# Project: Predictive Analytics Capstone

## About the Project

This project is my capstone project for my Predictive Analytics Nanodegree with Udacity. I will be combining multiple predictive analytics techniques to help solve a problem for a company. For this project, I will be doing my analysis in alteryx and Tableau.

## The Problem

A company currently has 85 grocery stores and is planning to open 10 new stores at the beginning of the year. Currently, all stores use the same store format for selling their products. Up until now, the company has treated all stores similarly, shipping the same amount of product to each store. This is beginning to cause problems as stores are suffering from product surpluses in some product categories and shortages in others. I will be providing analytical support to make decisions about store formats and inventory planning.

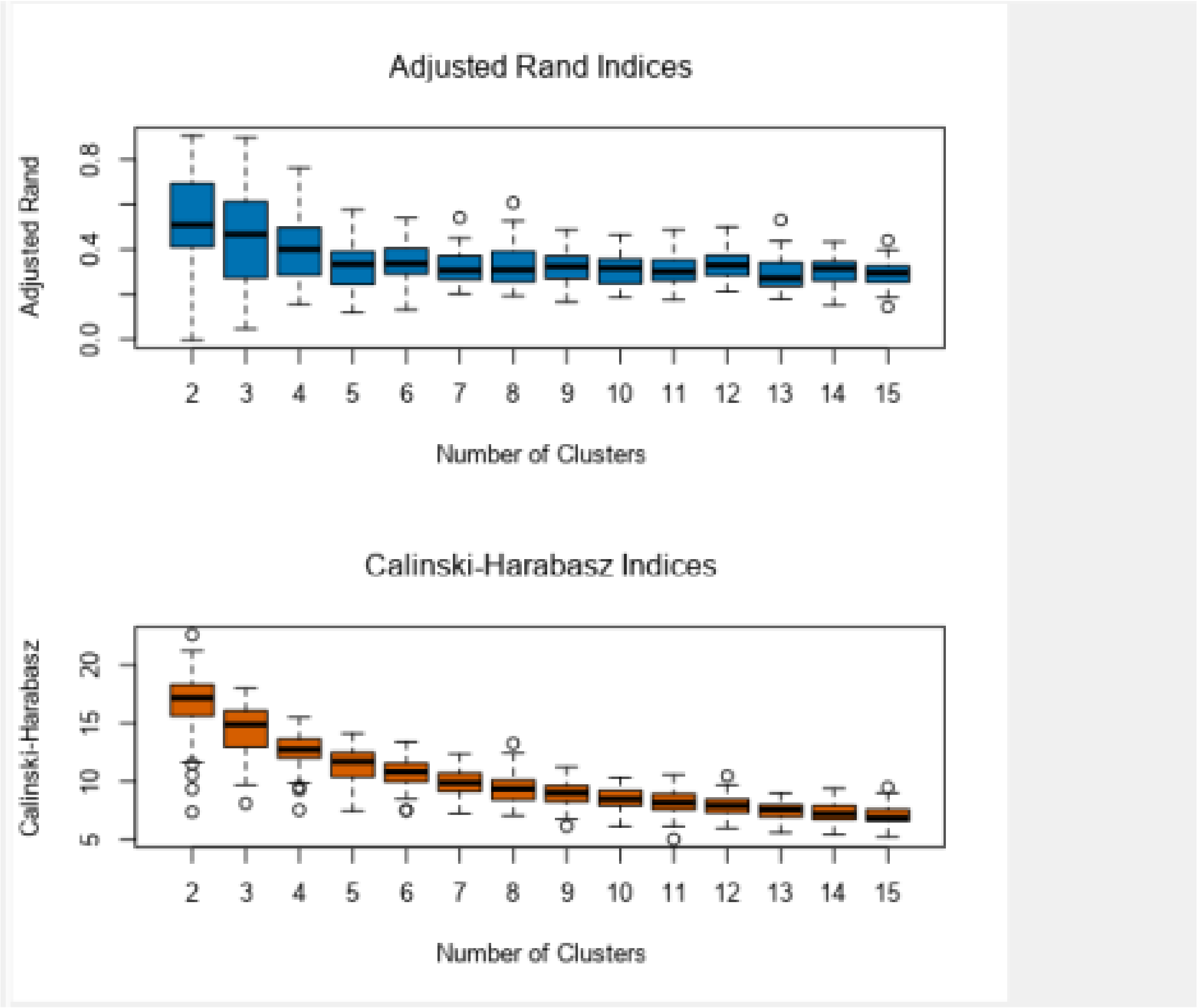
This analysis will involve three stages:

- Use a clustering model to group the stores into groups based on similar characteristics.
- Use a classification model to predict which group the new stores will fall into.
- Use a time series model to predict sales for both old and new stores.

