CSC 544
Data Visualization

Joshua Levine
josh@arizona.edu

Lecture 10
Tasks and Interaction

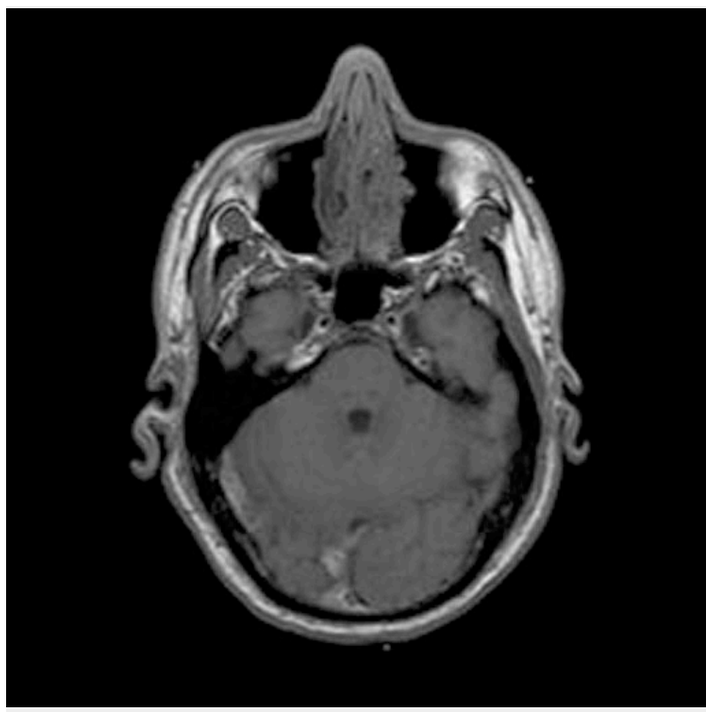
Feb. 15, 2023

Today's Agenda

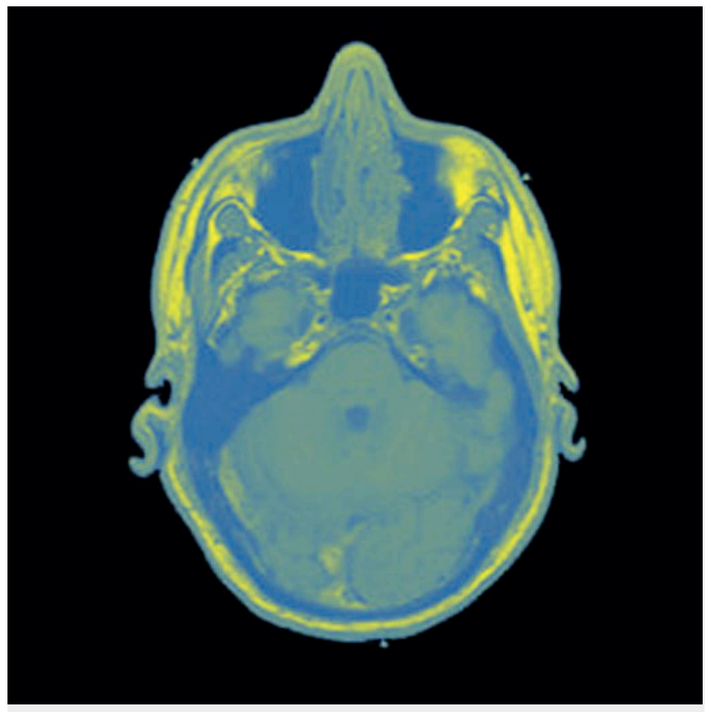
- Reminders:
  - P01, A02 questions?
- Goals for today:
  - Wrap up discussion on color
  - Discuss tasks and interaction

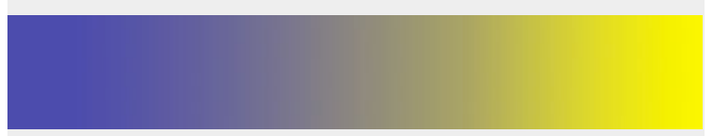
Last Time (Color)

