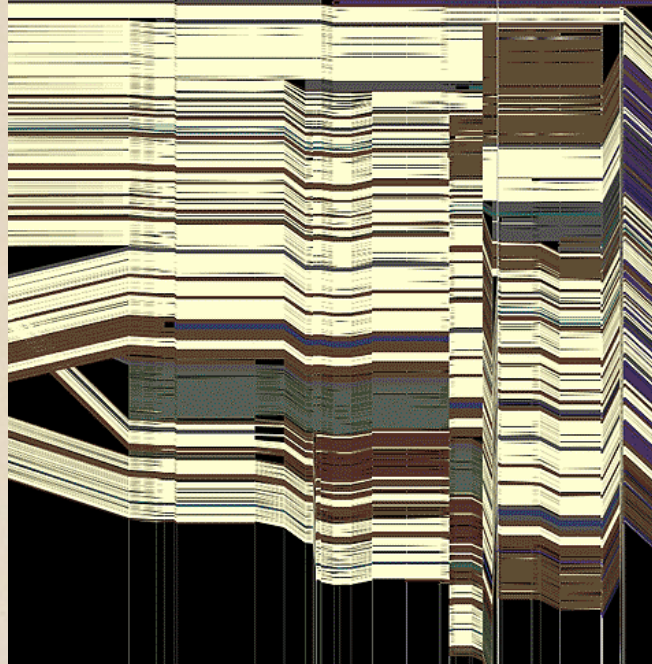
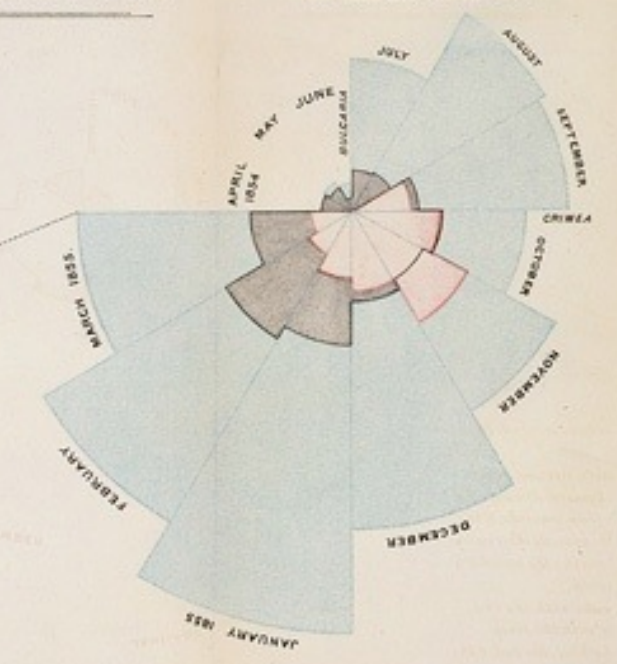


CSE 412 - Intro to Data Visualization

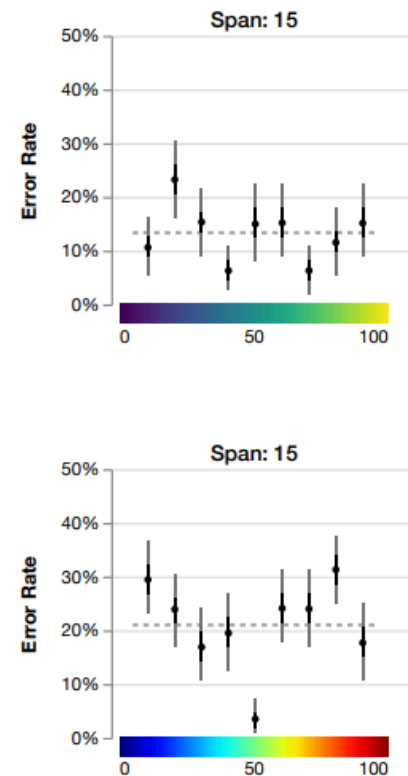
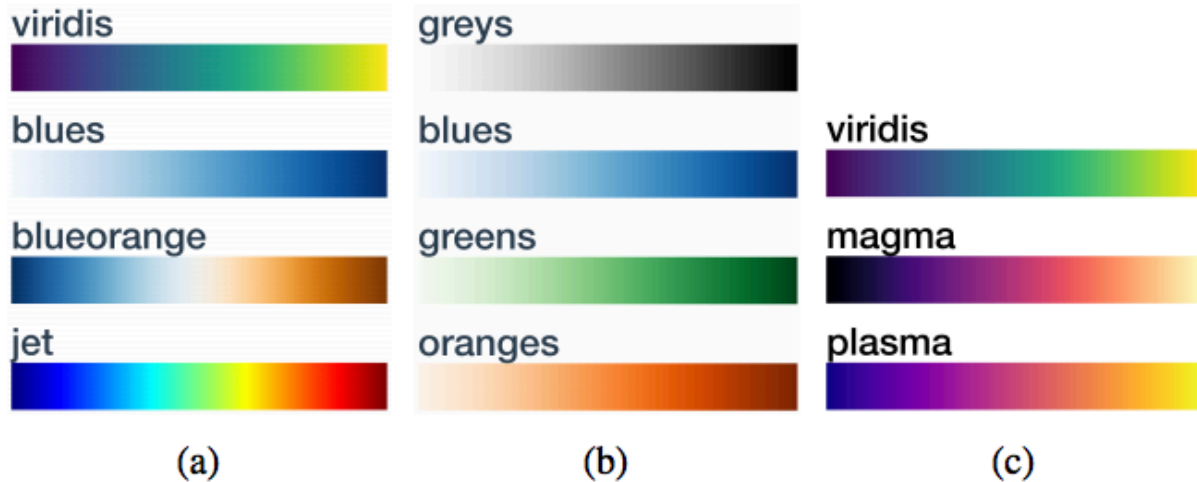
# Graphical Perception Pt. 2



Jane Hoffswell University of Washington

# Guest Lecture: Color

Fri Apr. 30 - Guest: Jeffrey Heer (UW)



**Figure 1: Colormaps under study.** We evaluate four single-hue, three perceptually-uniform multi-hue, a diverging, and a rainbow colormap(s). We divide them into (a) assorted, (b) single-hue and (c) multi-hue groups, with two colormaps repeated across groups for replication.

# Graphical Perception

The ability of viewers to interpret visual (graphical) encodings of information and thereby decode information in graphs.

