

ISA 401: Business Intelligence & Data Visualization

19: Charts Used Time-Series, Spatial and Spatiotemporal Data

Fadel M. Megahed, PhD

Endres Associate Professor
Farmer School of Business
Miami University

 @FadelMegahed

 fmegahed

 fmegahed@miamioh.edu

 Automated Scheduler for Office Hours

Fall 2023

08 : 00

Non-graded: COVID19 Data Viz

Over the next 8 minutes, use Tableau to answer the following questions based on the [`covid_cases_county.csv`](#) (which can be downloaded from Canvas):

- **What are the total number of cases per county?** Use a suitable map to answer this question.
- **What are the total number of deaths per state?** You can show that using either a table or a map. In case of a map, please show the numbers for each state on the map as well.

Learning Objectives for Today's Class

- Understand main goals behind visualizing time-series data
- Explain the different types of charts for univariate and multivariate time-series
- Explain the different types of spatial plots
- Select suitable spatial graphs for different scenarios
- Understand how spatiotemporal plots can help in storytelling (what makes BI special)

Types of Data Over Time

Cross Sectional Data

Cross Sectional Data: Measurements on multiple units, recorded in a single time period.

Example 1: H1B 2020-2022 Data for Senior Data Scientists at Netflix

	START DATE	JOB TITLE	BASE SALARY	LOCATION
1	2021-08-11	SENIOR DATA SCIENTIST	118,955	LOS GATOS, CA
2	2021-09-09	SENIOR DATA SCIENTIST	143,291	LOS GATOS, CA
3	2021-06-14	SENIOR DATA SCIENTIST	143,291	LOS GATOS, CA
4	2021-06-14	SENIOR DATA SCIENTIST	143,291	LOS GATOS, CA
5	2021-10-18	SENIOR DATA SCIENTIST	143,562	LOS GATOS, CA

Showing 1 to 5 of 23 entries

Previous

1

2

3

4

5

Next

Cross Sectional Data

Cross Sectional Data: Measurements on multiple units, recorded in a single time period.

Example 2: NBA 2023-2024 Leaders - Top Players in PTS/Game

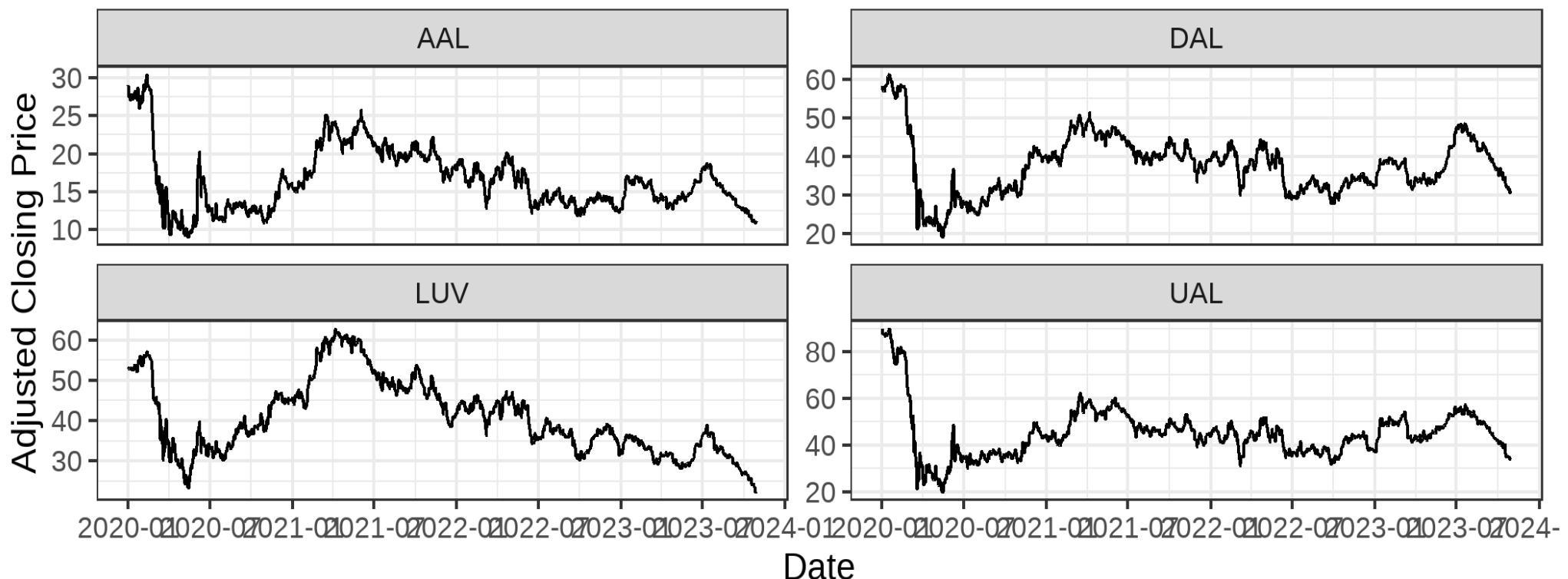
	Player	Pos	Age	Tm	G	FG
1	Ja Morant	PG	23	MEM	4	11.5
2	Luka Dončić	PG	23	DAL	2	11
3	Stephen Curry	PG	34	GSW	3	10.3
4	Damian Lillard	PG	32	POR	4	10.5
5	Donovan Mitchell	SG	26	CLE	3	11.3

Showing 1 to 5 of 404 entries

Time Series Data

Time Series Data: Comparable measurements recorded on a single (or a few) variables over time (usually a long period of time).

Example 2: Stock prices of U.S. Airlines



Panel Data

Panel Data: Cross sectional measurements (usually many variables) repeated over time (usually over a few time periods).

Example: World Bank's Data

	iso3c◆	date◆	NY.GDP.MKTP.KD.ZG◆	SH.DYN.NMRT◆	SH.HIV.INCD.ZS◆	SH.MED.BED◆
1	CHN	2020		2.2	3.4	
2	CHN	2021		8.4	3.2	
3	CHN	2022		3	3.2	
4	EGY	2020		3.6	10.4	
5	EGY	2021		3.3	10	

Showing 1 to 5 of 9 entries

Previous

1

2

Next

Source: Data queried from the [World Bank Data](#) using the `wbstats`  in R. The printed results show a snapshot of 7 variables (out of a much larger panel dataset). You can think of panel data as a cross-sectional dataset with a longitudinal/time component.

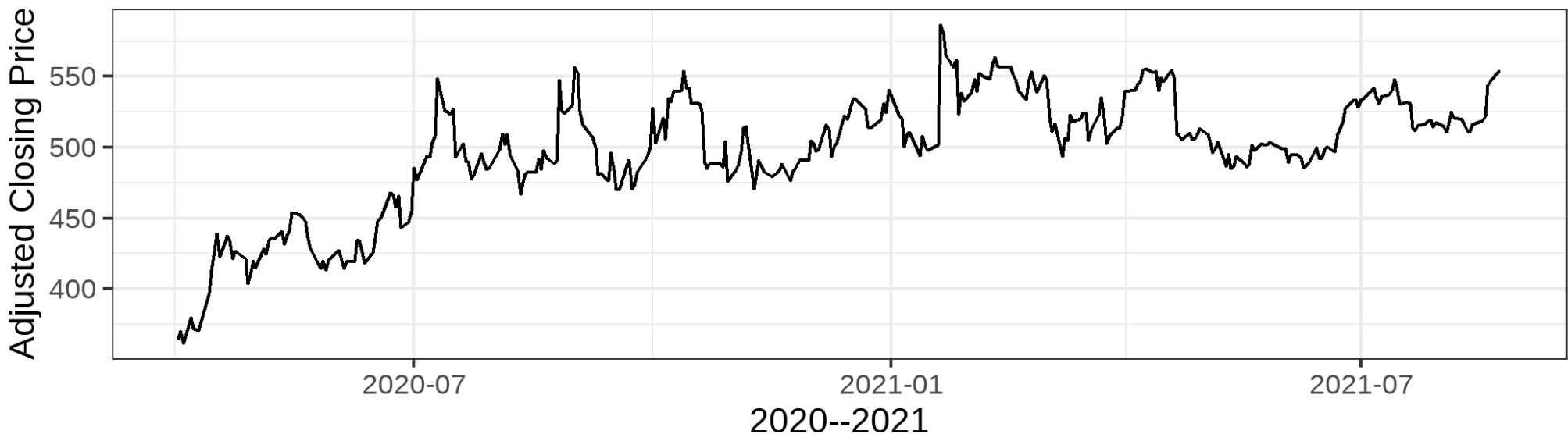
Components of a Time Series

Trend

A **trend** is an increasing or decreasing pattern over time.