Other Colormaps for Quantitative Data

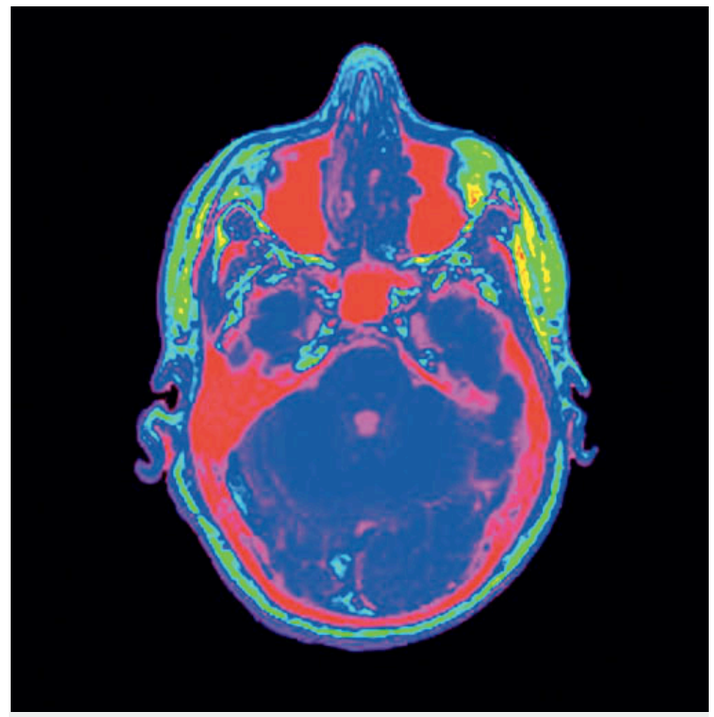


Lightness scale





Lightness scale with hue and chroma variation



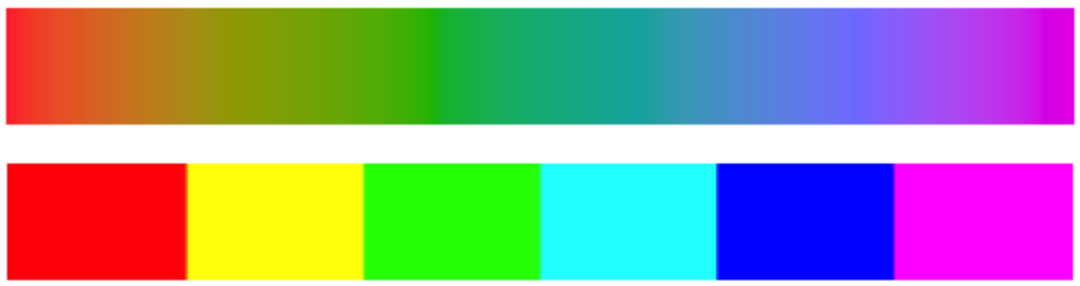
Hue scale with lightness variation

Summary/Guidelines

- Because of contrast effects, it is difficult to perceive absolute luminance of noncontiguous regions
  - Use only 2-4 bins when background is nonuniform
  - For text, ideally use 10:1 ratio, 3:1 minimum
- Show quantitative data with either a discrete set of colors or continuous (discrete for accuracy)
- Redundantly vary lightness and saturation

Poor

Better