# Topics

## Monday:

Signal Detection

Magnitude Estimation

Using Multiple Visual Encodings

Pre-Attentive Processing

## Today:

Gestalt Grouping

Change Blindness

**Final Project Discussion**

# Gestalt Grouping

# Gestalt Principles

Figure/Ground

Proximity

Similarity

Symmetry

Connectedness

Continuity

Closure

Common Fate

Transparency

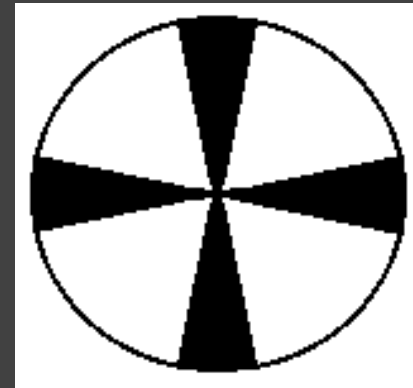
# Figure/Ground



Ambiguous



Principle of surroundedness



Principle of relative size

# Figure/Ground



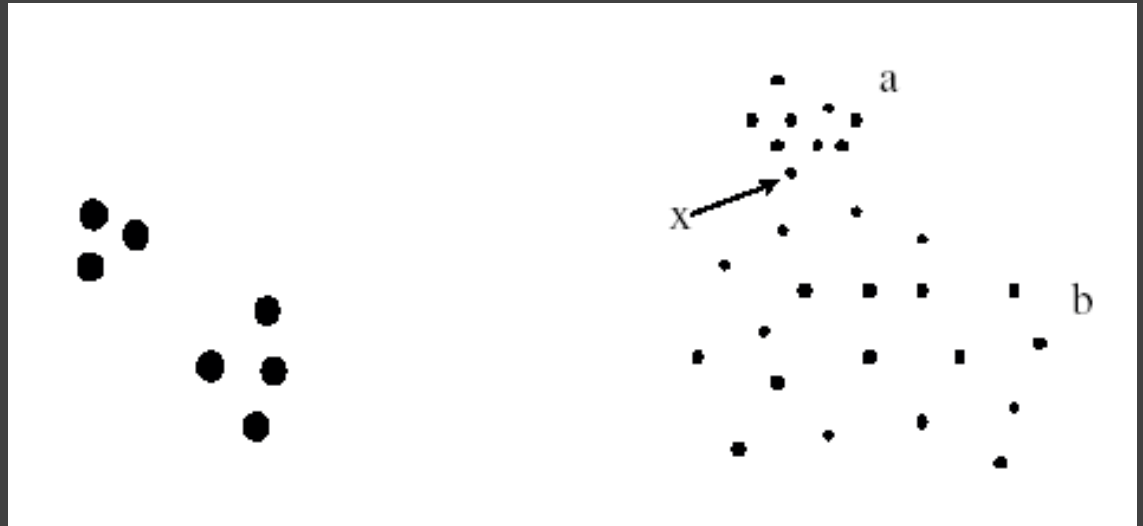
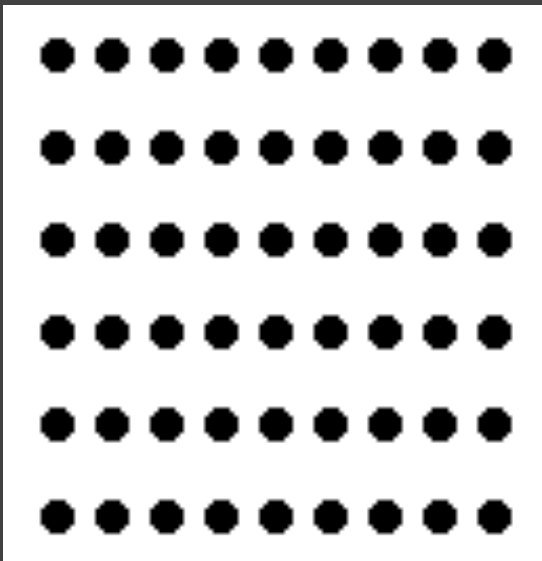
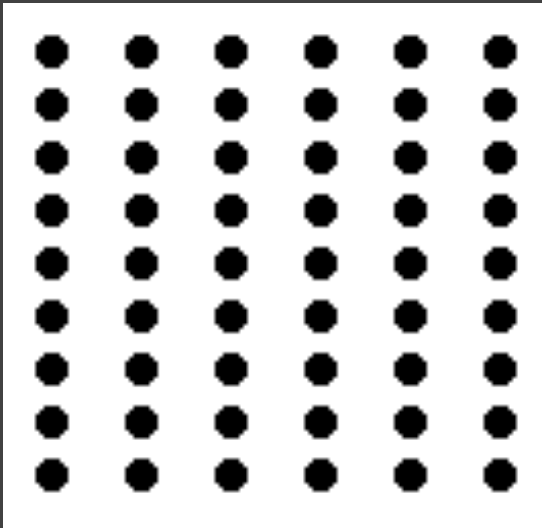
Ambiguous



Unambiguous (?)