Increasing Trend

The meteoric rise of \$NFLX from 2020-04-01 to 2021-08-25

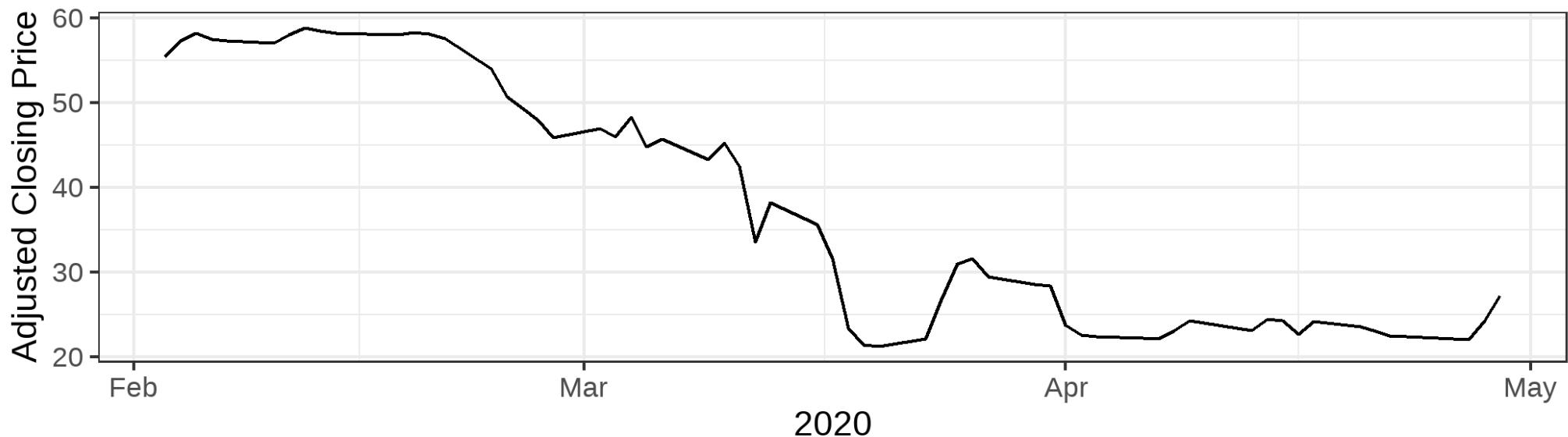


Trend

A **trend** is an increasing or decreasing pattern over time.

Decreasing Trend

The decline in \$DAL from 2020-02-03 to 2020-04-30



Seasonality

Seasonality refers to the property of a time series that displays REGULAR patterns that repeat at a constant frequency (m).

Seasonality with a Multiplicative Trend

Non-linear trend & seasonal component grows over time

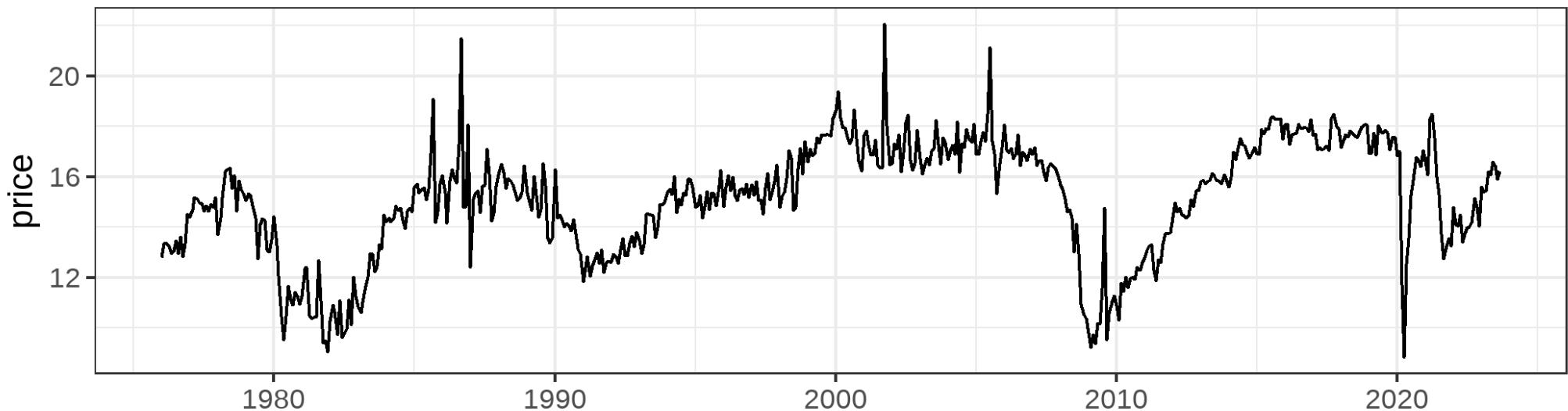


AirPassengers R Dataset -- Source: Box, G. E. P., Jenkins, G. M. and Reinsel, G. C. (1976) Time Series Analysis, Forecasting and Control.

Cycle

Cyclical fluctuations are somewhat irregular (unknown duration).

The cyclical nature of auto sales



U.S. Bureau of Economic Analysis, Total Vehicle Sales [TOTALSA], retrieved from FRED, Federal Reserve Bank of St. Louis
<https://fred.stlouisfed.org/series/TOTALSA>, on October 31, 2023

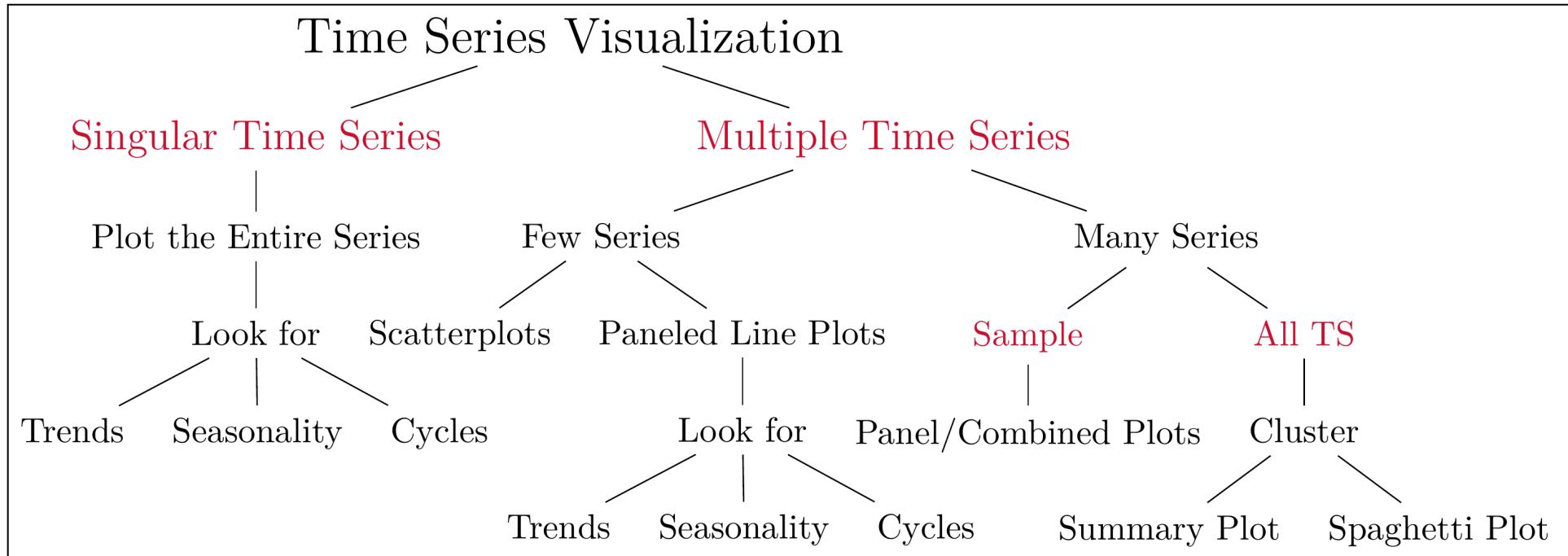
The Goals Behind Visualizing (Time Series) Data

Exploratory vs Confirmatory Viz Goals

Visualizations can be used to explore data, to confirm a hypothesis, or to manipulate a viewer. . . In exploratory visualization the user does not necessarily know what he is looking for. This creates a dynamic scenario in which interaction is critical. . . In a confirmatory visualization, the user has a hypothesis that needs to be tested. This scenario is more stable and predictable. System parameters are often predetermined.

