577599005588107

Ensemble

Mean MAE: 0.024139177700174794
Median MAE: 0.02184279620621709

Random Forest Feature Importances [.COM]