## Part 1: Clustering

1. What is the optimal number of store formats? How did you arrive at that number?

3 is the optimal number of store formats. I arrived at the number after using the k-centroids diagnostics tool in Alteryx to check out the Adjusted Rand indices and the Calinski - harabasz indices. The k-means clustering method stands out the most with the highest points at 2 clusters.



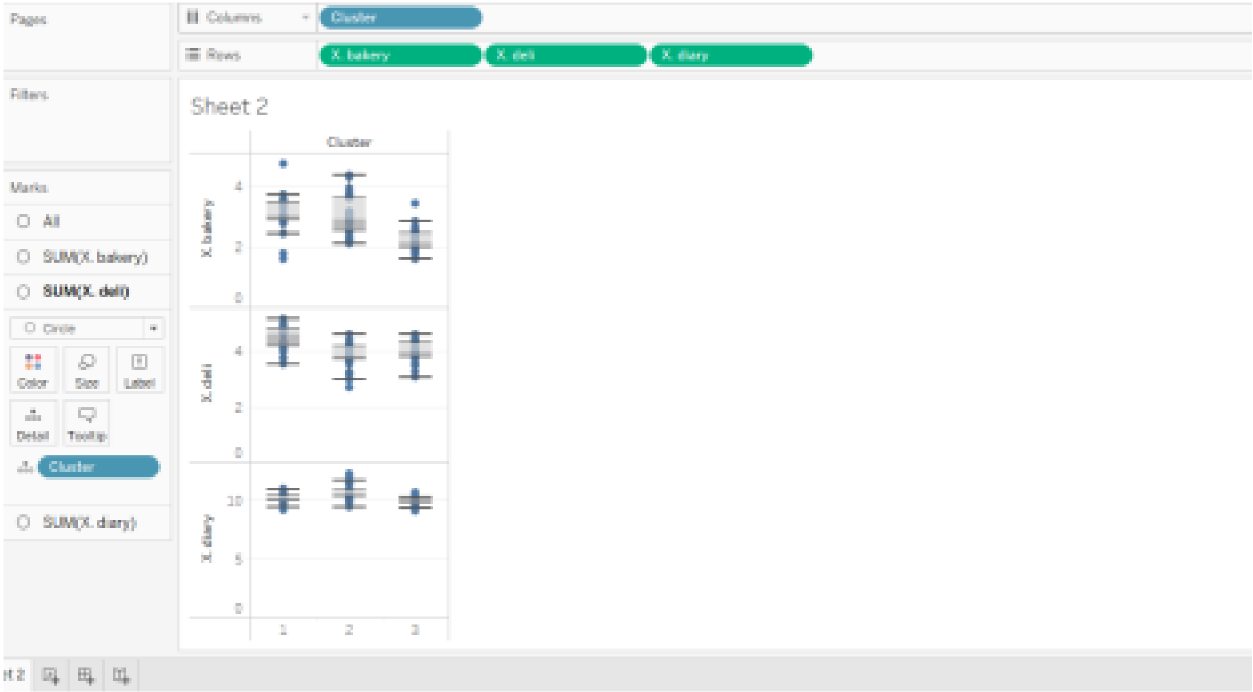
Adjusted Rand Indices

Calinski-Harabasz Indices

2. How many stores fall into each store format?

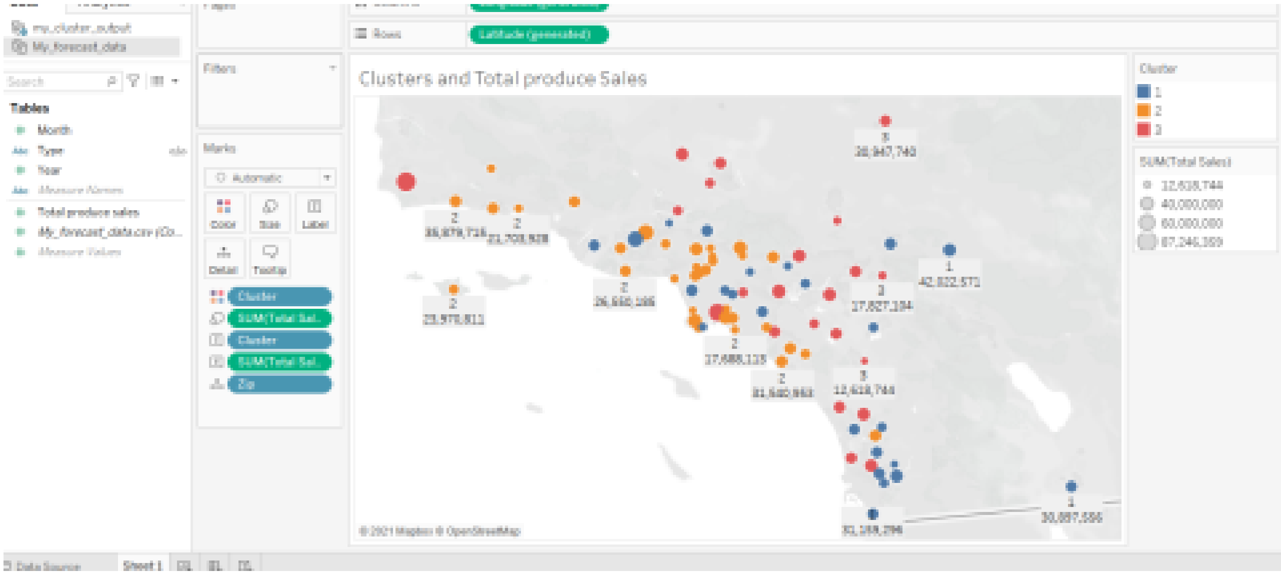
| Cluster | Number of stores |
|---|---|
| Cluster 1 | 25 |
| Cluster 2 | 35 |
| Cluster 3 | 25 |

3. Based on the results of the clustering model, what is one way that the clusters differ from one another?