-- (Grinstein and Ward 2001, 22)

A Structured Approach for Time Series Viz

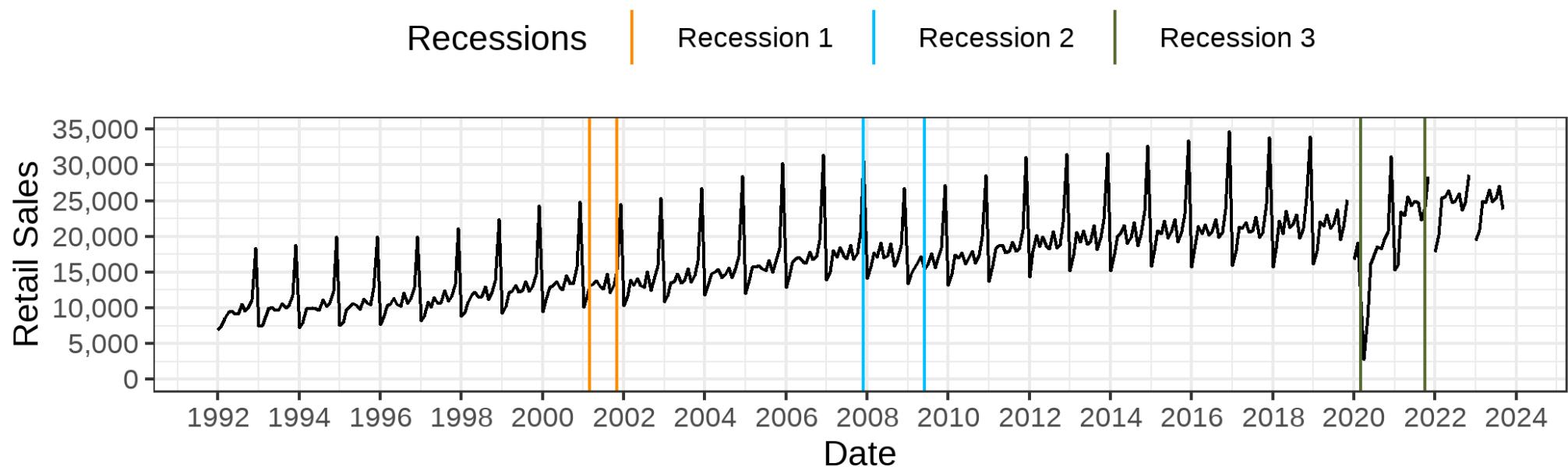


A Potential Framework for Time Series Visualization

This is my best attempt to improve on the general advice provided in the previous slide. Many of the suggestions, presented in this flow chart, stem from my past and current research/consulting collaborations. They are by no means a comprehensive list of everything that you can do.

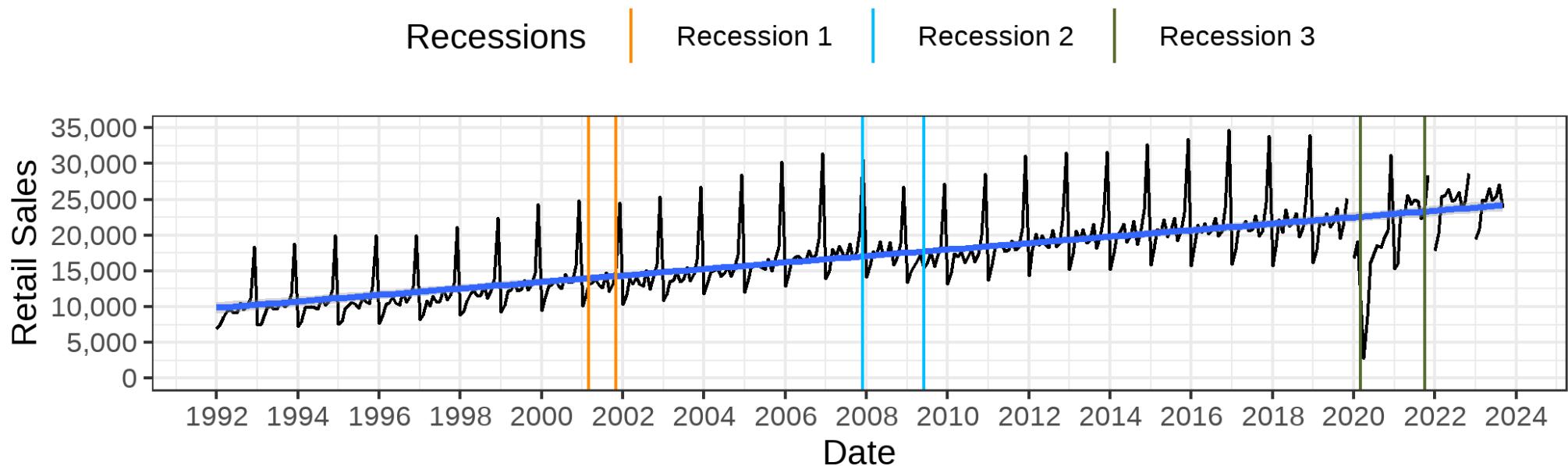
Singular TS

Monthly Retail Sales (RSCCASN) in the U.S.

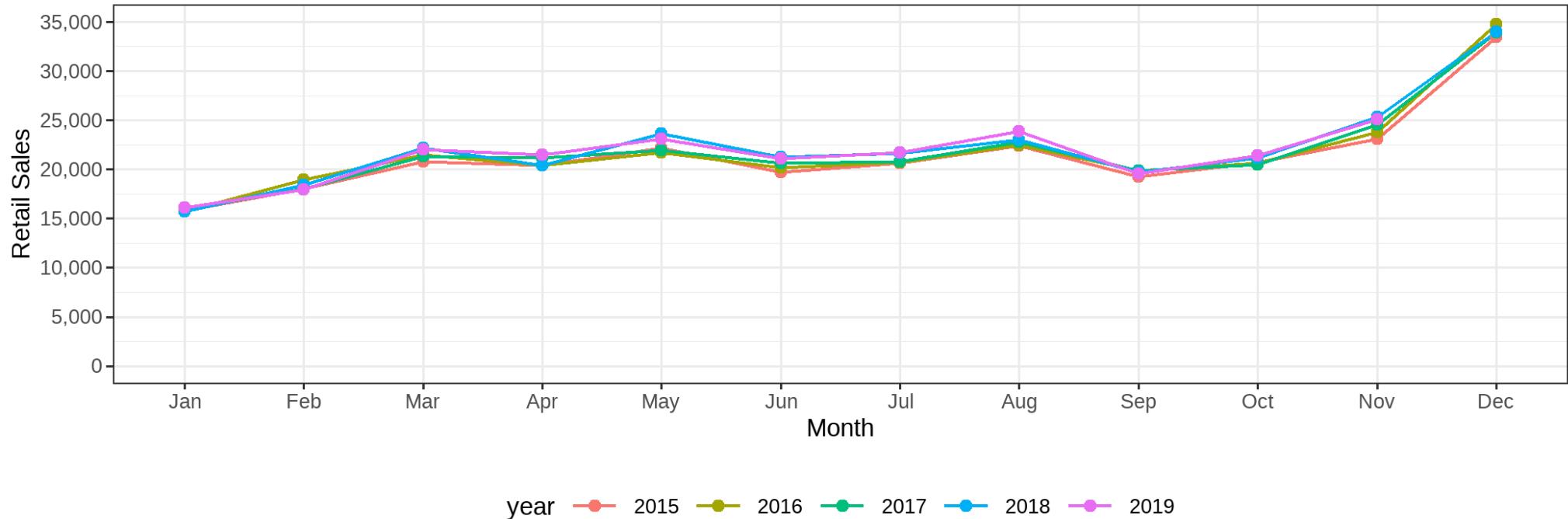


Looking for Trends

Monthly Retail Sales (RSCCASN) in the U.S.