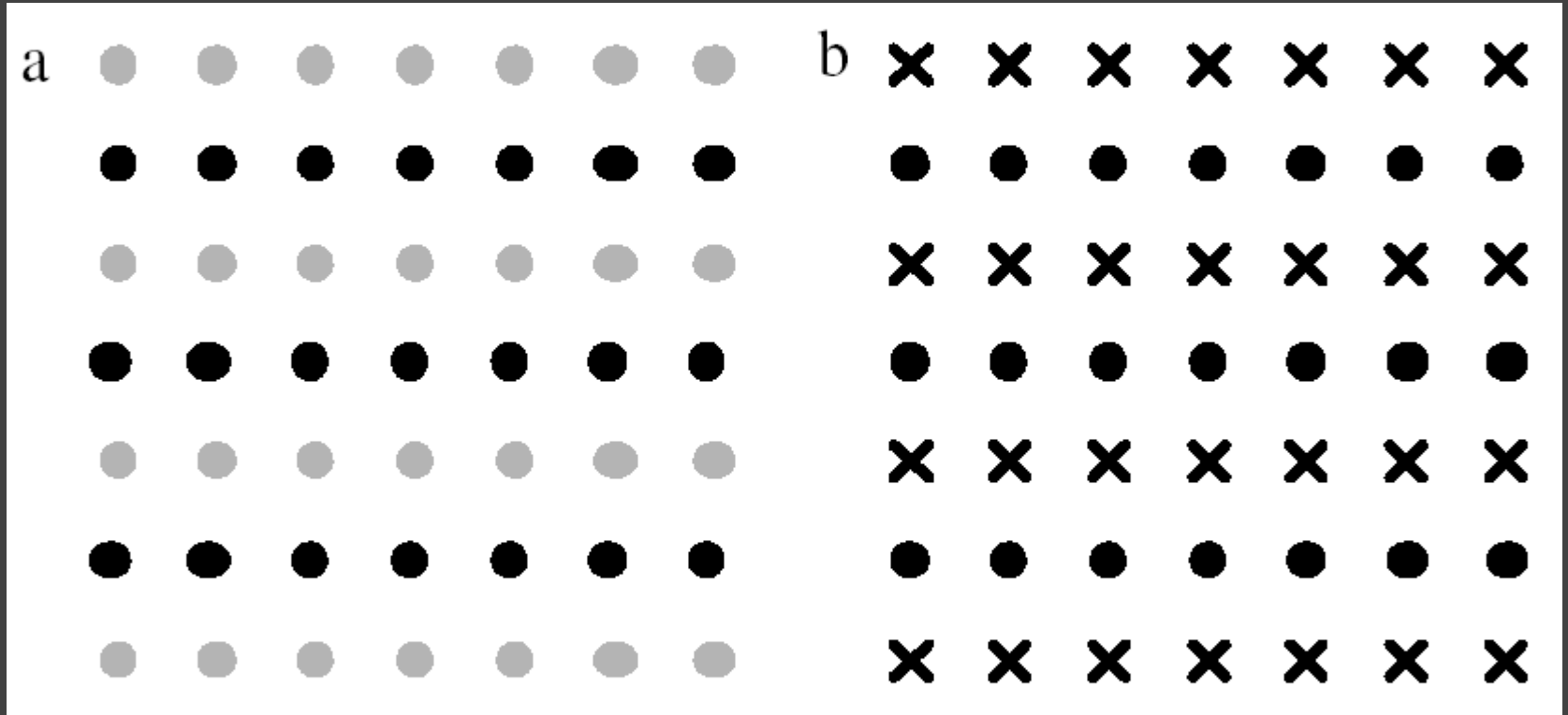


# Proximity



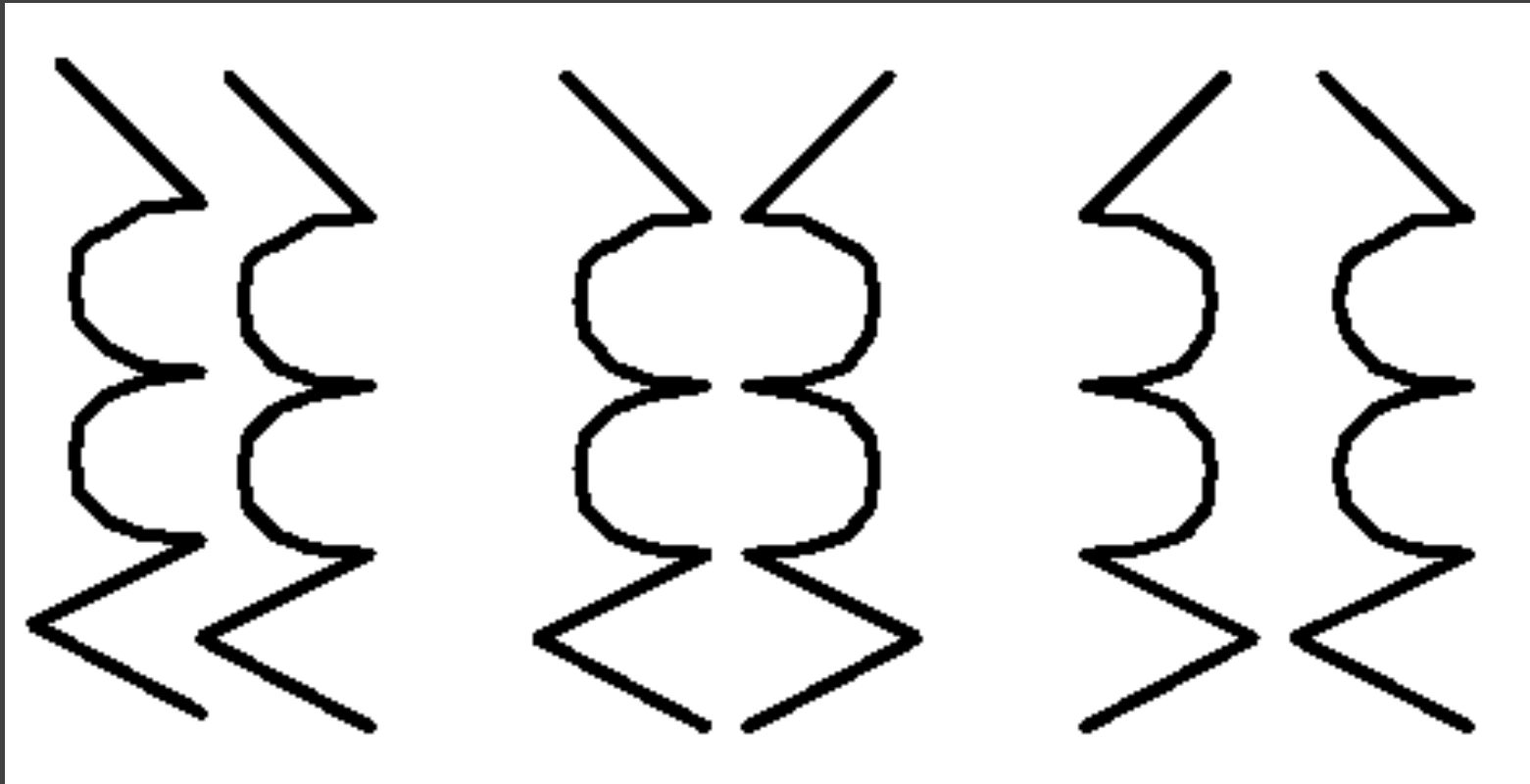
[Ware '00]

# Similarity



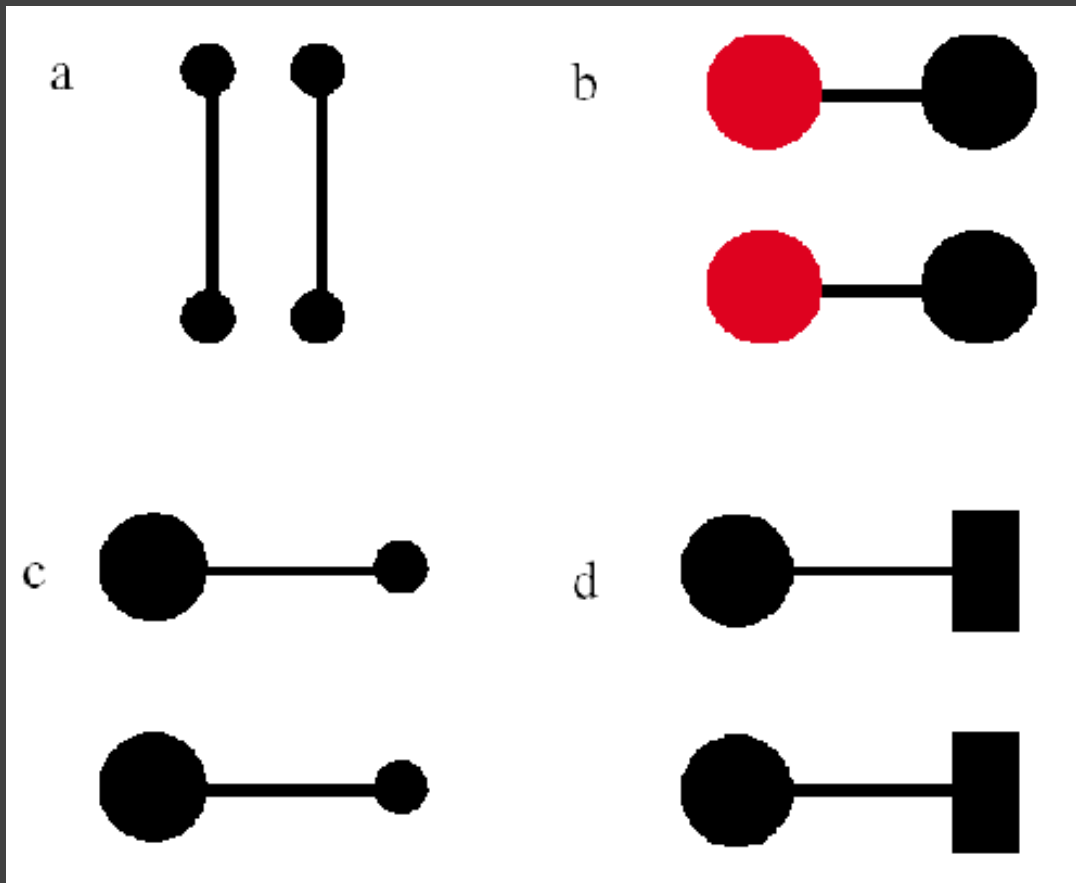
Rows dominate due to similarity [from Ware '04]

# Symmetry



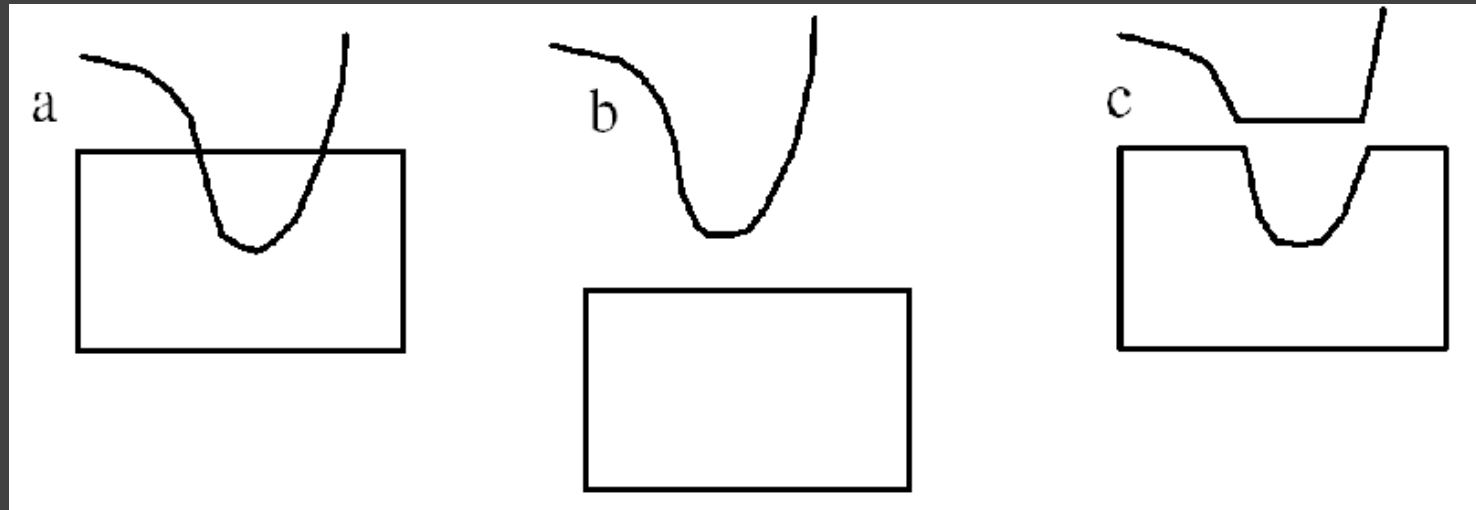
Bilateral symmetry gives strong sense of figure [from Ware '04]

