Montgomery County Alcohol Beverage Services Inventory Optimization

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Part 1: The Goal

Montgomery County Alcohol Beverage Services

- Wholesaler of beer, wine, and spirits in MoCo
- Retail locations
  - 27 stores in MoCo
- Alcohol licensing, enforcement, and education
- $35+ million dollars annually
  - Pay down county debt
  - Fund county services

Reordering Algorithm

- Optimize reordering algorithm
  - Overstocking = wasted products
  - Understocking = lost revenue
  - Aspects:
    - Reorder threshold
    - Reorder quantity
- Factors:
  - Product type
  - Seasonality
  - Trends
  - Availability

Product Clustering

- Fine-tuned models
  - Variability
  - Volatility
- Cluster-specific changes
  - Seasonal patterns
- Outliers
  - May require special treatment

Part 2: The Data

ABS Sales Data

3 data sets, 500 rows each

- High, medium, and low volume stores
- Same products in each data set

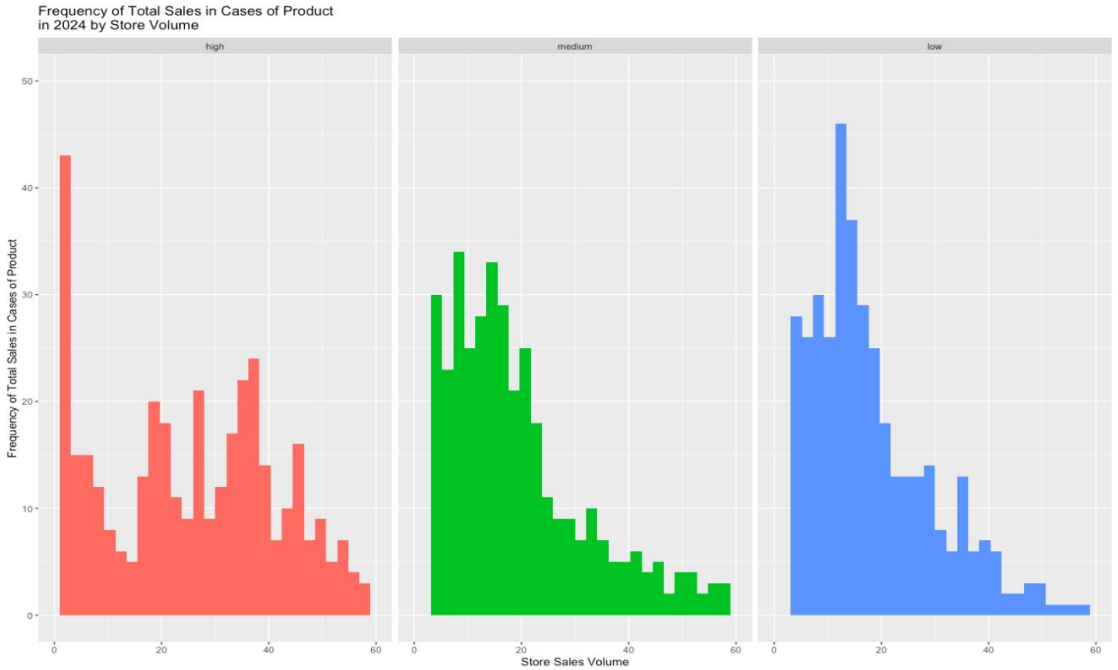
Variables

- Product Name
- Product ID
- Cost per bottle
- Bottles per case
- Total sales during 2024
- Sales per week (53 weeks)

Data Cleaning and Exploratory Data Analysis

volume	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Mean	Variance
<fctr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
high	1.008333	6.583333	17.08333	35.53542	1150.167	29.6131	2360.639
medium	1.008333	6.583333	17.08333	35.53542	1150.167	29.6131	2360.639
low	1.008333	6.583333	17.08333	35.53542	1150.167	29.6131	2360.639