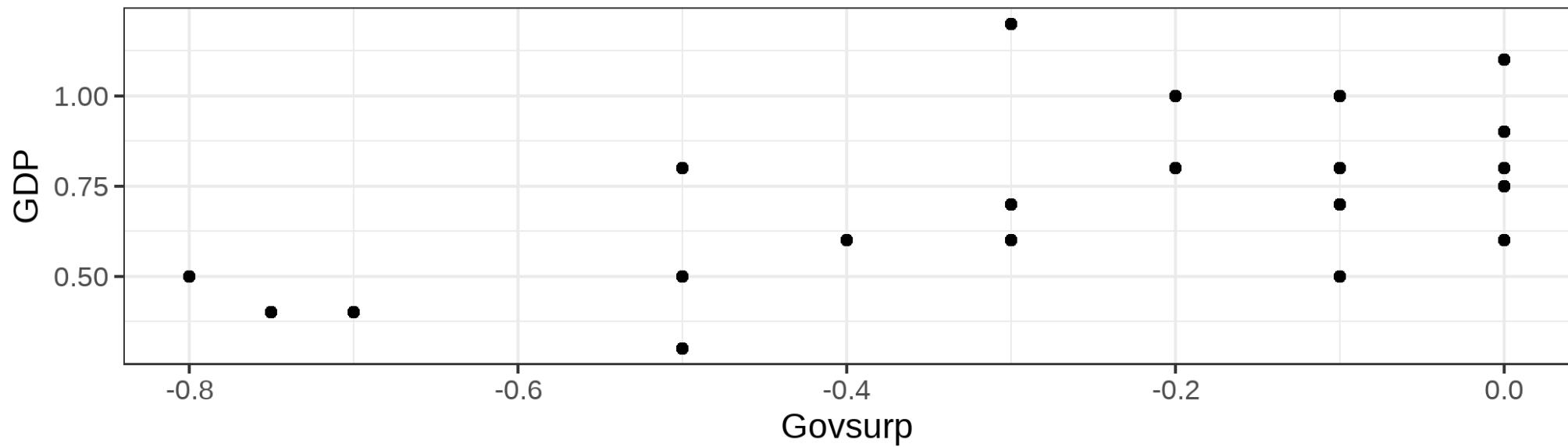


Looking for Seasonality



Multiple TS: Scatterplots

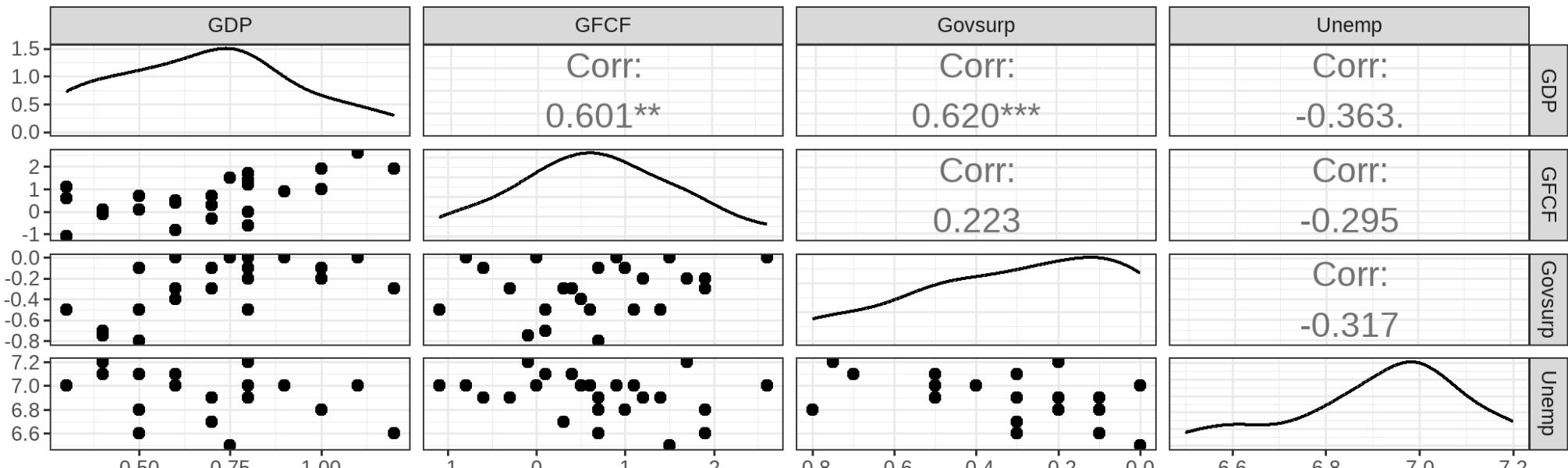
Scatterplot of GDP vs. Government Spending



Data from Muller-Droge et al. (2016)