From the above box and whiskers plot of clusters and sales category, it can be seen that each cluster is different in terms of sales for each of the categories, for instance in terms of deli, cluster 2 is made up of stores that their percentage of sales from deli is the lowest.

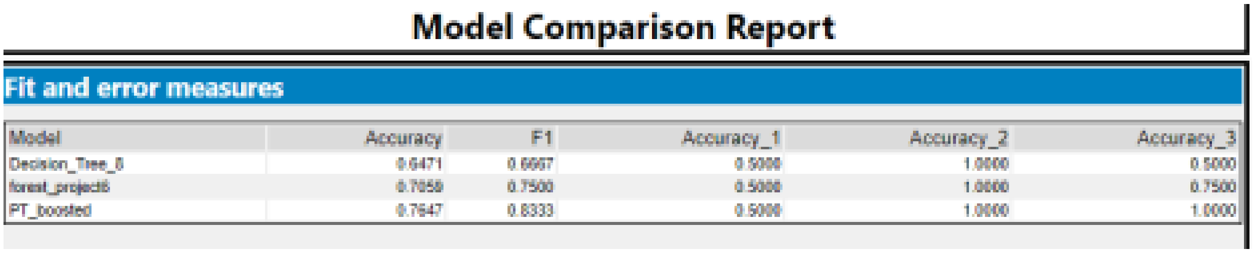
4. Please provide a Tableau visualization (saved as a Tableau Public file) that shows the location of the stores, uses color to show cluster, and size to show total sales.
   Answer:[Link to Tableau Workbook]



## Part 2: Formats for New Stores

1. What methodology did you use to predict the best store format for the new stores? Why did you choose that methodology? (Remember to Use a 20% validation sample with Random Seed = 3 to test differences in models.)

