

Adjustments Made Easy:

**A Look at Clustering Time Series
from the US Census Bureau
Manufacturers' Shipments,
Inventories, and Orders**

Matthew Barton, Allyson Hineman, Kampbell Howard, Ryan Plumer
Advisor: Dr. Lan Cheng, SUNY Fredonia
Industrial Liaison: Dr. James Livsey



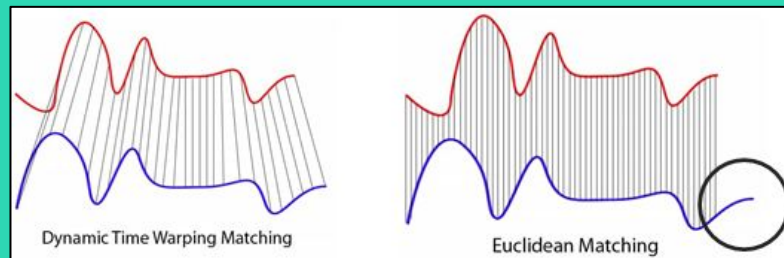
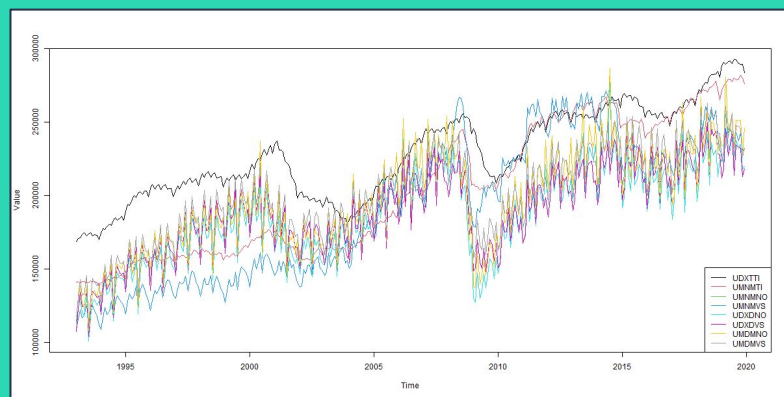
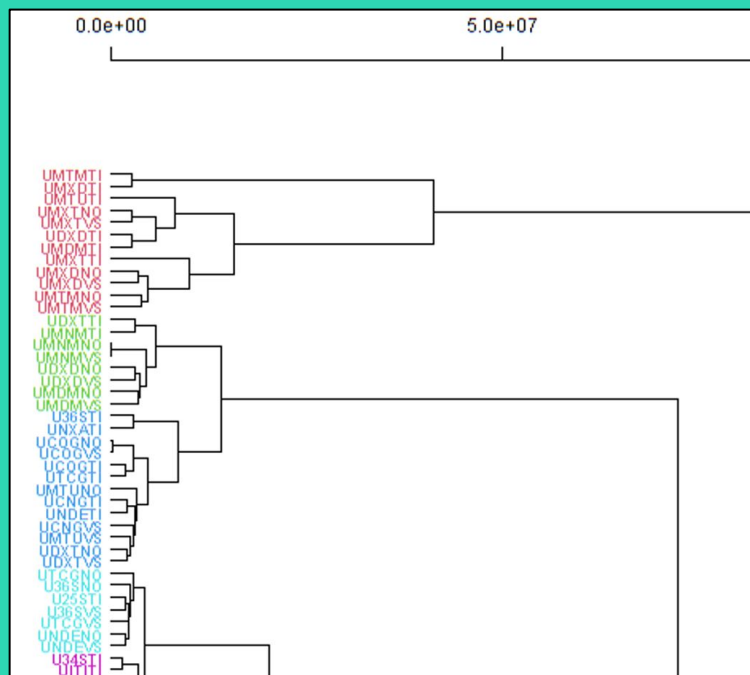
Problem Statement

- Taking data released from the Domestic Manufacturing Sector of the Economic Directorate
- Clustering data together based on certain correlations
- Use clusters to adjust data in a multivariate manner instead of univariately

Disclaimer: This report is released to inform interested parties of research and to encourage discussion. The views expressed on statistical issues are those of the authors and not those of the U.S. Census Bureau.



Results



Approach

- Gathered economic data
 - Converted the data into time series objects
- Clustered related data using Dynamic Time Warping
- Outputted data from DTW into a dendrogram
 - Showcase similarities between time series objects
- R programming language
- GitHub collaborative coding environment



Approach

$$DTW(x, x') = \min_{\pi \in \mathcal{A}(x, x')} \sqrt{\sum_{(i, j) \in \pi} d(x_i, x'_j)^2}$$