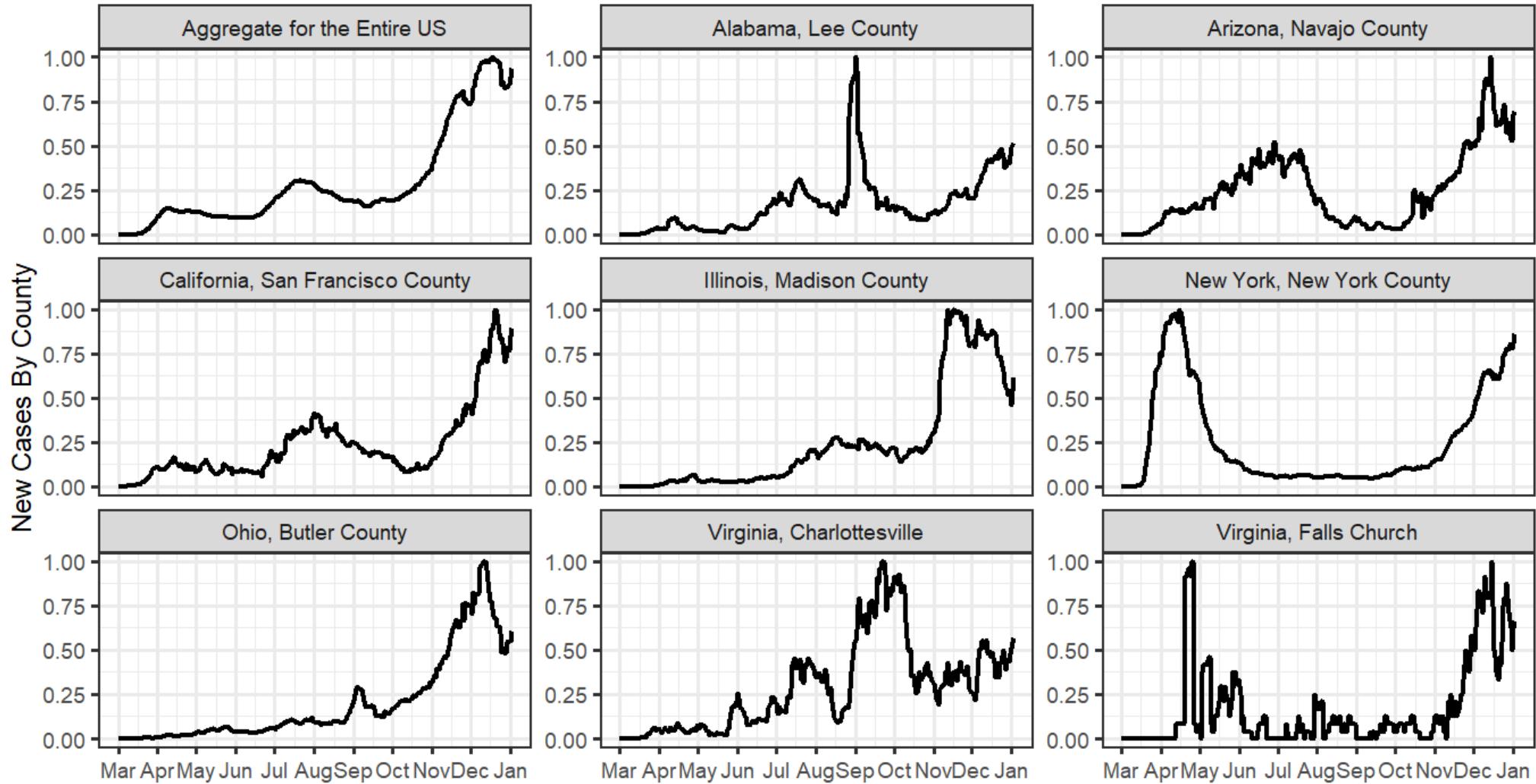
Multiple TS: Scatterplot Matrix

Matrix Plot of GDP, GFDCF, Govsurp & Unemp

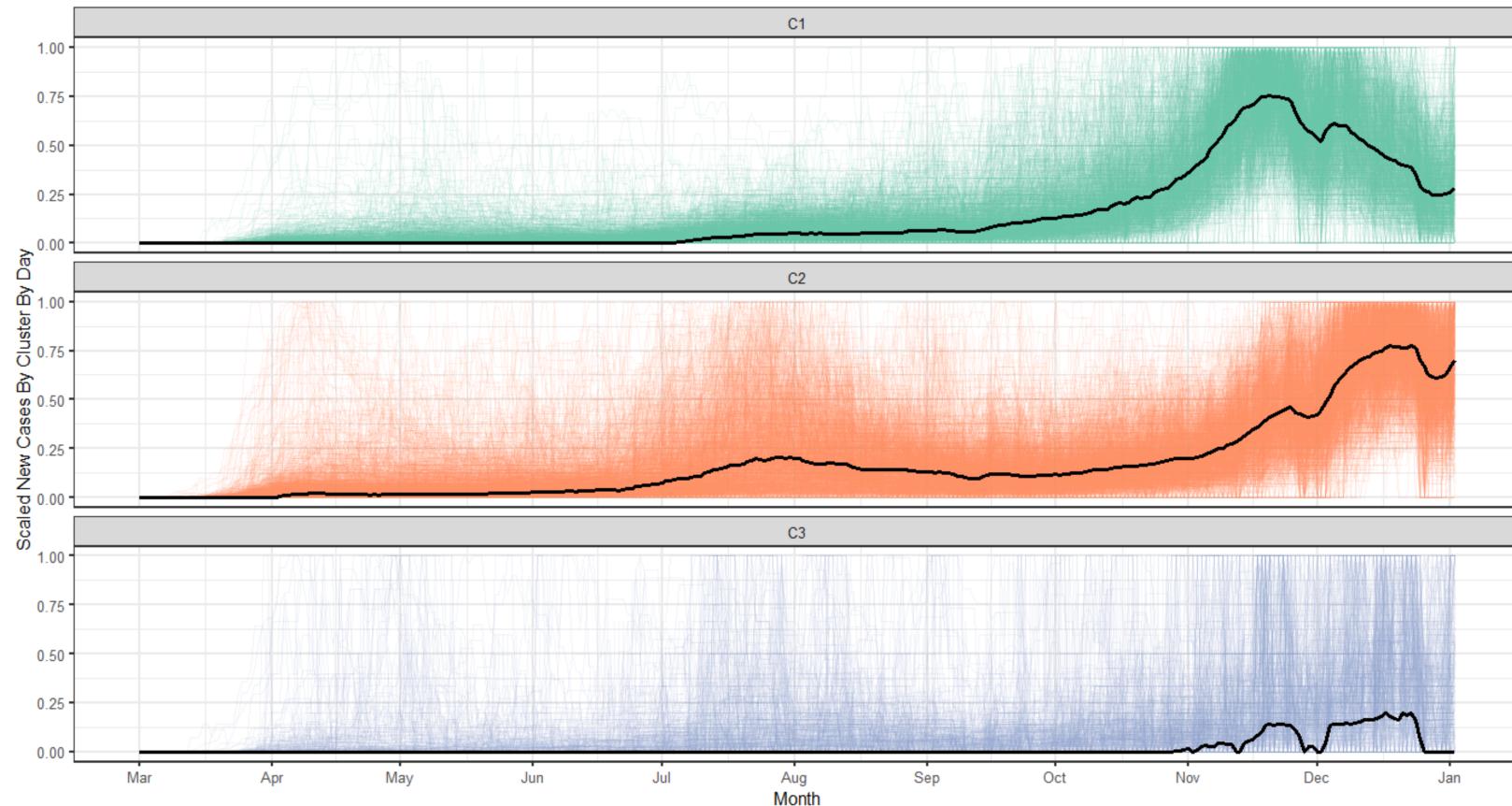


Data from Muller-Droge et al. (2016)

Multiple TS: Panel Plots

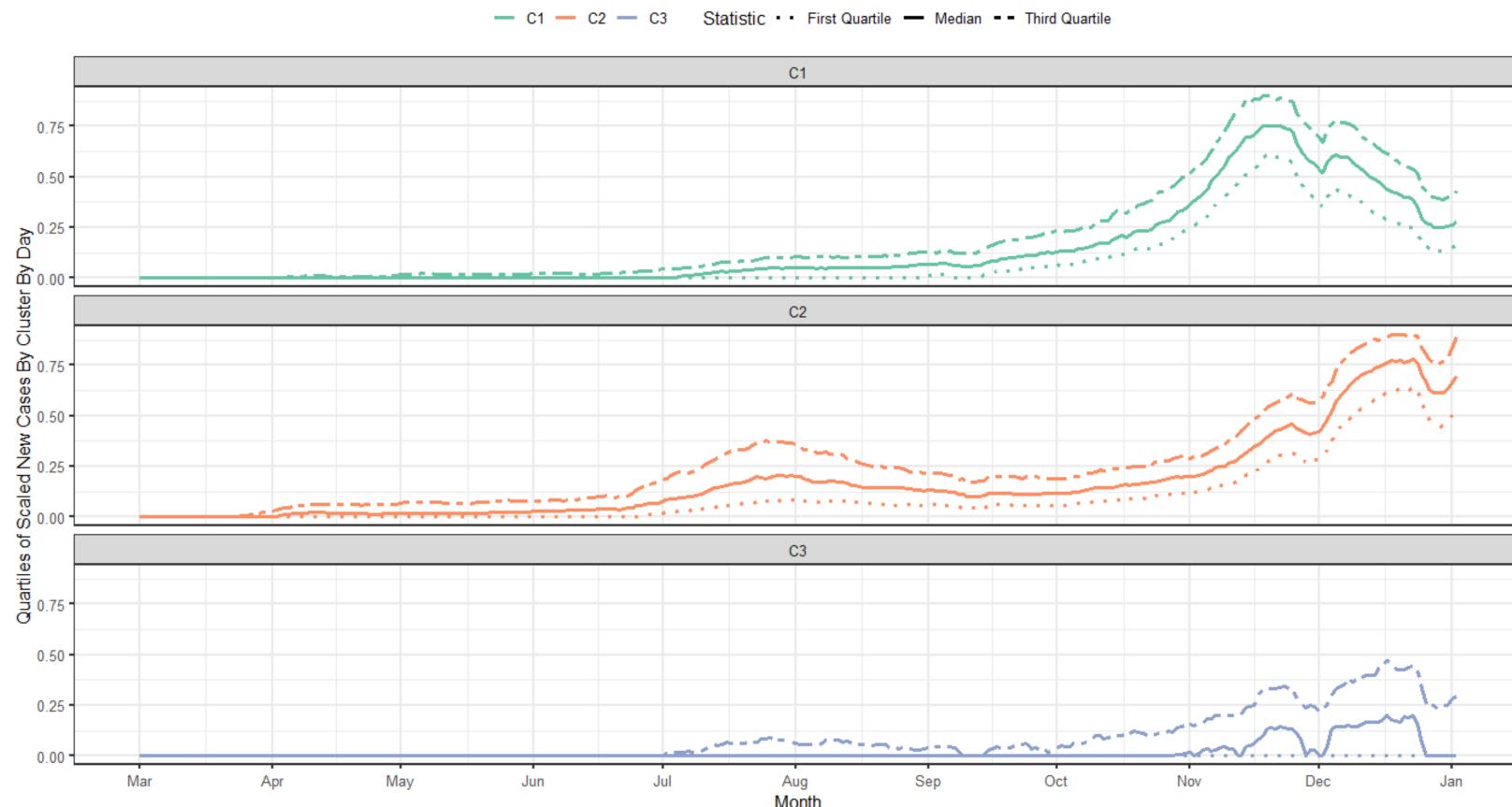


Spaghetti Plots (Often w/ Clustering)



Solid black line represents the median for each cluster.
Based on Data from March 01, 2020 - Jan 02, 2021