Frequency of Total Sales in Cases of Product in 2024 by Store Volume



Volume:
High = Orange
Medium = Green
Low = Blue

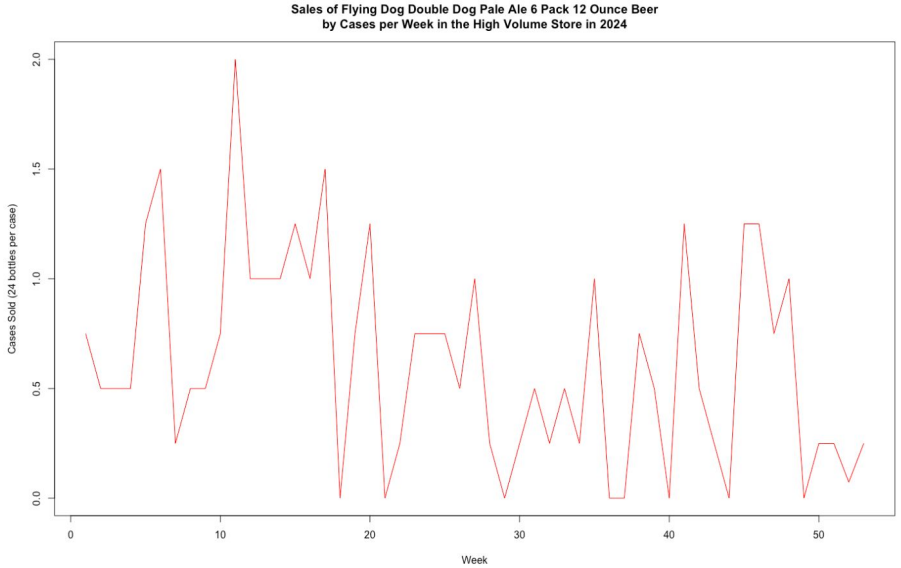
Part 3: The Analysis

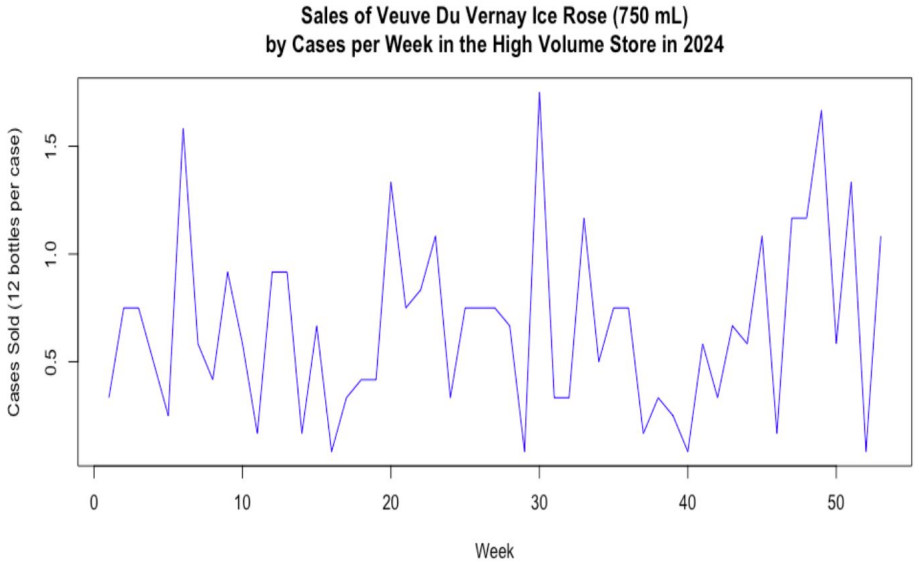
Tools

R Packages

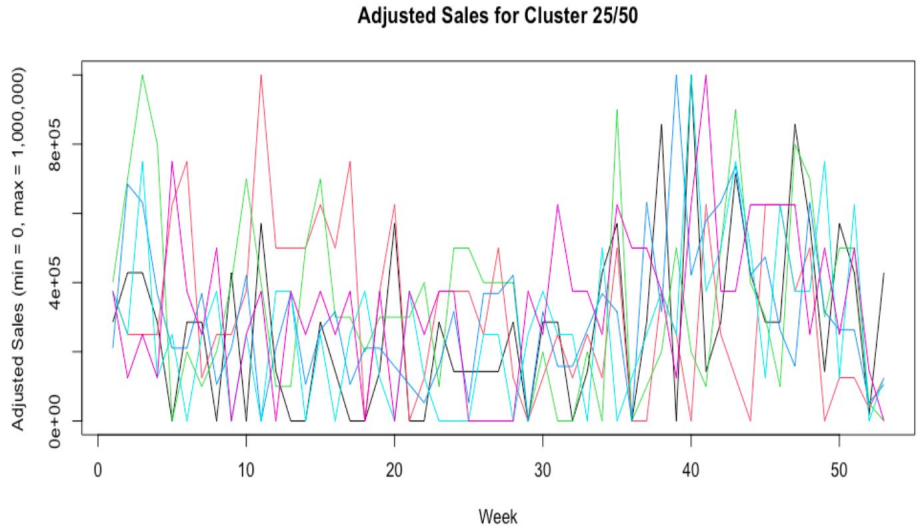
- tidyverse
- ggplot2
- dtwclust
  - tsclust()
  - cvi()
- reshape2