Answer: I chose the boosted model for classifying the new stores because of all the models it has the best accuracy metrics that is in terms of the general accuracy, the precision and in-class accuracy as shown below:



**Model Comparison Report**

**Fit and error measures**

| Model | Accuracy | F1 | Accuracy_1 | Accuracy_2 | Accuracy_3 |
|---|---|---|---|---|---|
| Decision_Tree_8 | 0.6471 | 0.6667 | 0.5000 | 1.0000 | 0.5000 |
| forest_project6 | 0.7059 | 0.7500 | 0.5000 | 1.0000 | 0.7500 |
| PT_boosted | 0.7647 | 0.8333 | 0.5000 | 1.0000 | 1.0000 |

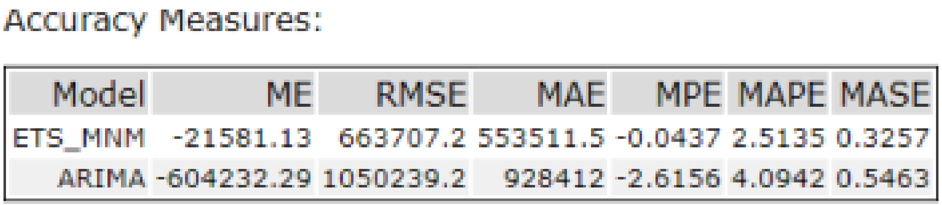
2. What format do each of the 10 new stores fall into?

| Store Number | Segment |
|---|---|
| S0086 | 1 |
| S0087 | 2 |
| S0088 | 3 |
| S0089 | 2 |
| S0090 | 2 |
| S0091 | 3 |
| S0092 | 2 |
| S0093 | 3 |
| S0094 | 2 |
| S0095 | 2 |

## Task 3: Predicting Produce Sales

1. What type of ETS or ARIMA model did you use for each forecast? Use ETS(a,m,n) or ARIMA(ar, i, ma) notation. How did you come to that decision?

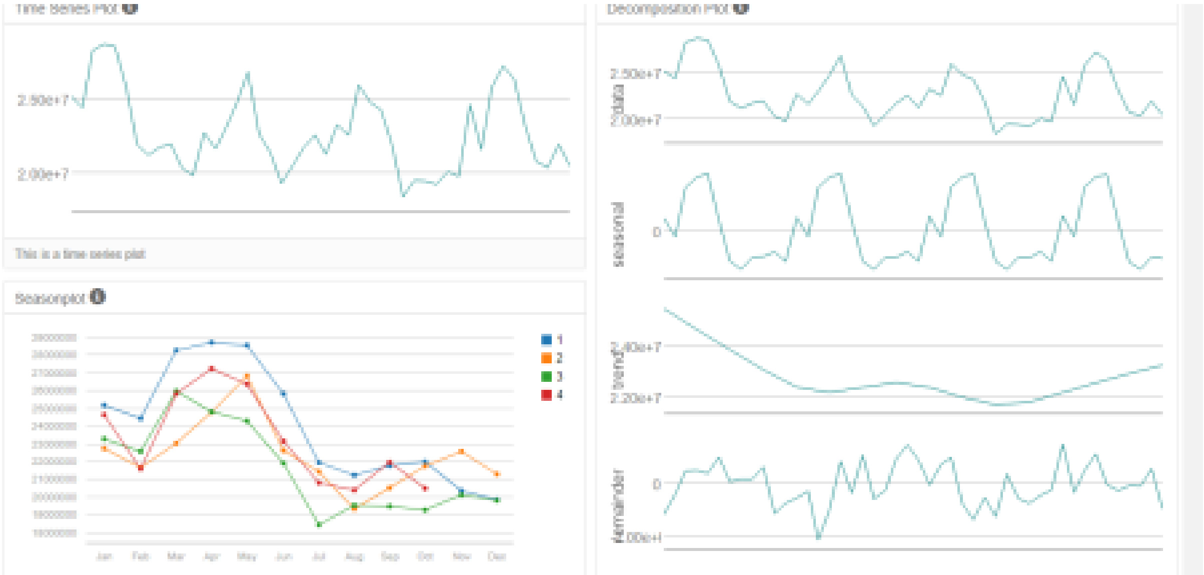
Answer: I used the ETS (M, N, M) for forecasting. This is because overall, it has the better accuracy measures in terms of the Mean error, the Root mean squared error and the MASE when compared with the ARIMA model as shown below:



Accuracy Measures:

| Model | ME | RMSE | MAE | MPE | MAPE | MASE |
|---|---|---|---|---|---|---|
| ETS_MNM | -21581.13 | 663707.2 | 553511.5 | -0.0437 | 2.5135 | 0.3257 |
| ARIMA | -604232.29 | 1050239.2 | 928412 | -2.6156 | 4.0942 | 0.5463 |