“Get it right in black and white”

–Maureen Stone

Tools for Color

ColorBrewer: Color Advice for Maps

colorbrewer2.org

Reader

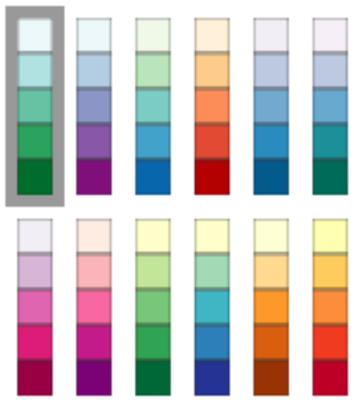
Device(Anonymous) camera http://192.168.2.1/ Google Scholar UT hiking poetry-vis Marriott Library

Number of data classes: 3

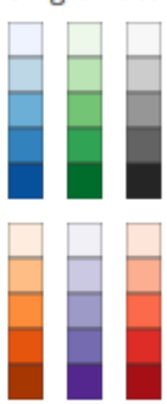
Nature of your data:
(•) sequential ( ) diverging ( ) qualitative

Pick a color scheme:

Multi-hue:



Single hue:



Only show:
- [ ] colorblind safe
- [ ] print friendly
- [ ] photocopy safe

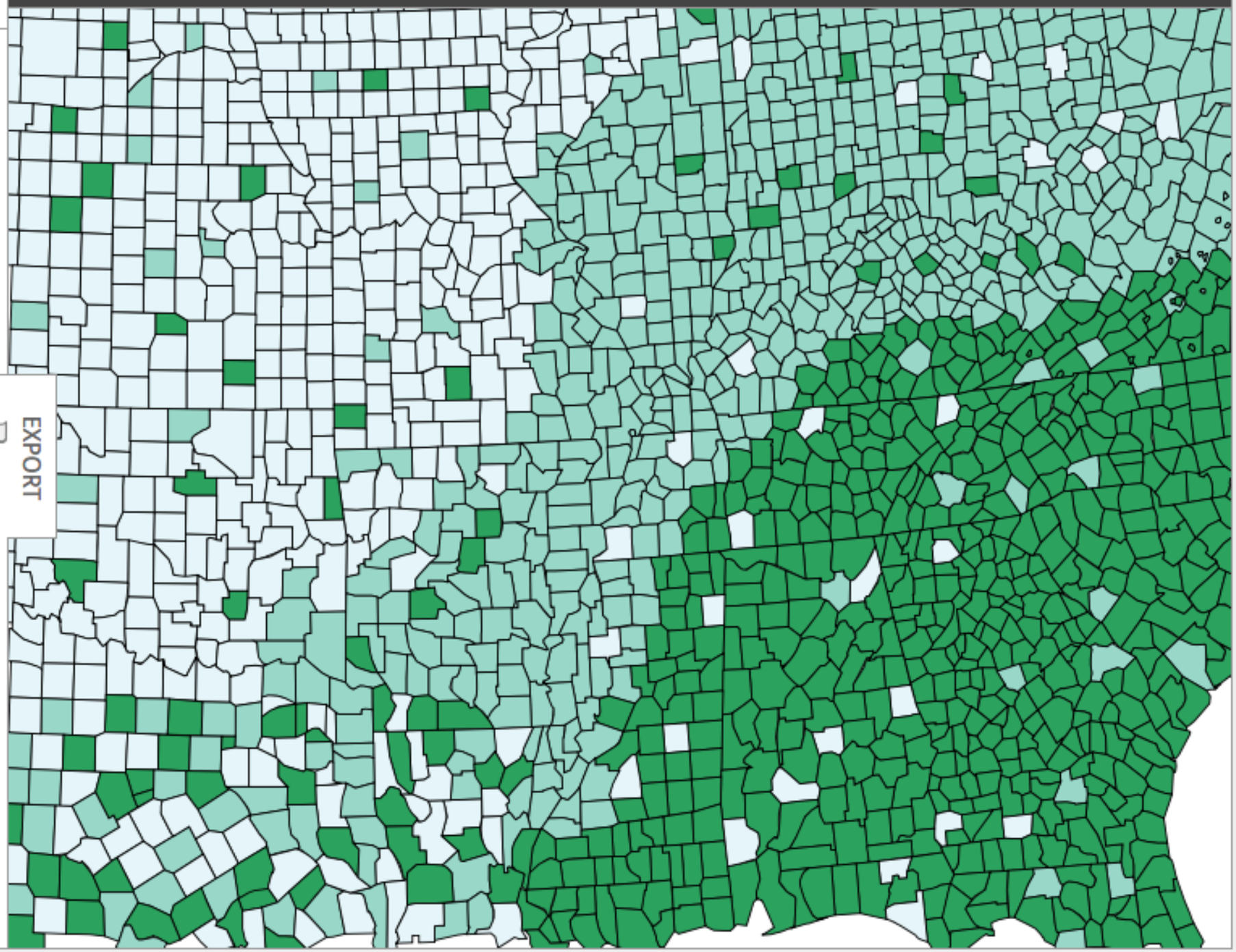
Context:
- [ ] roads
- [ ] cities
- [x] borders