# Connectedness

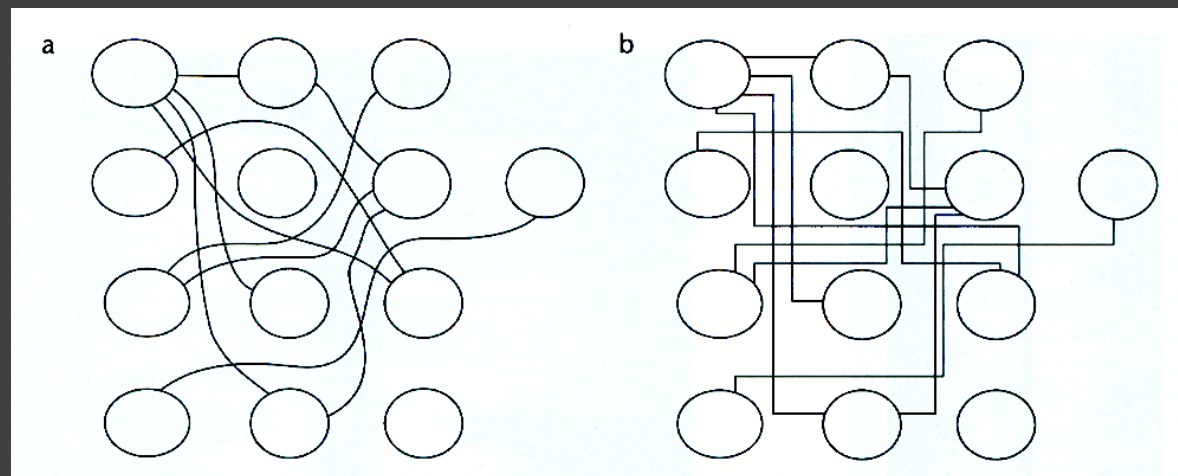


Connectedness overrules proximity, size, color shape [from Ware '04]

# Continuity

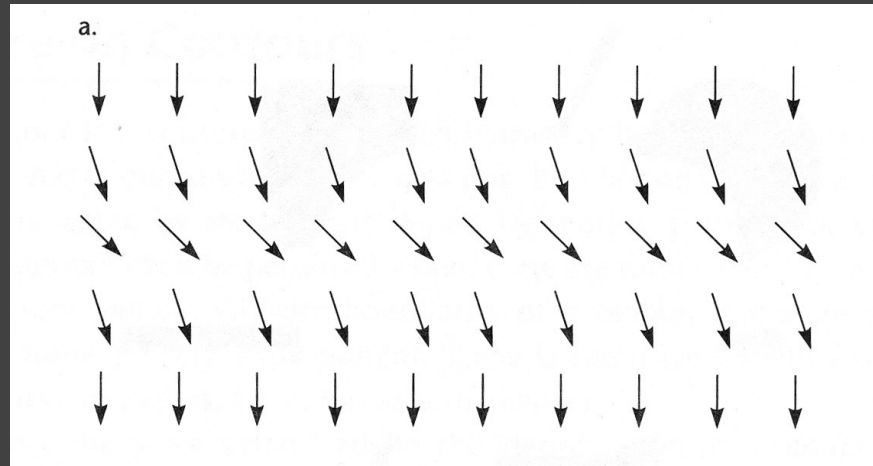


We prefer smooth not abrupt changes [from Ware '04]

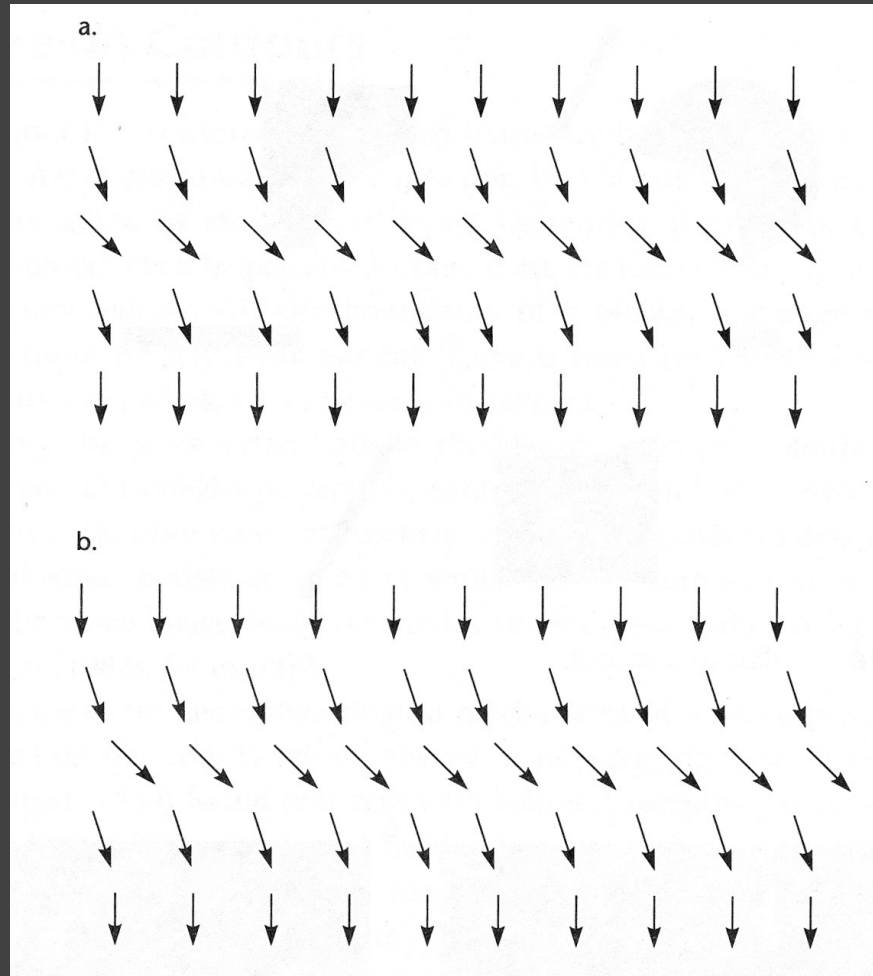


Connections are clearer with smooth contours [from Ware '04]