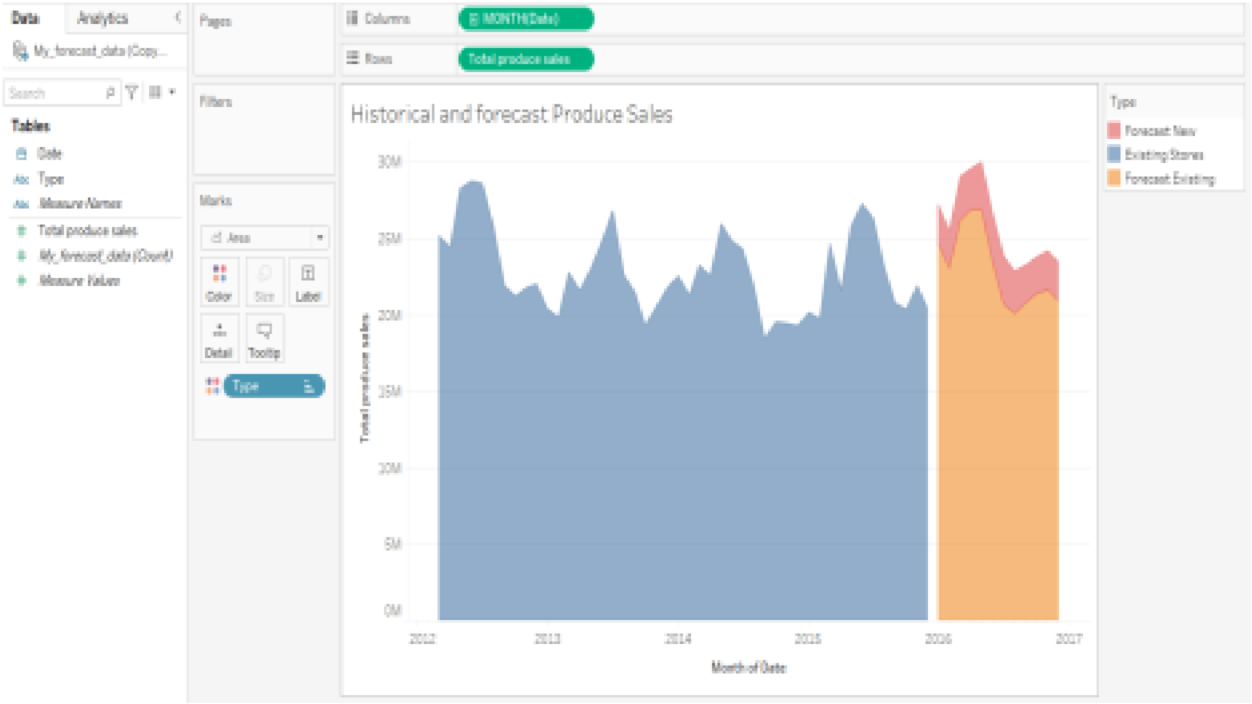
Although the AIC of the ARIMA model is lower than that of the ETS, I cannot use the AIC as a metric because one cannot compare the AICs of two different models. Also the ETS is applied in M,N,M because as can be seen from the decomposition plot below, the error is fluctuating over time which shows that it should be applied multiplicatively, there is no clear pattern in the trend(Neutral) and the seasonality also shows highs and lows suggesting multiplicity.



2. Please provide a table of your forecasts for existing and new stores. Also, provide visualization of your forecasts that includes historical data, existing stores forecasts, and new stores forecasts.

| Month | Existing Stores | New Stores |
|---|---|---|
| Jan | 21,611,877.980495 | 2,542,607.196008 |
| Feb | 20,931,380.132725 | 2,453,949.95867 |
| March | 24,588,621.430699 | 2,852,466.037767 |
| April | 22,974,656.794772 | 2,707,887.118146 |
| May | 26,185,910.648663 | 3,063,031.113953 |
| June | 26,879,542.76363 | 3,120,920.161619 |

| | | |
|---|---|---|
| July | 26,860,649.680752 | 3,143,616.534095 |
| August | 23,468,263.325883 | 2,792,396.757633 |
| September | 20,668,472.421463 | 2,481,441.001115 |
| October | 20,054,551.621834 | 2,425,385.938578 |
| November | 20,752,511.328094 | 2,517,119.713135 |
| December | 21,328,394.834456 | 2,490,642.445392 |



Columns: MONTH(Date)

Rows: Total produce sales

Marks: Area

[Link to Tableau Public]