Background:
- (•) solid color
- ( ) terrain

color transparency

how to use | updates | downloads | credits

COLORBREWER 2.0
color advice for cartography



3-class BuGn

HEX

#e5f5f9
#99d8c9
#2ca25f

EXPORT

Support
Back to Flash version

axismaps

Color Scales in d3.js

D3 Color spaces

- Comparing interpolation in different spaces:
  - https://blocks.roadtolarissa.com/mbostock/3014589
- Color Pickers:
  - Lab: https://blocks.roadtolarissa.com/mbostock/9f37cc207c0cb166921b
  - HCL: https://blocks.roadtolarissa.com/mbostock/3e115519a1b495e0bd95
  - HSL: https://blocks.roadtolarissa.com/mbostock/debaad4fcce9bcee14cf

D3’s Colorscales

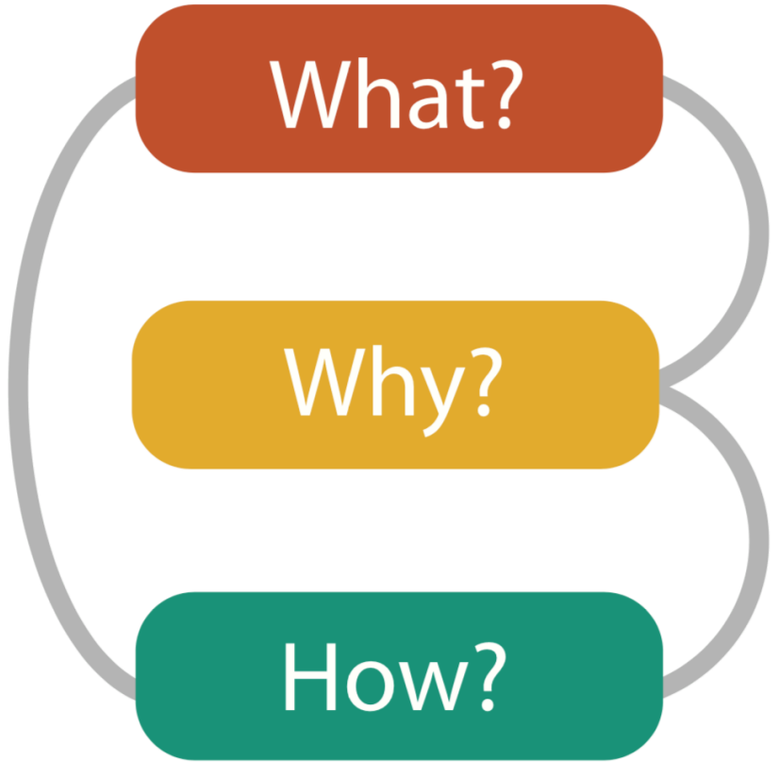
- Helpful links:
  - https://github.com/d3/d3-scale-chromatic
  - https://observablehq.com/@d3/color-schemes?collection=@d3/d3-scale-chromatic
  - https://observablehq.com/@d3/sequential-scales?collection=@d3/d3-scale-chromatic
- Testing them out:
  - https://cscheid.net/projects/d3-scale-playground/

New for Today:

Task Abstraction

Recall: Munzner's What-Why-How Framework

- **What** data the user sees?
- **Why** the user intends to use vis?
- **How** the visual encoding and interaction idioms are constructed in terms of design choices?



- Each of these questions will be mapped to a data-task-idiom trio to evaluate the quality of the visualization.

Data Abstraction

What?

Datasets

Data Types

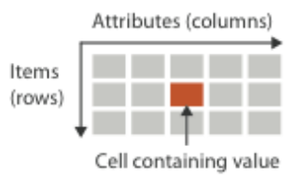
→ Items → Attributes → Links → Positions → Grids

Data and Dataset Types

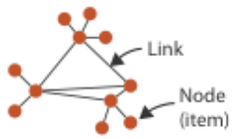
Tables	Networks & Trees	Fields	Geometry	Clusters, Sets, Lists
Items	Items (nodes)	Grids	Items	Items
Attributes	Links	Positions	Positions	
	Attributes	Attributes		

Dataset Types

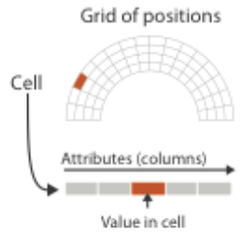
→ Tables



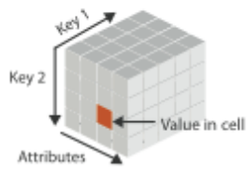
→ Networks



→ Fields (Continuous)



→ *Multidimensional Table*



→ *Trees*

→ Geometry (Spatial)