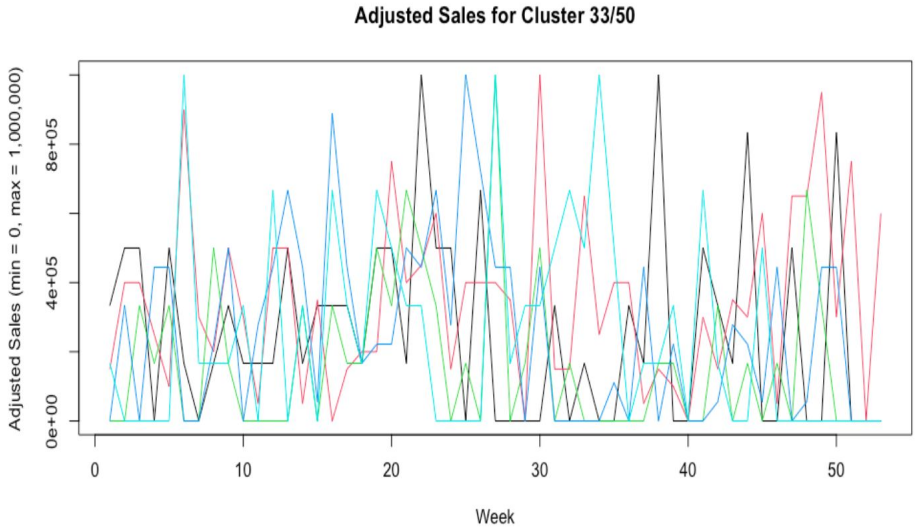
Part 1: Product Sales



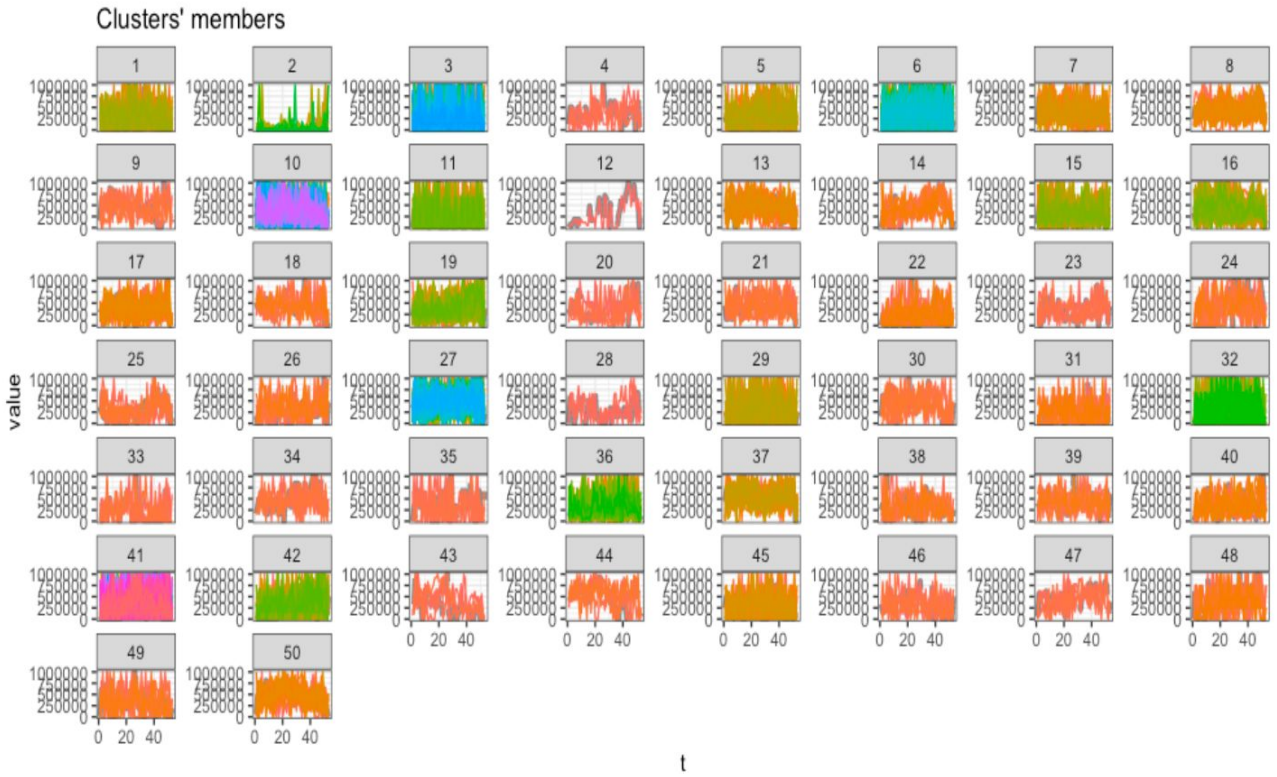


Part 2: Clustered Normalized Product Sales





Part 3: Clustered Normalized Product Sales



Part 4: An Analysis of Varying k = Clusters

	K = 10	K = 25	K = 50	K = 100
Calinski-Harabasz Index	93.88816887	42.88126022	21.12122747	11.783747650
Davies-Bouldin Index	2.51595387	2.03270419	2.04084868	1.9101442736

Part 4: The Conclusion

Lessons Learned and Future Plans

Lessons Learned:

- Clustering is possible
- K = clusters can be optimized

Future Plans:

- Test more cluster sizes
- Test different clustering algorithms
- Test clustering with different data transformations
- Test predictive algorithms on clusters

Part 5: The End

Thank you for your assistance!

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- Jocelyn Rawat
- Melissa Romeo

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Sources

Works Cited

"About Us - Alcohol Beverage Services - Montgomery County, Maryland." *Www.montgomerycountymd.gov*, www.montgomerycountymd.gov/ABS/AboutABS.html.

Hyndman, Rob, and George Athanasopoulos. "Chapter 3 the Forecaster's Toolbox | Forecasting: Principles and Practice (2nd Ed)." *Otexts.com*, 2025, otexts.com/fpp2/toolbox.html. Accessed 14 May 2025.

"Moving Averages in R." *GeeksforGeeks*, 16 Nov. 2023, www.geeksforgeeks.org/moving-averages-in-r/.

Posit Sotware, PBC. "Calculate the Similarity between Pairs of Time Series Data." *Posit Community*, 7 Jan. 2021, forum.posit.co/t/calculate-the-similarity-between-pairs-of-time-series-data/92546/2. Accessed 14 May 2025.