# Continuity: Vector Fields

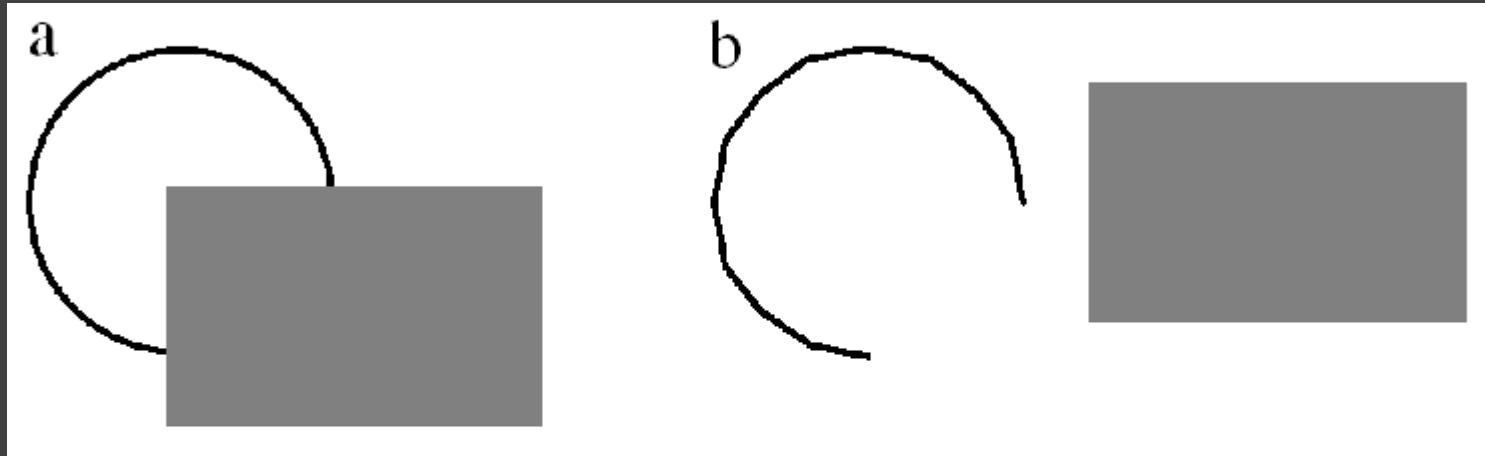


# Continuity: Vector Fields

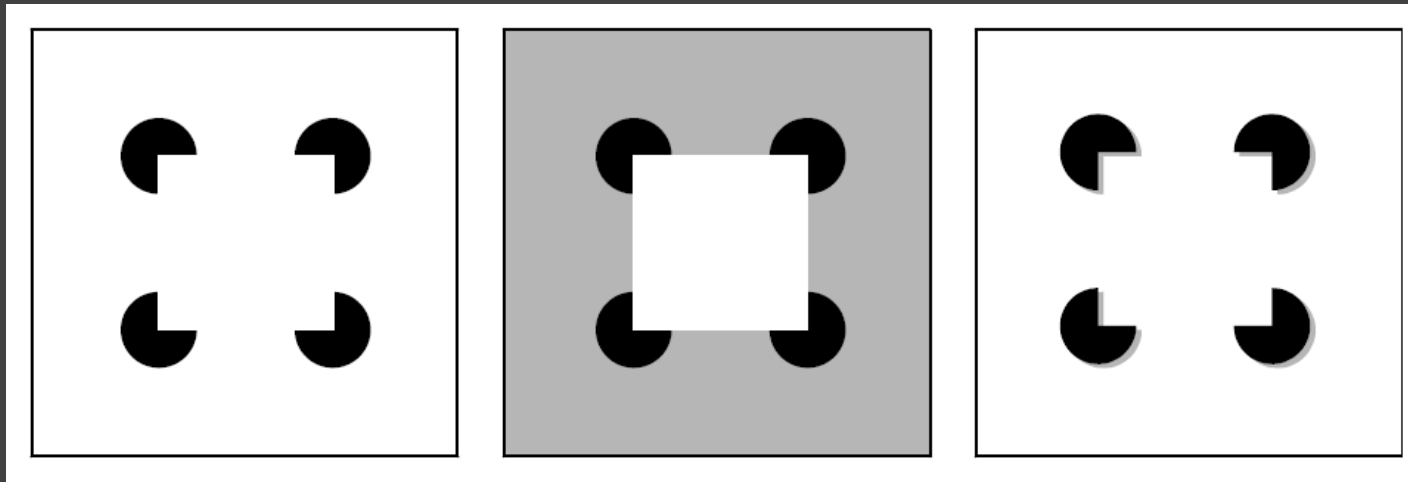


Prefer field that shows smooth continuous contours [from Ware '04]

# Closure



We see a circle behind a rectangle, not a broken circle [from Ware '04]



Illusory contours [from Durand '02]



# Common Fate



Dots moving together are grouped

# Transparency



Requires continuity and proper color correspondence [from Ware '04]

# Change Blindness

# Change Blindness



# Change Blindness



# Change Blindness



# Change Blindness



# Change Blindness





# Change Blindness



# Change Blindness



# Change Blindness



# Change Blindness



[Example from Palmer 99, originally due to Rock]

# Summary

Choosing effective visual encodings requires knowledge of visual perception.

## **Visual features/attributes**

Individual attributes often pre-attentive

Multiple attributes may be separable or integral

**Gestalt principles** provide high-level guidelines

We don't always see everything that is there!

# Administrivia

# A3: Ethical & Deceptive Visualization

Use visualizations to communicate and influence insights

Design both an ethical and deceptive visualization

**Ethical Visualization:** honestly and transparently communicate the data with an effective and expressive visualization design that is easy to interpret for viewers

**Deceptive Visualization:** intentionally influence viewer's perception to mislead their insights, without revealing it's role as the deceptive design

Due by **11:59 pm PT, next Monday May 3rd**

# A3: Ethical & Deceptive Visualization

**Deliverables** (upload via Canvas; [see A3 page](#))

Image of your visualization (.png or .jpg format)

Images should be named **ethical** and **deceptive** accordingly

Image itself **should not give away which design is which**

Write-up including a short description + design rationale

Due by **11:59 pm PT, next Monday May 3rd**

**Assignment A3b: Peer Evaluation** ([see course website](#))

Provide constructive feedback on **four peer designs**

Guess which visualization designs are deceptive and ethical

Due by 11:59pm PT, Monday May 10th (the following Monday)



# A3: Ethical & Deceptive Visualization

**Must use the same dataset**, but can ask different questions

Both visualizations should emphasize **communication**

Ethical visualization should be a clear, thoughtful design that is both **effective and expressive**, demonstrating course principles

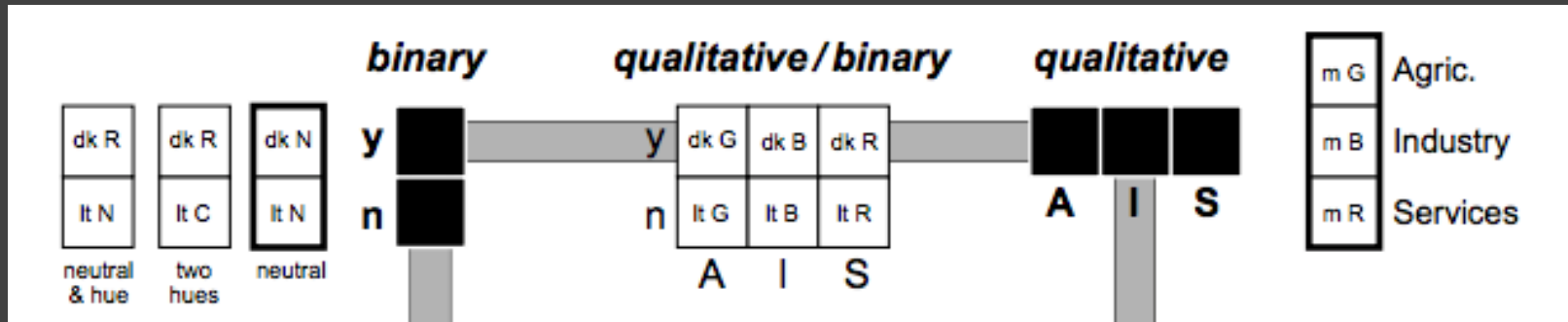
Deceptive design should not be incorrect or illegible, but rather subtly misleading. **It should not be obviously deceptive!**

Image filenames must be exactly "**ethical**" and "**deceptive**"

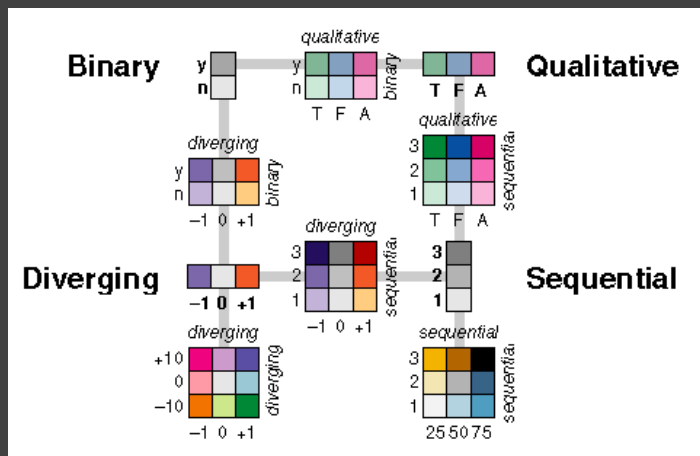
Due by **11:59 pm PT, next Monday May 3rd**

**Please submit on time!** Assignments submitted late will not receive any peer evaluations (which are due Monday 5/10).

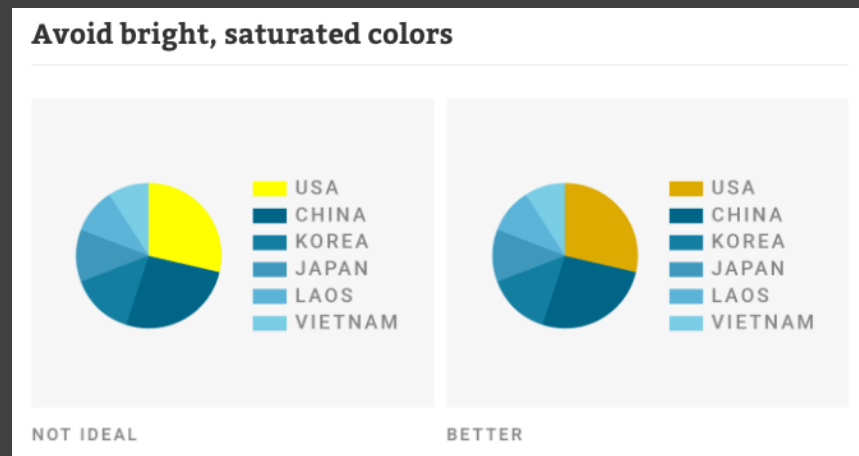
# Required Readings for Fri 4/30



Color Use Guidelines for Data Representation. Cynthia Brewer. Section on Statistical Graphics, American Statistical Association. 1999.



Color Scheme Explorer.



How to pick more beautiful colors for your data visualizations. Lisa Charlotte Rost. 2020.