Attributes

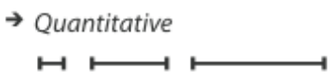
Attribute Types

→ Categorical

→ Ordered

→ *Ordinal*

→ *Quantitative*

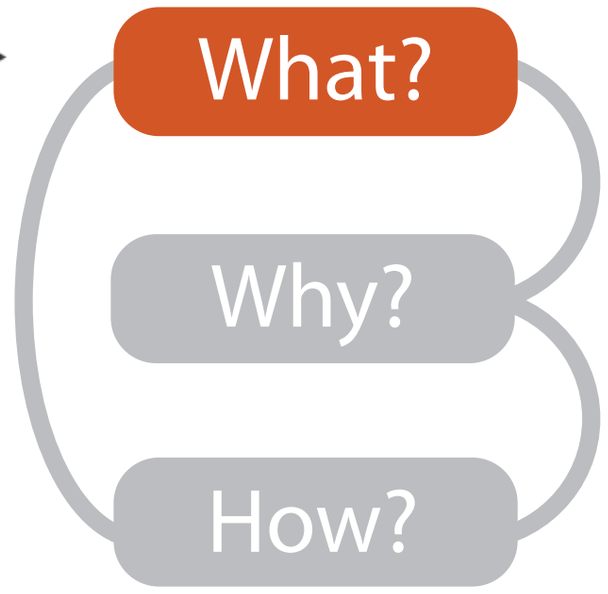


Ordering Direction

→ Sequential

→ Diverging

→ Cyclic



Visual Encoding

How?

Encode

Arrange

- Express
- Separate

- Order
- Align

- Use

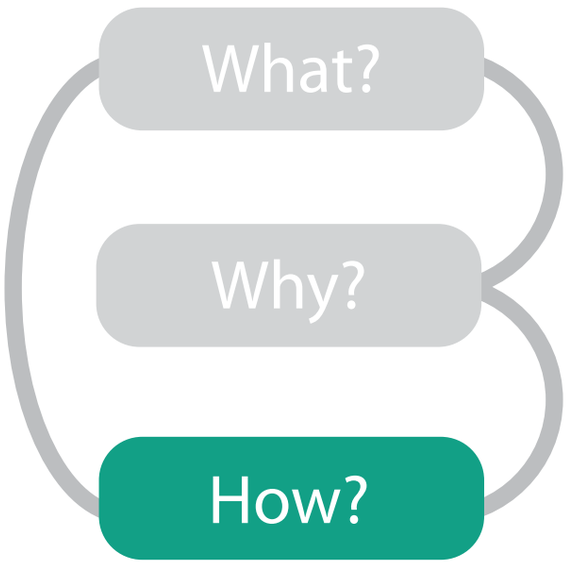
Map
from categorical and ordered attributes

- Color
  - *Hue*
  - *Saturation*
  - *Luminance*

- Size, Angle, Curvature, ...

- Shape

- Motion
  Direction, Rate, Frequency, ...



Task Abstraction

Why?

Actions

Analyze

- Consume
  - *Discover*
  - *Present*
  - *Enjoy*
- Produce
  - *Annotate*
  - *Record*
  - *Derive*

Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

- Identify
- Compare
- Summarize

Targets

All Data

- Trends
- Outliers
- Features

Attributes

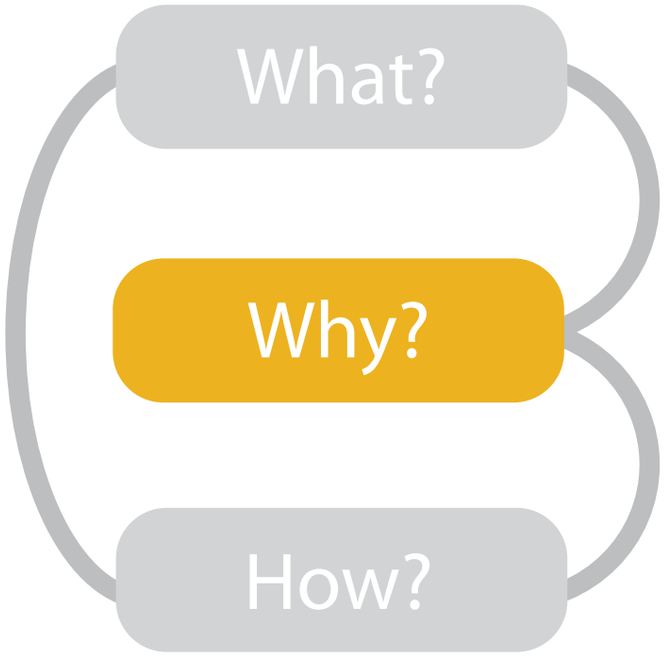
- One
  - *Distribution*
  - *Extremes*
- Many
  - *Dependency*
  - *Correlation*
  - *Similarity*

Network Data

- Topology
- *Paths*

Spatial Data

- Shape



{action, target} pairs

- **action**: verb describing a particular goal
- **target**: noun describing some aspect of the data that is of interest

- Examples:
  - {discover, distribution}
  - {compare, trends}
  - {locate, outliers}
  - {browse, topology}