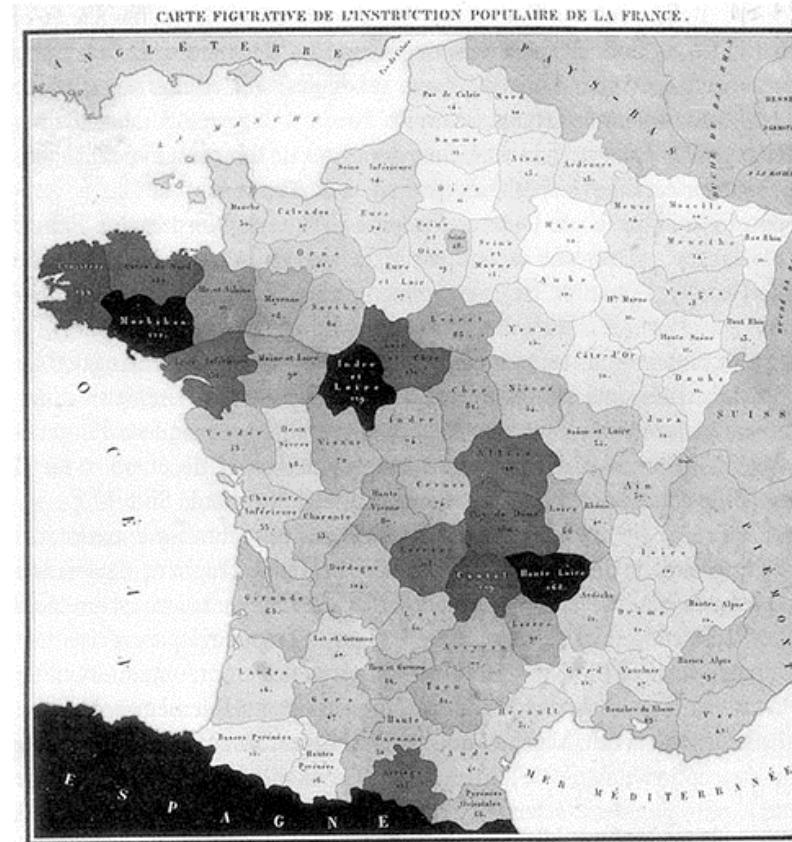
Summary Plots (Often w/ Clustering)



Spatial Plots

Choropleth Maps

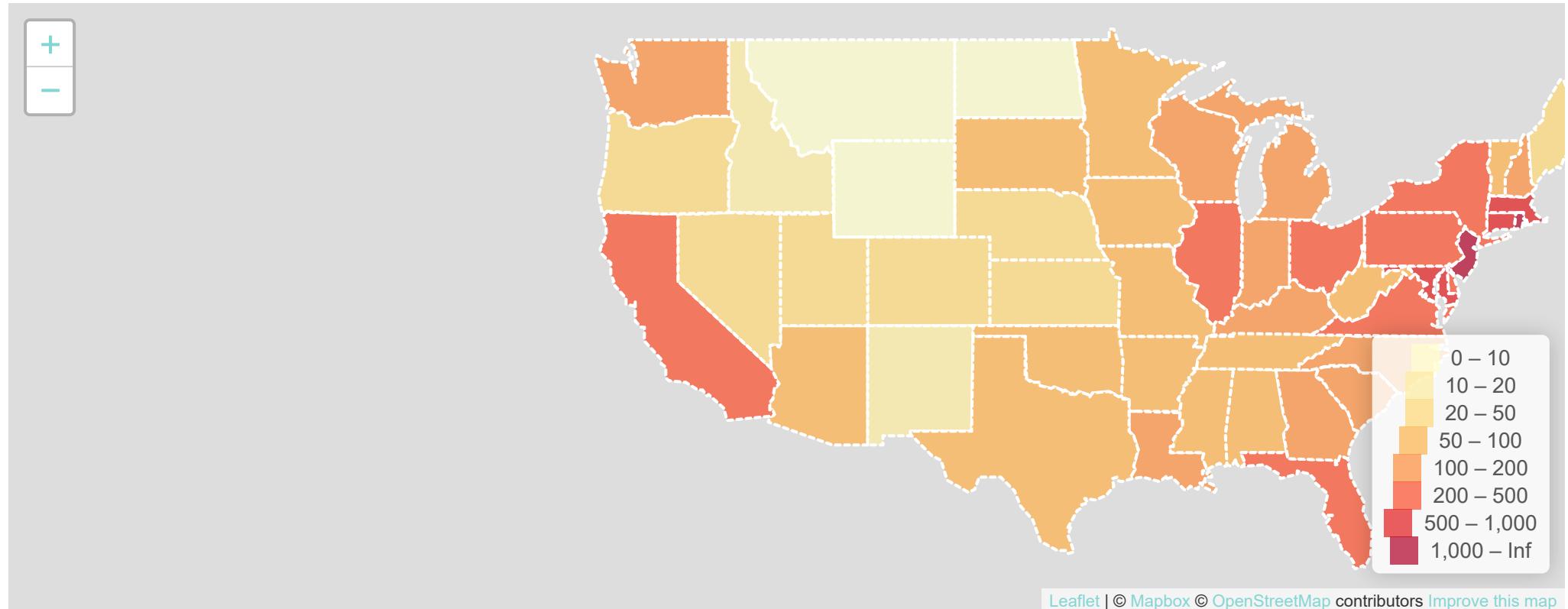
Maps where areas are **shaded, colored, or patterned** relative to a data attribute value.



Charles Dupin's Illiteracy in France Choropleth, created in 1826

Choropleth Maps

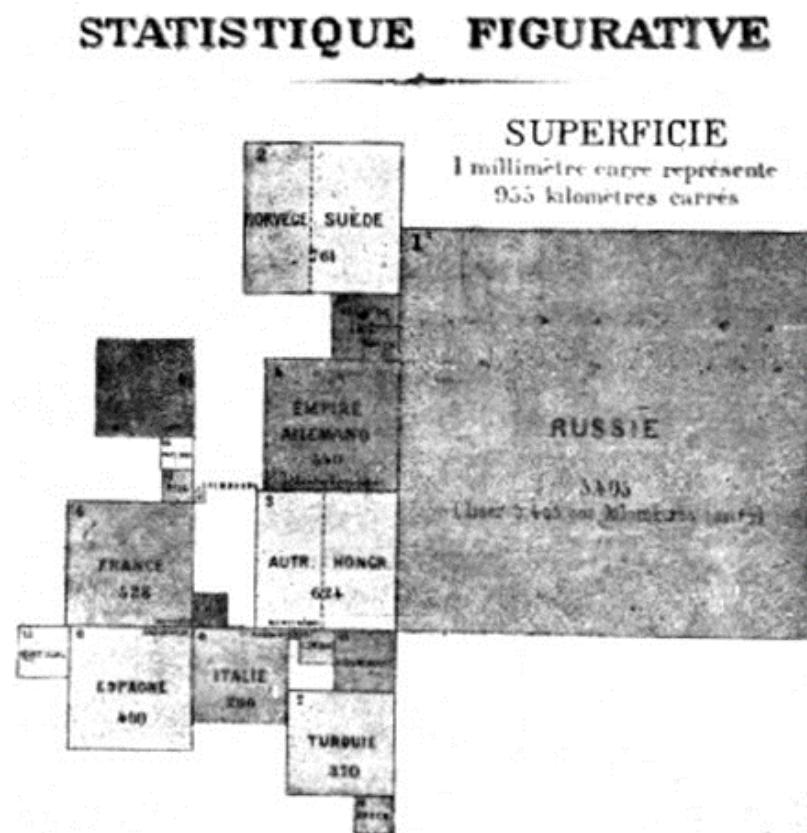
Maps where areas are **shaded, colored, or patterned** relative to a data attribute value.



Population Density in U.S.