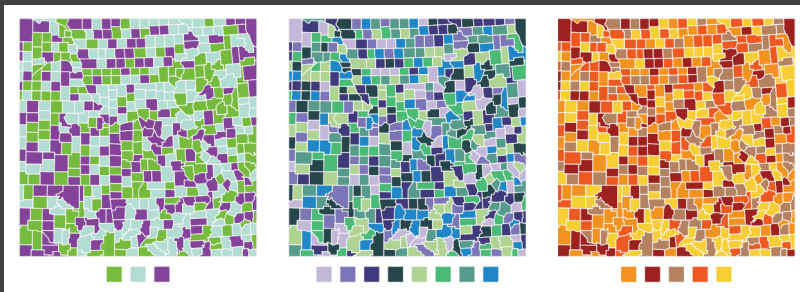
# Optional Readings for Fri 4/30

# d3.interpolateViridis(t) <>

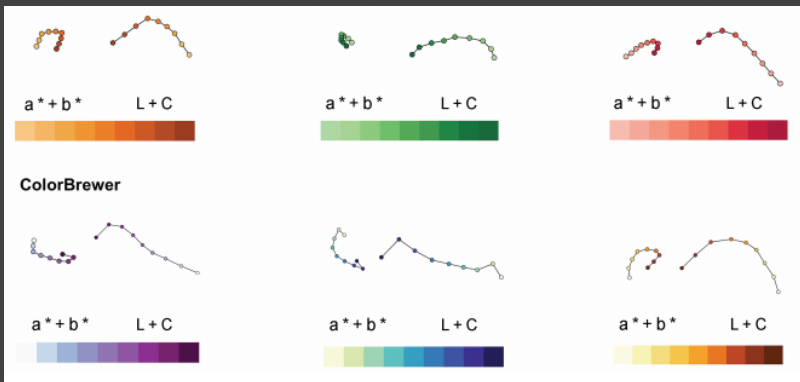


Given a number  $t$  in the range  $[0,1]$ , returns the corresponding color from the "viridis" perceptually-uniform color scheme designed by van der Walt, Smith and Firing for matplotlib, represented as an RGB string.

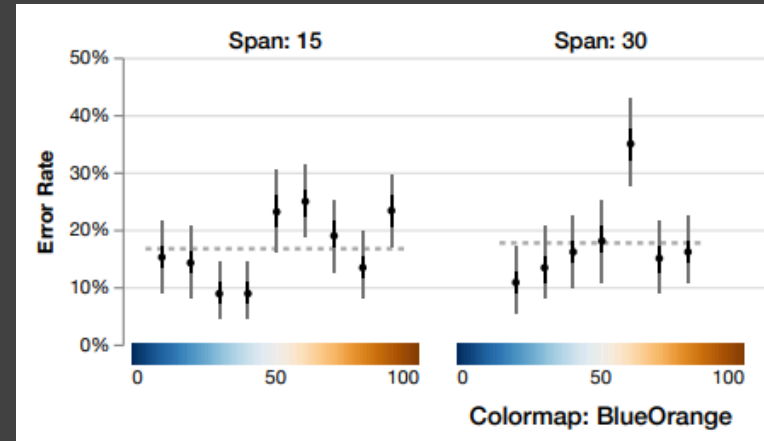
## FRI D3 color scales: d3-scale-chromatic



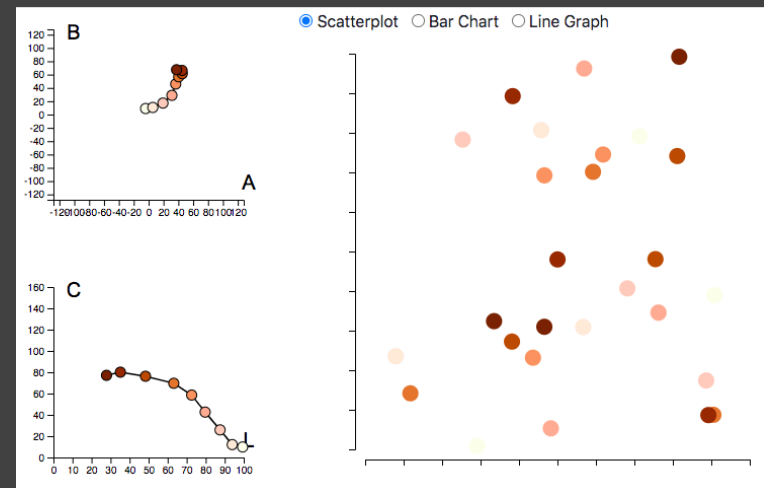
## FRI Colorgorical: Creating Discriminable and Preferable Color Palettes for Information Visualization.



## FRI Color Crafting: Automating the Construction of Designer Quality Color Ramps.



## FRI Somewhere Over the Rainbow: An Empirical Assessment of Quantitative Colormaps.



## FRI Color Crafter (Online Tool)

# Readings for Mon 5/3

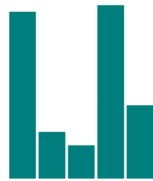


Figure 6-6. New data values

Figure 6-7 shows 25 data points instead of 5!

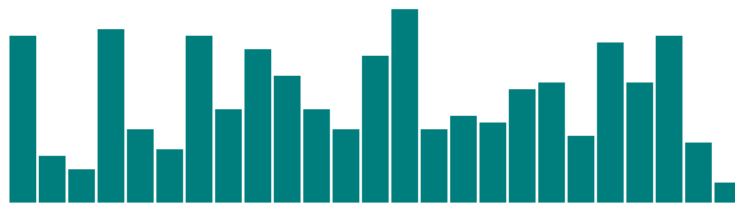


Figure 6-7. Lots more data values

How does D3 automatically expand our chart as needed?

```
d3.select("body").selectAll("div")
  .data(dataset) // <-- The answer is here!
  .enter()
  .append("div")
  .attr("class", "bar")
  .style("height", function(d) {
    var barHeight = d * 5;
    return barHeight + "px";
  });
```



**REQUIRED** Chapters 6, 7, 8 in Interactive Data Visualization for the Web, 2nd Edition. Scott Murray.

**OPTIONAL** Critical Reflections on Visualization Authoring Systems.

# Final Project

# Final Project

Produce **narrative web-based visualizations**

Initial **prototype** and **design review**

**Final deliverables** and **video presentation**

Submit and **publish online** (GitHub)

Projects from previous classes (442, 512) have been:

- Published as research papers
- Shared widely (some in the New York Times!)
- Released as successful open source projects

# Final Project Theme

## **Data Visualization for Communicating Scientific Advancements or Social Phenomena**

*Goal: find data of social or scientific import, design visualizations to communicate it effectively to a general audience.*

The specific data domain is open-ended. Possibilities include transportation, campaign finance, education, economics, chemical engineering, sociology, statistics, atmospheric science, molecular interactions, scientific research, and so on...

Use Assignment 2 and 3 to explore a data set of interest prior to committing to final project teams and topic!