Analyze

{action, target} pairs

Search

Query

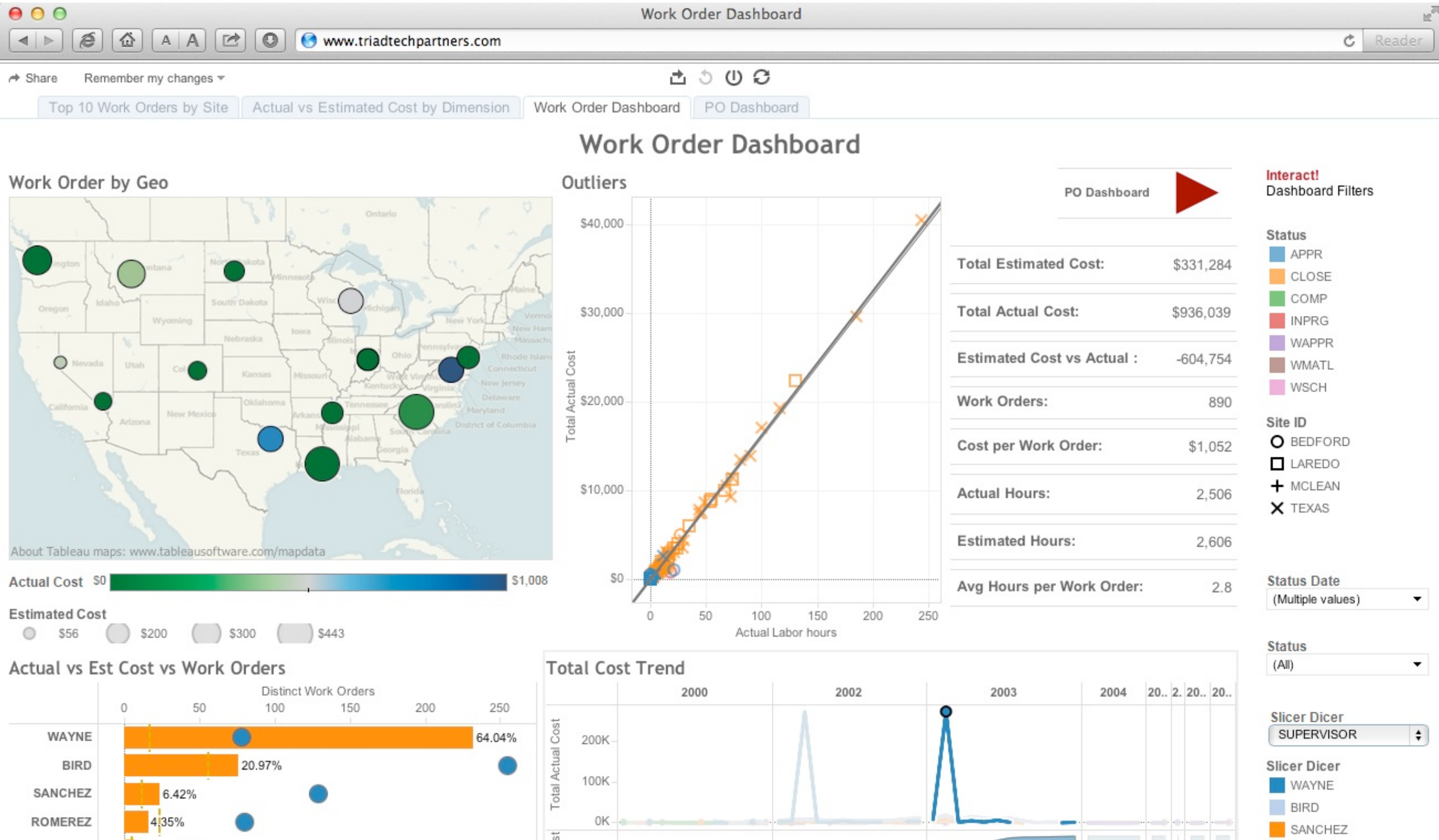
{action, target} pairs

- Analyze
  - Consume
    - *Discover*
    - *Present*
    - *Enjoy*

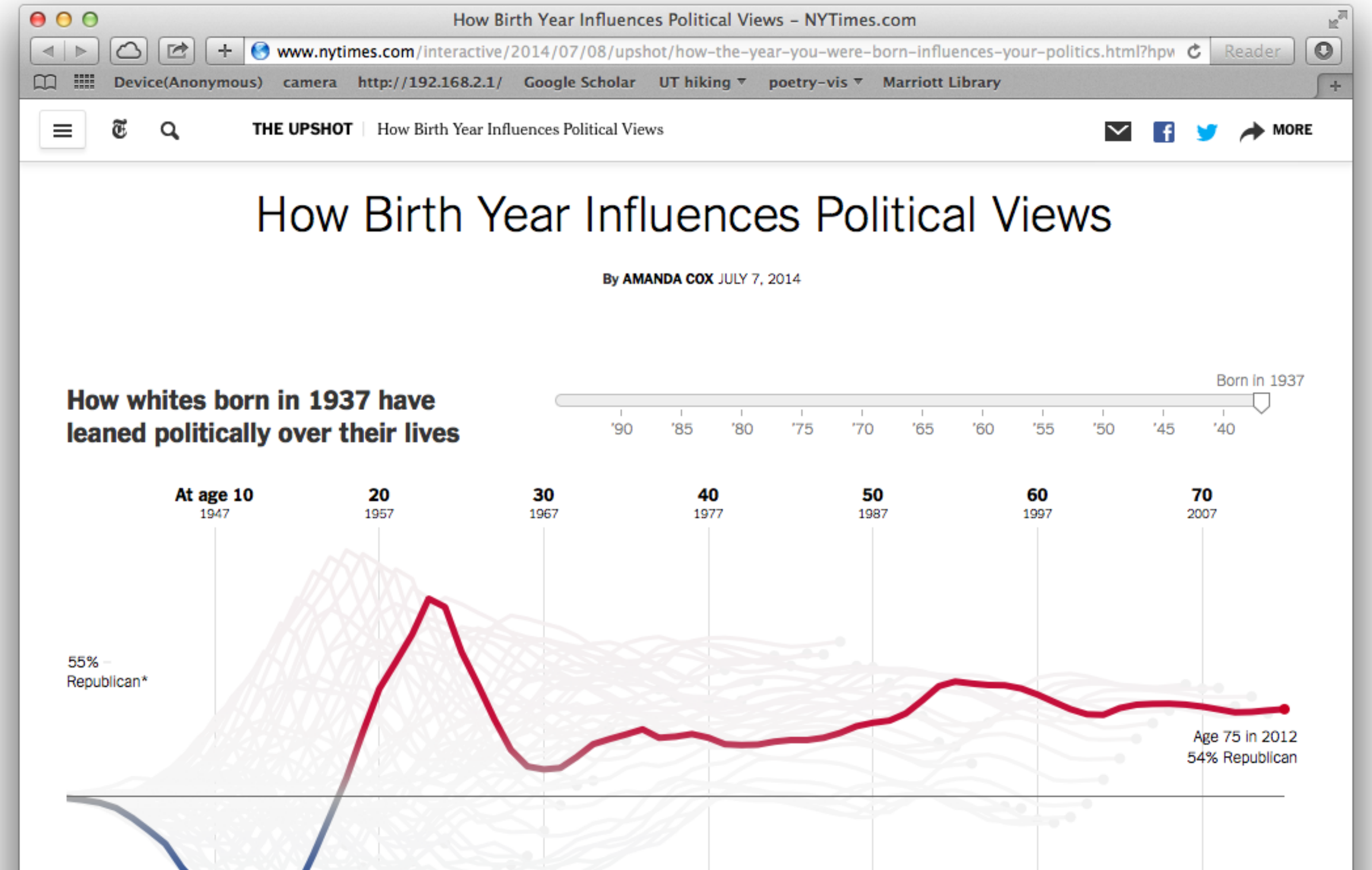
  - Produce
    - *Annotate*
    - *Record*
    - *Derive*