Cartograms

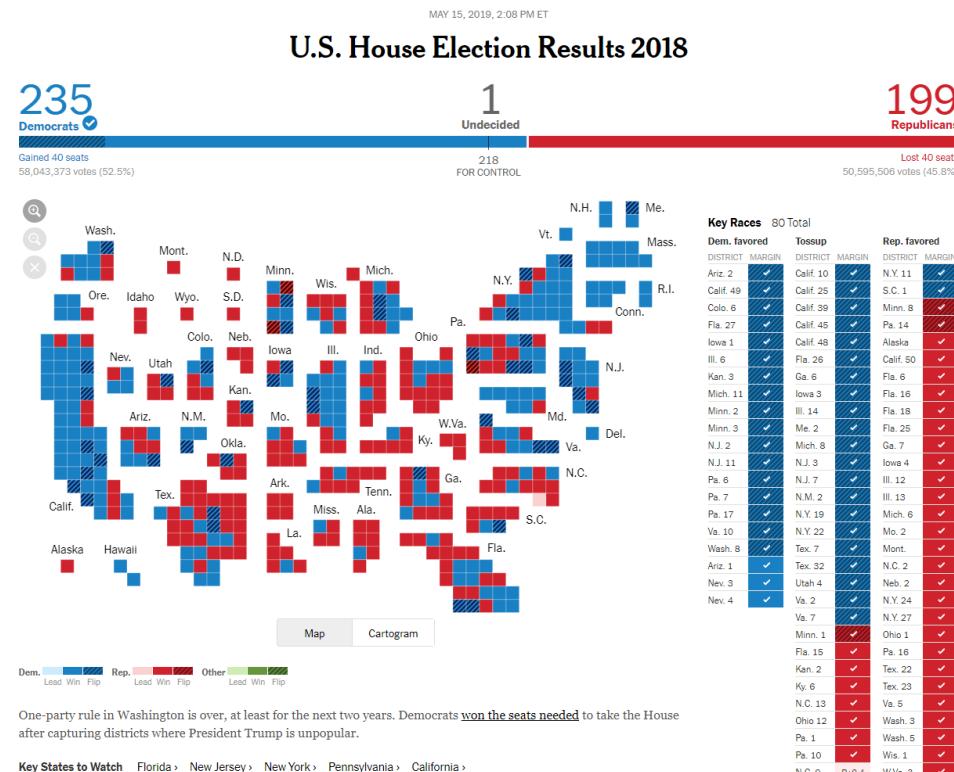
A cartogram is a map in which **areas are scaled and distorted relative to a data attribute value**



The First Cartogram – Emile Levasseur, 1868

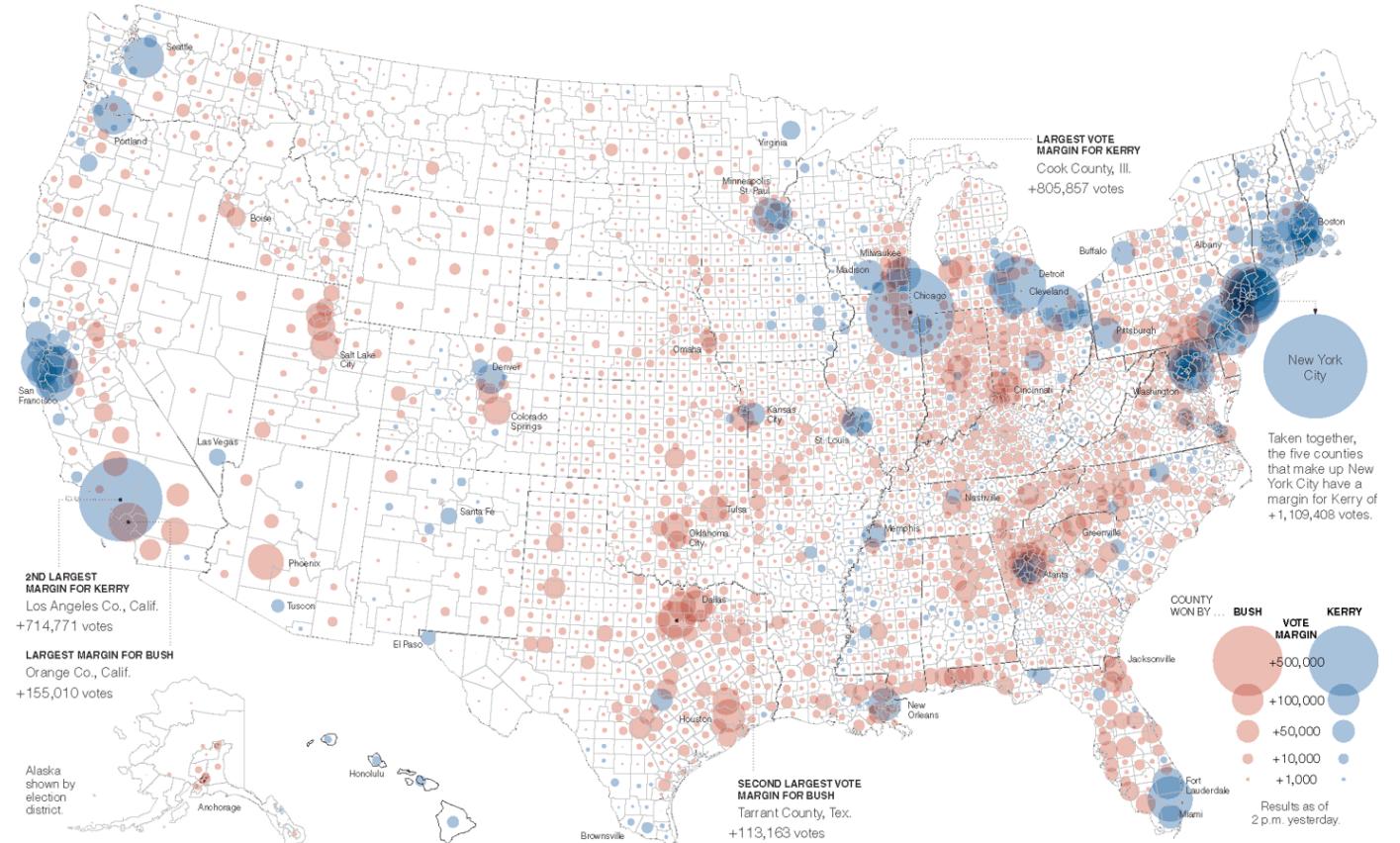
Cartograms

A cartogram is a map in which **areas are scaled and distorted relative to a data attribute value**



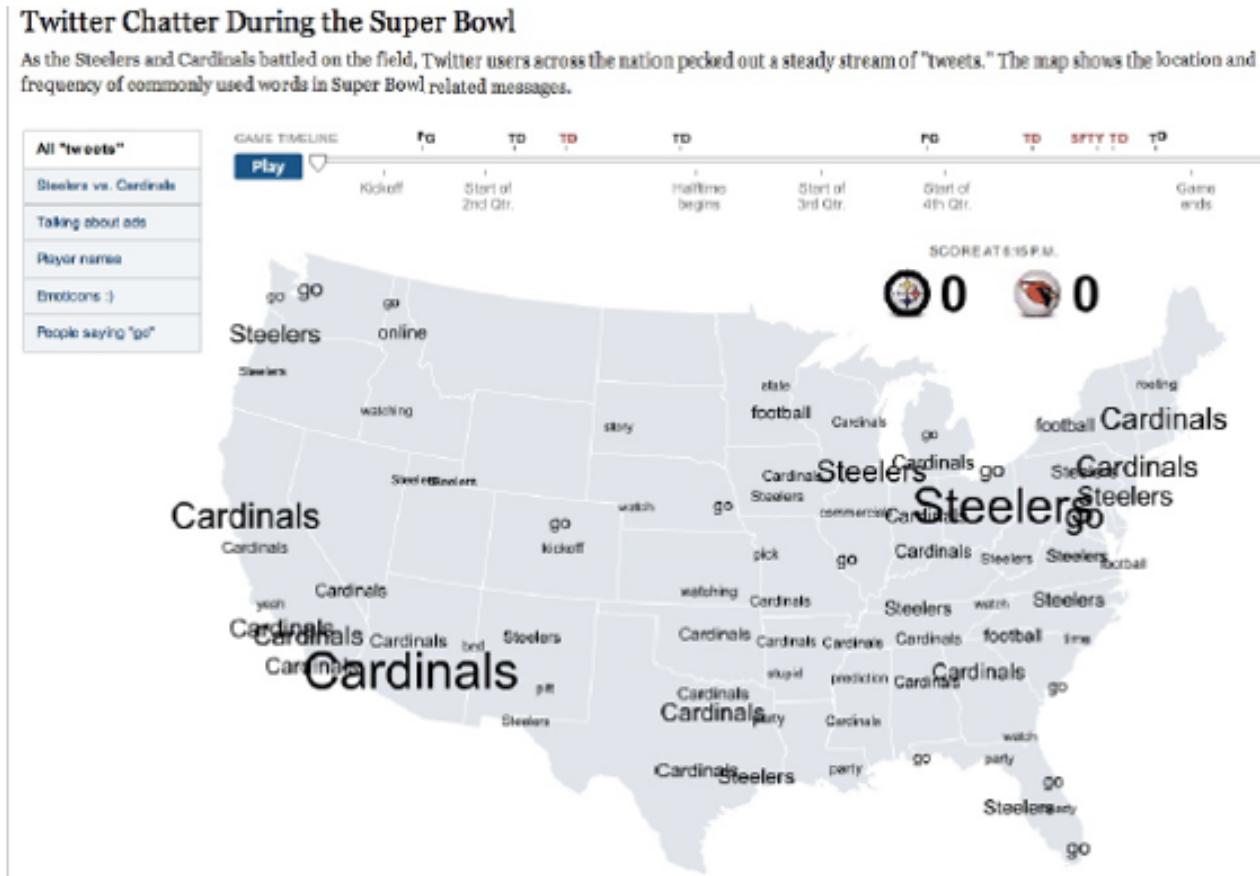
The NYT's U.S. House Election Results 2018