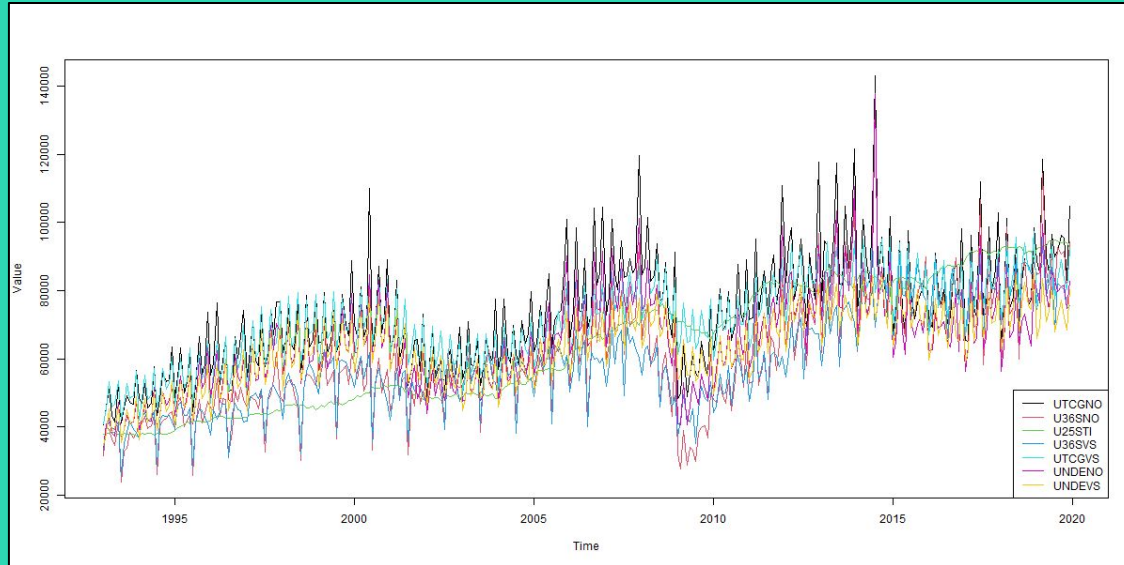
where $\mathcal{A}(x, x')$ is the set of all admissible paths ,i.e., the set of paths π such that: $\pi = [\pi_0, \dots, \pi_K]$ is a path that satisfies the following properties:

- π is a sequence $[\pi_0, \dots, \pi_{K-1}]$ of index pairs $\pi_k = (i_k, j_k)$ with $0 \leq i_k < n$ and $0 \leq j_k < m$
- $\pi_0 = (0, 0)$ and $\pi_{K-1} = (n-1, m-1)$
- for all $k > 0$, $\pi_k = (i_k, j_k)$ is related to $\pi_{k-1} = (i_{k-1}, j_{k-1})$ as follows
 - $i_{k-1} \leq i_k \leq i_{k-1} + 1$
 - $j_{k-1} \leq j_k \leq j_{k-1} + 1$



Results

Unadjusted Domestic Manufacturing Sector Clusters from the US Census Bureau Economic Directorate



Cluster 4



Review of Problem and Results

Problem:

- Clustering Economic Directorate data using a multivariate approach rather than univariate.



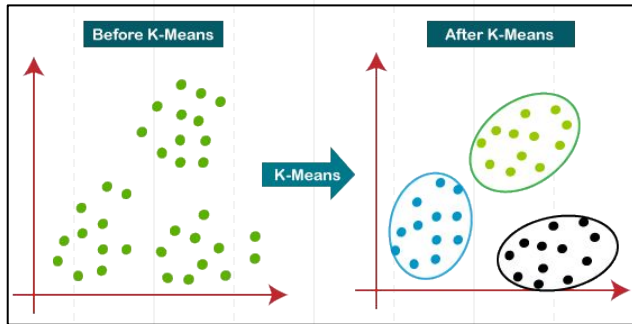
Results:

- Dynamic Time Warping methods clearly and effectively cluster time series in a multivariate manner
- Hierarchical clustering graphics show the relations between industries



Suggested Future Work

Clustering Using Other Methods



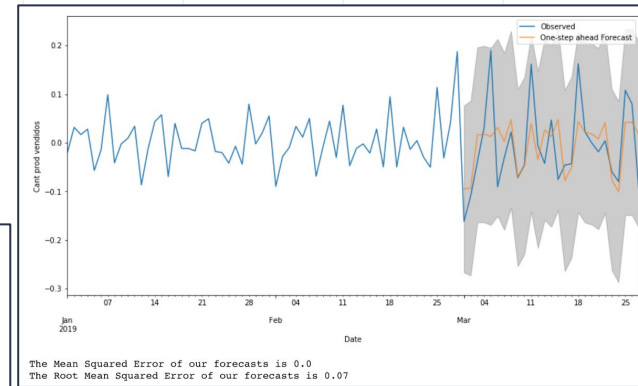
Compiling More Data from Different Directorates

List of Business Surveys

The U.S. Census Bureau conducts more than 100 surveys each year. These surveys include the business surveys listed below, and many more. To find more information on a specific survey you received please select it from the list of business surveys below.

- Small Business Pulse Survey
- Economic Census
- Annual Retail Trade Survey (ARTS)
- Service Annual Survey (SAS)
- Annual Wholesale Trade Survey (AWTS)
- Export Statistics
- Annual Survey of Entrepreneurs

Creating Models for the Data for Analysts



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