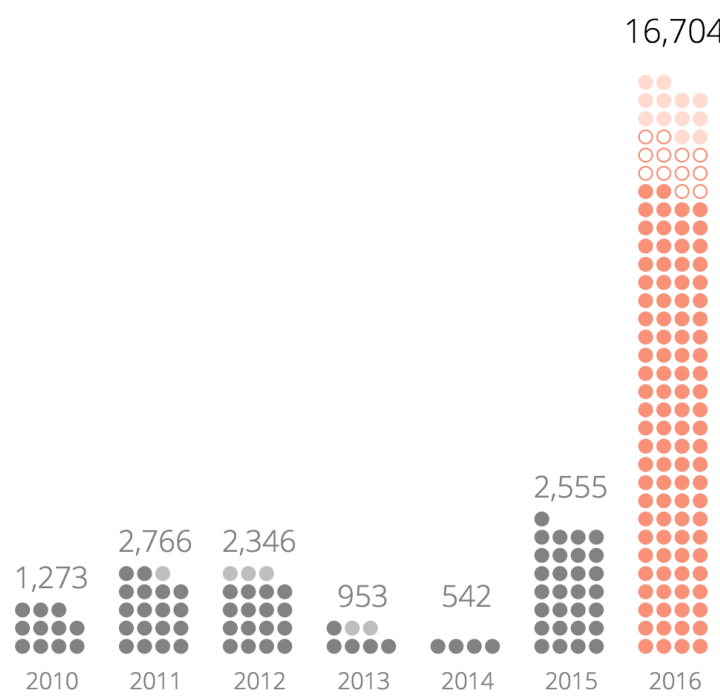
**Inspiration...**



**Professional, Scientific and Technical Services** ●

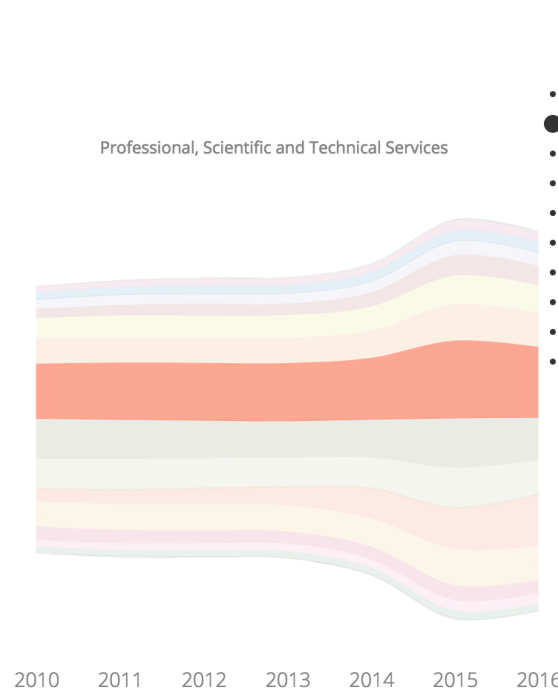
● approx. 131 businesses

- Transportation and Warehousing
- Other Services (Except Public Administration)
- Retail Trade
- Construction
- Health Care & Social Assistance
- Arts, Entertainment, & Recreation
- Accommodation & Food Services
- Administrative & Support & Waste
- Wholesale Trade
- Manufacturing
- Real Estate, Rental & Leasing
- Information
- Educational Services
- Finance and Insurance
- Public Administration
- Management of Companies and Enterprises
- Agriculture, Forestry, Fishing and Hunting
- Utilities
- Mining
- Unclassified



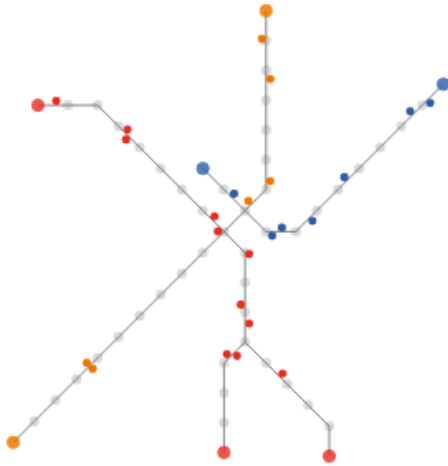
● new businesses ○ old businesses (records appearing in that year) ● old businesses  
 ● new businesses that got left behind ● old businesses that got left behind

Business Count



# Change In Times (CSE 442, Spring '17)

Gunnar Olson, Halden Lin, Lilian Liang, and Shobhit Hathi



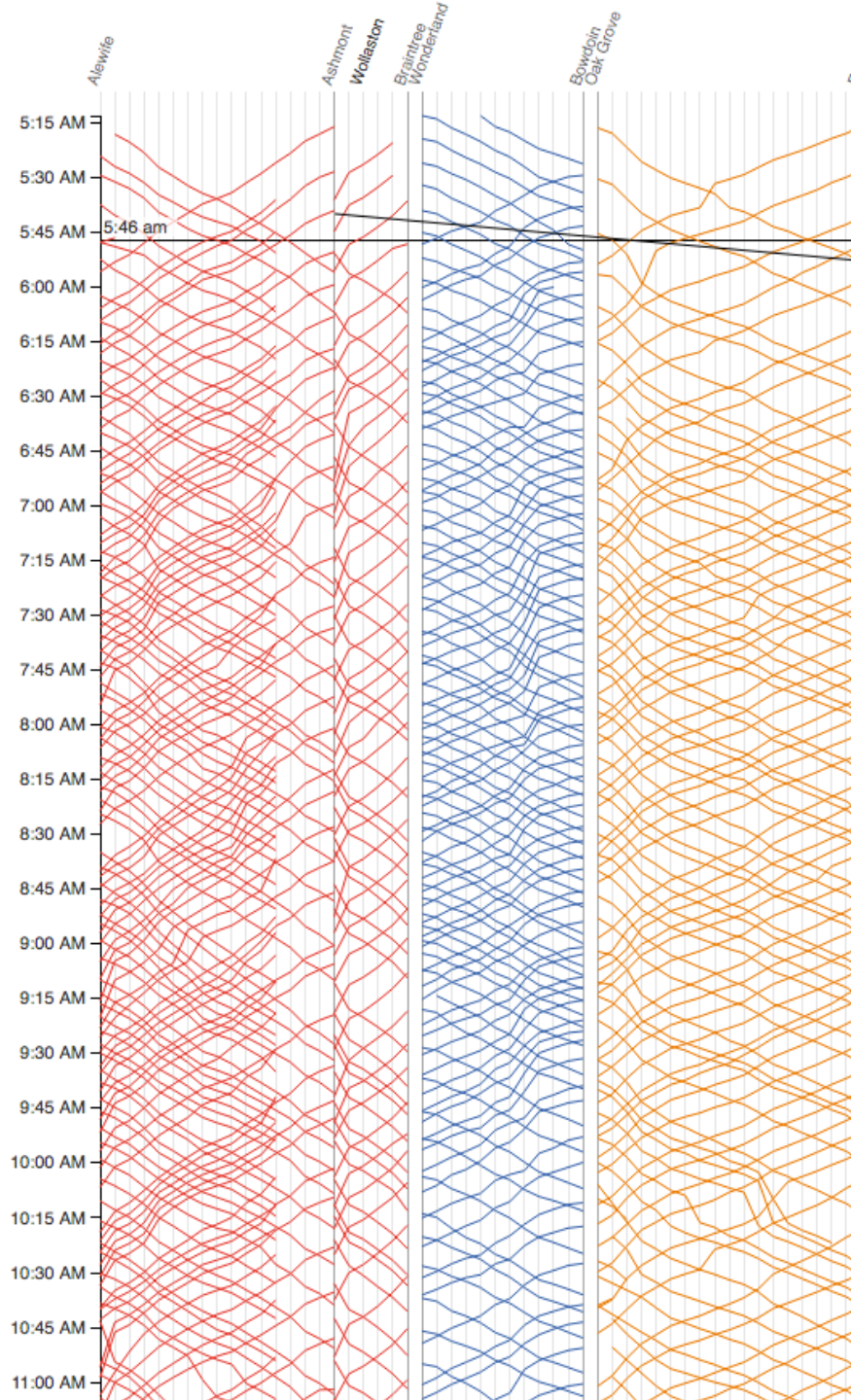
Locations of each train on the [red](#), [blue](#), and [orange](#) lines at 5:46 am. Hover over the diagram to the right to display trains at a different time.

Trains are on the right side of the track relative to the direction they are moving.

See the [morning rush-hour](#), [midday lull](#), [afternoon rush-hour](#), and the [evening lull](#).