- Search
- Query

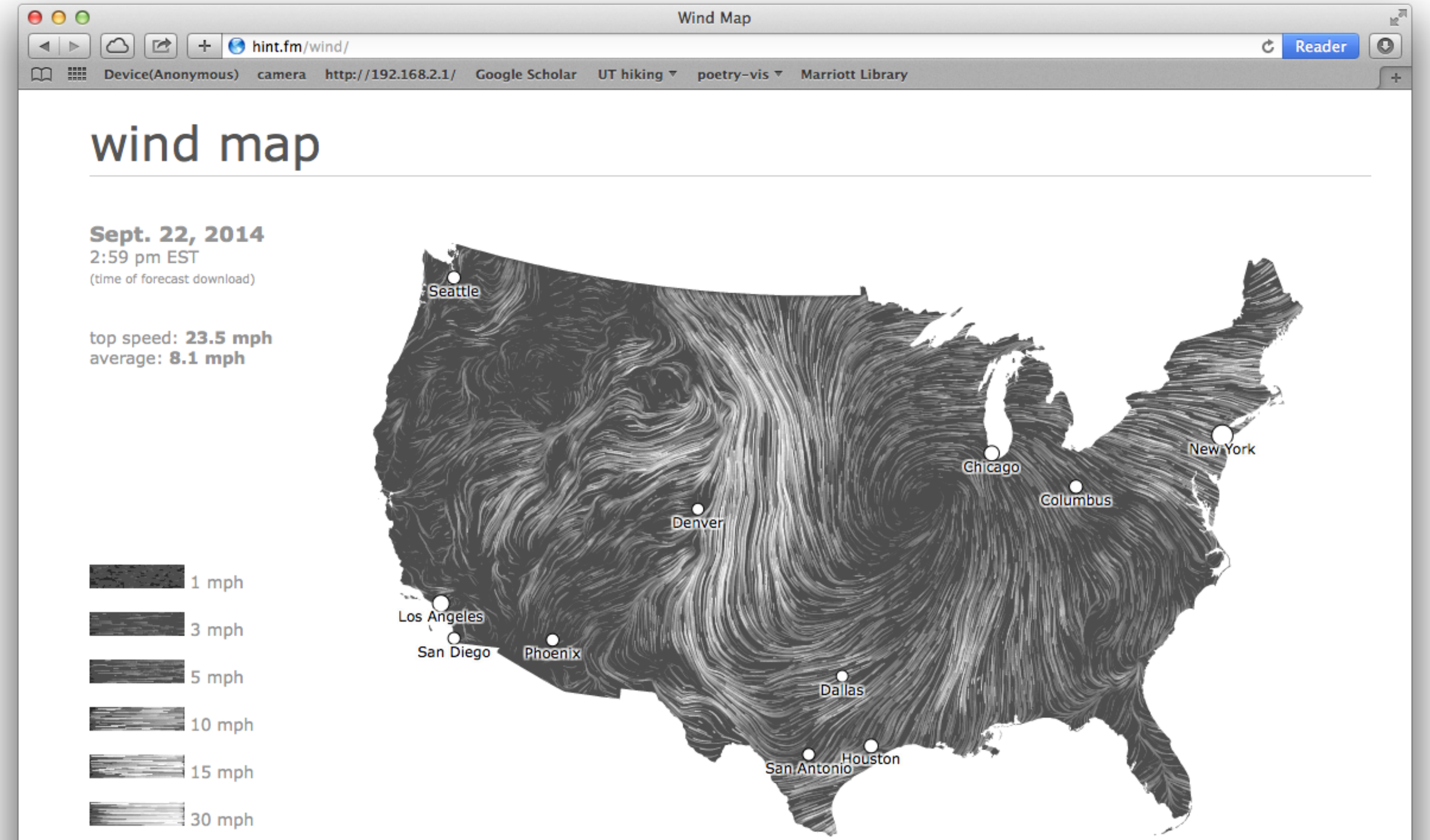
Discover


Work Order Dashboard
www.triadtechpartners.com
Reader
Share
Remember my changes
Top 10 Work Orders by Site
Actual vs Estimated Cost by Dimension
Work Order Dashboard
PO Dashboard
Work Order Dashboard
Work Order by Geo
About Tableau maps: www.tableausoftware.com/mapdata
Actual Cost $0 $1,008
Estimated Cost
$56 $200 $300 $443
Outliers
$40,000
$30,000
$20,000
$10,000
$0
Total Actual Cost
0 50 100 150 200 250
Actual Labor hours
PO Dashboard
Total Estimated Cost: $331,284
Total Actual Cost: $936,039
Estimated Cost vs Actual : -604,754
Work Orders: 890
Cost per Work Order: $1,052
Actual Hours: 2,506
Estimated Hours: 2,606
Avg Hours per Work Order: 2.8
Interact!
Dashboard Filters
Status
APPR
CLOSE
COMP
INPRG
WAPPR
WMATL
WSCH
Site ID
BEDFORD
LAREDO
MCLEAN
TEXAS
Status Date
(Multiple values)
Status
(All)
Slicer Dicer
SUPERVISOR
Slicer Dicer
WAYNE
BIRD
SANCHEZ
ROMEREZ
Actual vs Est Cost vs Work Orders
Distinct Work Orders
0 50 100 150 200 250
WAYNE 64.04%
BIRD 20.97%
SANCHEZ 6.42%
ROMEREZ 4.35%
SMITH 1.67%
Total Cost Trend
2000 2002 2003 2004 20.. 2. 20.. 20..
Total Actual Cost
200K
100K
0K

Present


How Birth Year Influences Political Views – NYTimes.com
www.nytimes.com/interactive/2014/07/08/upshot/how-the-year-you-were-born-influences-your-politics.html?hpw
Reader
Device(Anonymous)
camera
http://192.168.2.1/
Google Scholar
UT hiking
poetry-vis
Marriott Library
THE UPSHOT | How Birth Year Influences Political Views
MORE
How Birth Year Influences Political Views
By AMANDA COX JULY 7, 2014
How whites born in 1937 have leaned politically over their lives
Born in 1937
'90
'85
'80
'75
'70
'65
'60
'55
'50
'45
'40
At age 10
1947
20
1957
30
1967
40
1977
50
1987
60
1997
70
2007
55%
Republican*
Age 75 in 2012
54% Republican

Enjoy


Wind Map
hint.fm/wind/
Reader
Device(Anonymous)
camera
http://192.168.2.1/
Google Scholar
UT hiking
poetry-vis
Marriott Library
wind map
Sept. 22, 2014
2:59 pm EST
(time of forecast download)
top speed: 23.5 mph
average: 8.1 mph
1 mph
3 mph
5 mph
10 mph
15 mph
30 mph
Seattle
Denver
Chicago
Columbus
New York
Los Angeles
San Diego
Phoenix
Dallas
San Antonio
Houston