Proportional Symbols Map



The NYT's U.S. Coverage of the Bush Vs Kerry Presidential Elections

Proportional Symbols Map

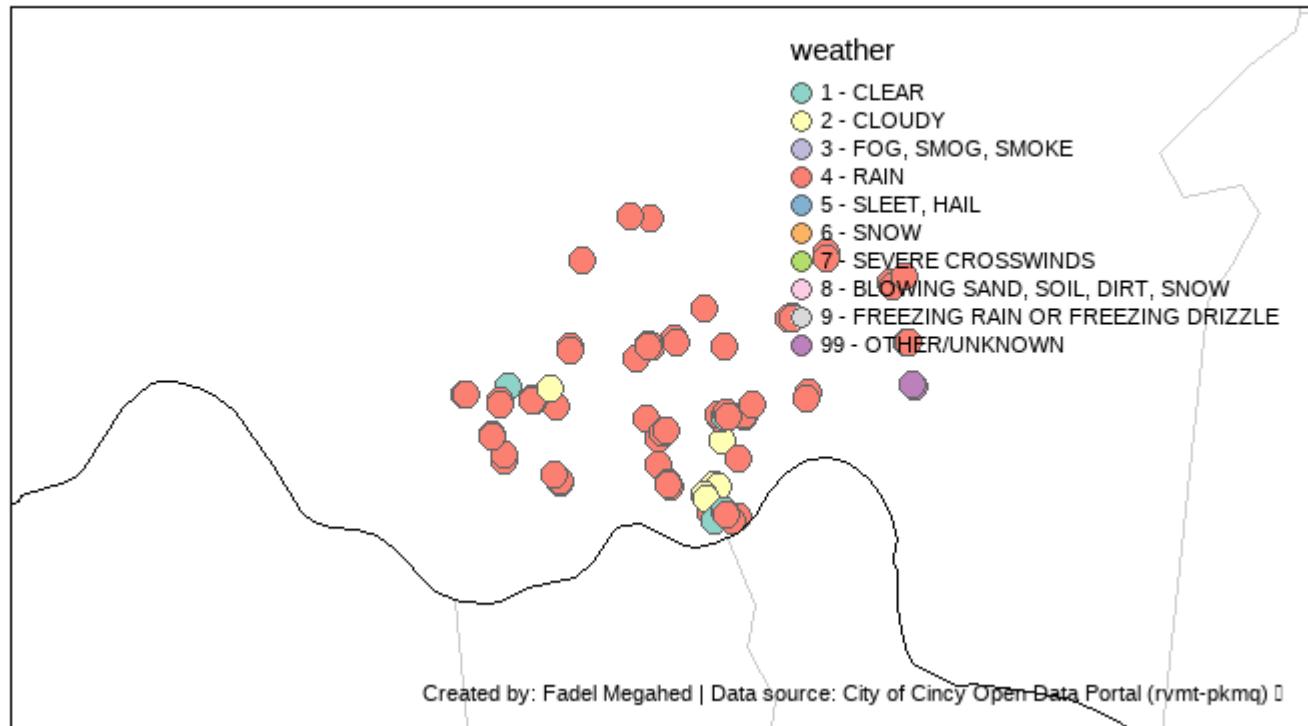


The NYT's U.S. Coverage of 2009 Super Bowl

Spatiotemporal Maps

Spatiotemporal Maps

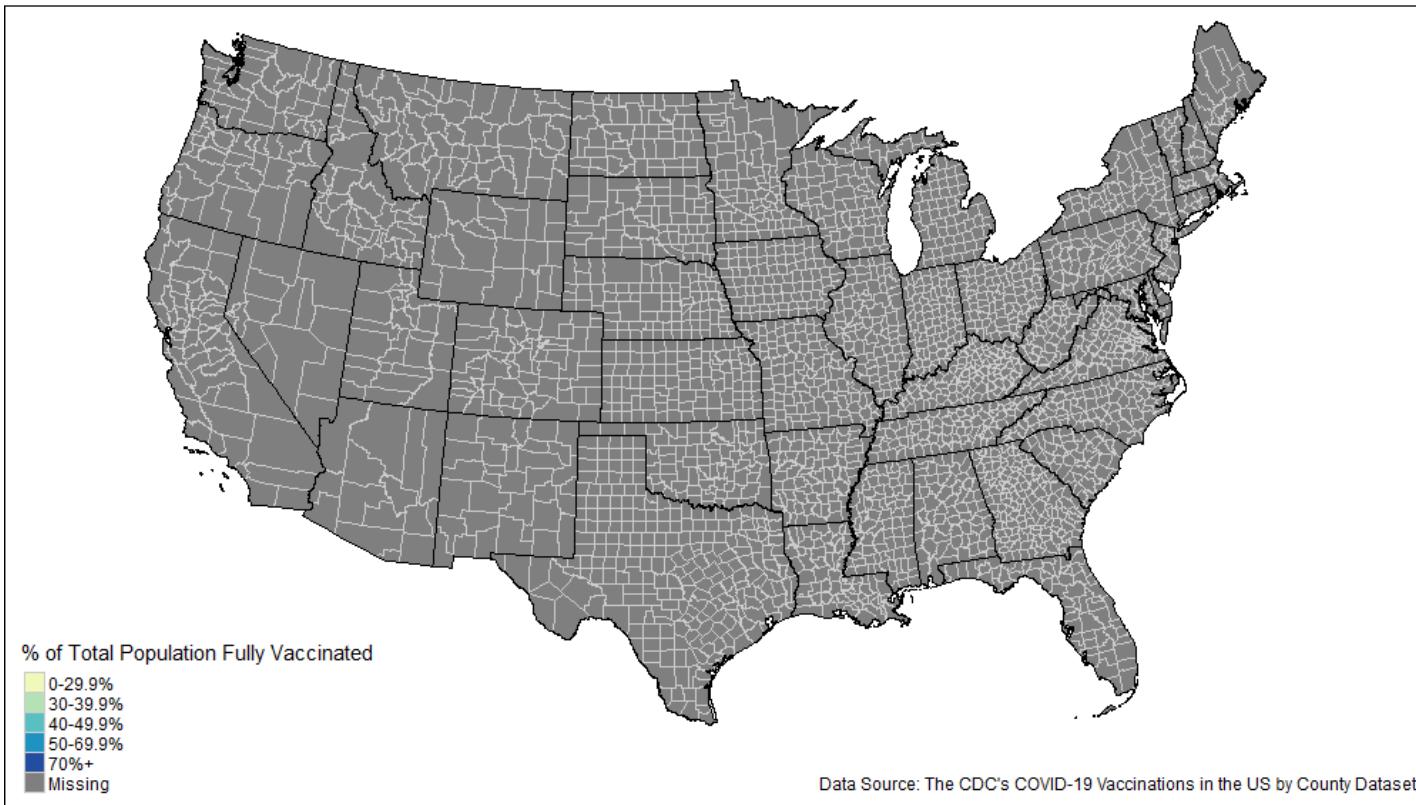
2022-01-01



A visualization of car crashes in the Cincinnati metro area

Spatiotemporal Maps

2020-12-13



Software Demo

Exploring the Cincy Crashes Dataset

Let us use Tableau to explore the [cincy_2021_crashes.csv](#), where we will create the following:

- A calculated field titled `unique_count`
- A plot of the total number of unique crashes per day
- A table of number of unique crashes by week day
- A table of number of unique crashes by week day
- An animated symbols map

Recap

Summary of Main Points

- Understand main goals behind visualizing time-series data
- Explain the different types of charts for univariate and multivariate time-series
- Explain the different types of spatial plots
- Select suitable spatial graphs for different scenarios
- Understand how spatiotemporal plots can help in storytelling (what makes BI special)