# MBTA Viz

Barry & Card

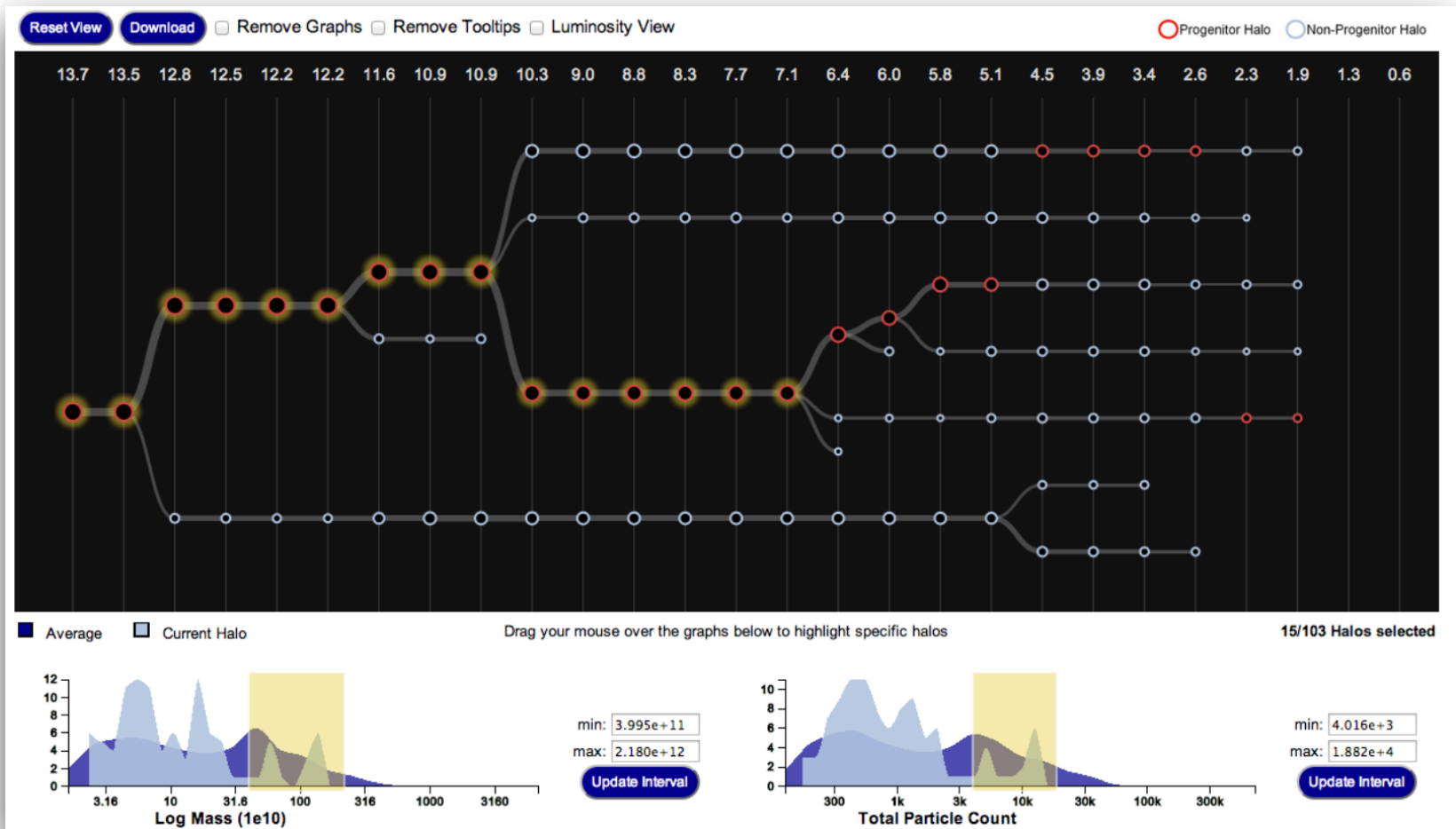


Service starts at 5AM on Monday morning. Each line represents the path of one train. Time continues downward, so steeper lines indicate slower trains.

Since the red line splits, we show the Ashmont branch first then the Braintree branch. Trains on the Braintree branch "jump over" the Ashmont branch.

Train frequency increases around 6:30AM as morning rush hour begins.

# Visualizing Galaxy Merger Trees

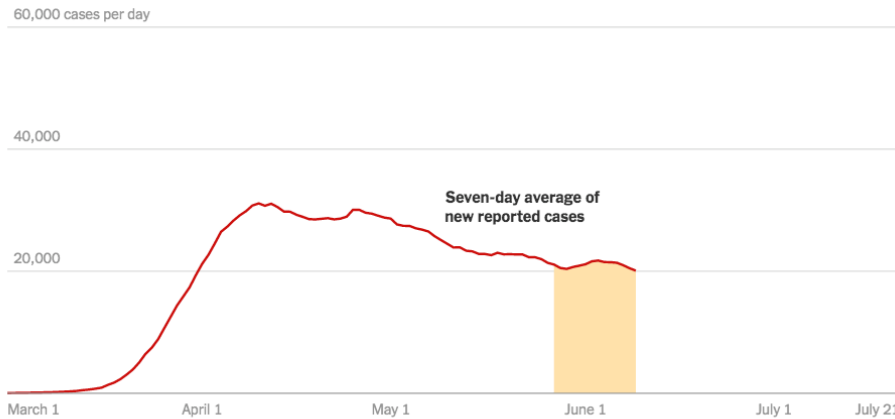


S. Loebman, J. Ortiz, L. Orr, M. Balazinska, T. Quinn et al. [SIGMOD '14]

# Inspiration from the News

## The Rise in Testing Is Not Driving the Rise in U.S. Virus Cases

By Matthew Conlen July 22, 2020



## New York Times

## Emissions of Websites

Parametric Press (you are here)

51 mg

Google (search result)

10 mg

The New York Times (interactive article)

60 mg

Amazon (product page)

64 mg

Facebook (newsfeed)

168 mg

↑ A minute scrolling through Facebook is equivalent to driving a car **0.67** meters

50 mg

100 mg

150 mg

Each bar represents the carbon emitted when scrolling through a website for 60 seconds. Car distance equivalent is calculated using the fuel economy of an average car. Click each bar to show a preview clip of the scroll.

SOURCE Aslan et al. 2017 [2], EPA

Parametric Press

## Parametric Press

# Final Project Schedule

<i>Proposal</i>	Fri May 07 (next Friday!)
<i>Milestone</i>	Fri May 21
<i>Demo Video</i>	Mon May 31
<i>Video Showcase</i>	Wed June 2 & Fri June 4
<i>Deliverables</i>	Mon June 7

## **Logistics**

Final project description posted online ([link](#))

Work in groups of up to 5 people

Start determining your project topic!

# Final Project Poll

# Final Project Teams

Work in groups of 3-5 people

Post your project ideas and interests on Ed,  
or respond to classmates about their projects

**Mark thread as resolved when you are no  
longer looking for additional members**

<https://edstem.org/us/courses/4910/discussion/354324>

# Final Project Proposal

Form: <https://forms.gle/D3WpCvdQkMa3kt6z6>

**Project Name** - short name for GitHub  
e.g., food-deserts or solar-panel-manufacturing

**Abstract** - describing goals and motivation

**Team members** - UW email, GitHub username

Due by **11:59 pm PT, next Friday May 7th**



# Final Project GitHub Repository

Repositories will be created by course staff based on the final project proposal form.

**Please accept the GitHub invite as soon as you receive it; invites will expire.**

Repositories will be initialized with recommended project structure and initial webpage.

# Final Project Template

Repositories will be initialized with recommended project structure and initial webpage.

Free to modify the page in any way you see fit, but be sure to carefully consider all design decisions.

Project template leverages Idyll for page structure.



**idyll**

**GitHub Pages**

# CSE412 Final Project Template

Use this structure to get started, but make the narrative your own!

By: Jane Hoffswell

Apr 6, 2021

The final project will provide hands-on experience designing, implementing, and deploying interactive visualizations for the web. For this project, you will select a topic of interest and author a narrative article and accompanying visualizations to educate and inform a general audience. Think of your project as contributing to our own class newspaper or scientific magazine. The final deliverable will take the form of an explanatory narrative, deployed as an interactive web page using GitHub Pages. You will leverage the template and style provided here.

**The theme is data visualization for communicating scientific advancements or social phenomena. How might data visualization help us better understand the workings of our society or our physical world?**

# Tips for a Successful Project

Focus on a compelling **real-world problem**.  
How will you gauge success?

Consider **multiple design alternatives**.

Prototype quickly (use Tableau, R, *etc...*).

**Seek feedback** (representative users, peers, ...).

Even informal usage can provide insights.

Choose **appropriate team roles**.

**Start early** (and read the suggested paper!)

**Start early**

# Ask questions often!

<https://edstem.org/us/courses/4910/discussion/354324>

## **Office Hours:**

Mon 12:00-1:00pm - Dalton

Tue 5:30-6:30pm - Yueqian

Wed 11:20-12:20pm - Jane

Thur 2:30-3:30pm - Kalyani

Fri 6:00-7:00pm - Yue

**By Appointment:** Aayush, Yueqian

# Tips for Asking Questions

Include **all the information** we need to answer.  
Project name, link to repo, demo in Observable...

**Give context!** Describe what you've already tried  
and **share resources** you thought might be helpful.

If you're comfortable doing so, **share questions  
publicly** on Ed to help your fellow students.

**Questions?**



# Quiz Section: Intro to Git & Web

Tomorrow, Thursday April 29th

Introduction to Git and HTML/CSS

Useful skills for getting started with the final project

**Next Week:** Intro to Idyll

Section will include an overview of the project template and visualization embedding in Idyll

**Up Next:** Jane's Office Hour (link on Canvas)