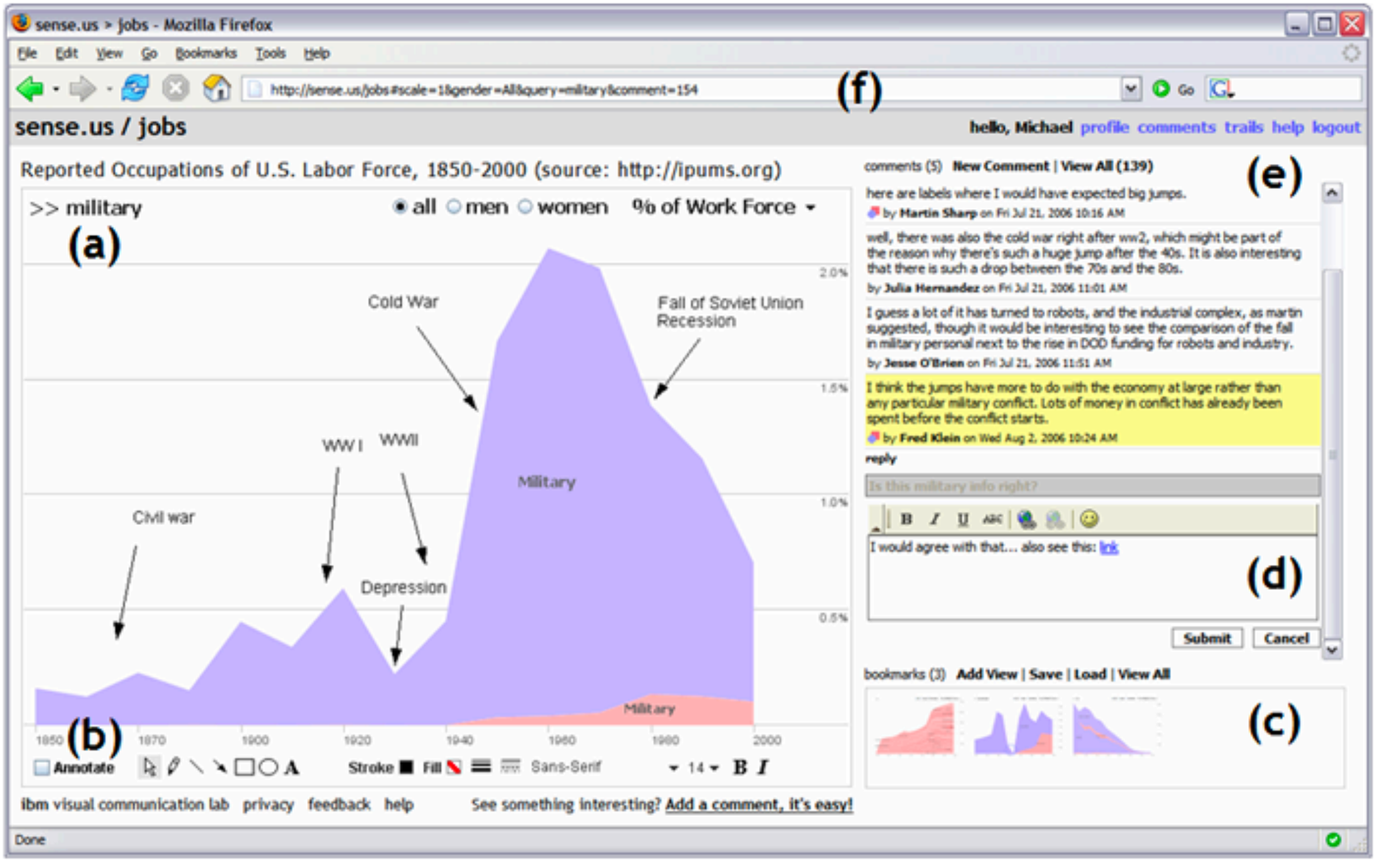
{action, target} pairs

- Analyze
  - Consume
    - *Discover*
    - *Present*
    - *Enjoy*

  - Produce
    - *Annotate*
    - *Record*
    - *Derive*

- Search
- Query

Annotate & Record



https://vis.berkeley.edu/papers/sense.us/

{action, target} pairs

Analyze

Consume

→ *Discover*

→ *Present*

→ *Enjoy*

Produce

→ *Annotate*

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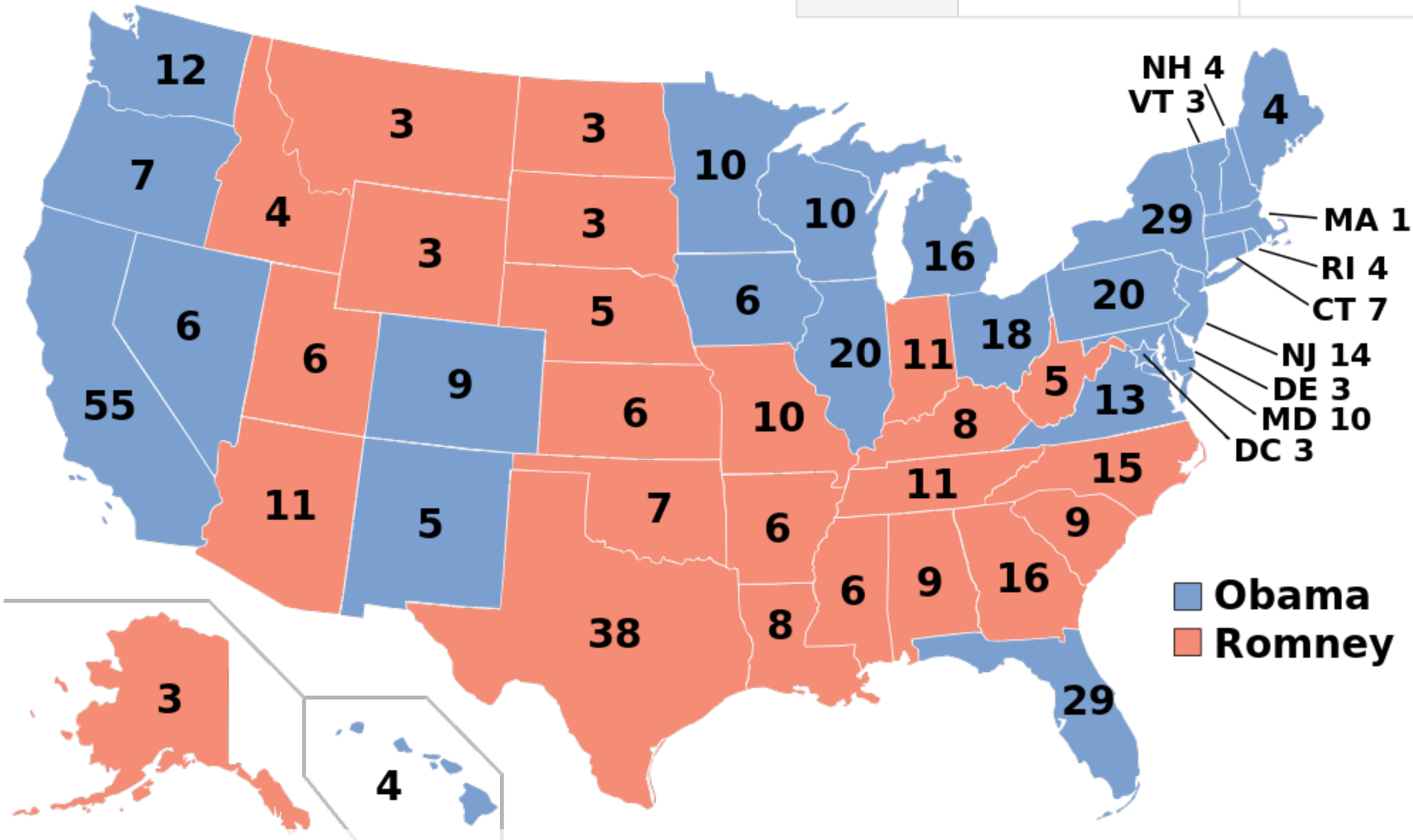

2012 election results: https://en.wikipedia.org/wiki/Political_colour

{action, target} pairs

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Search

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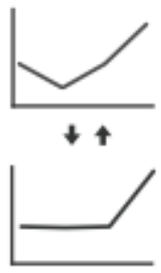
Query

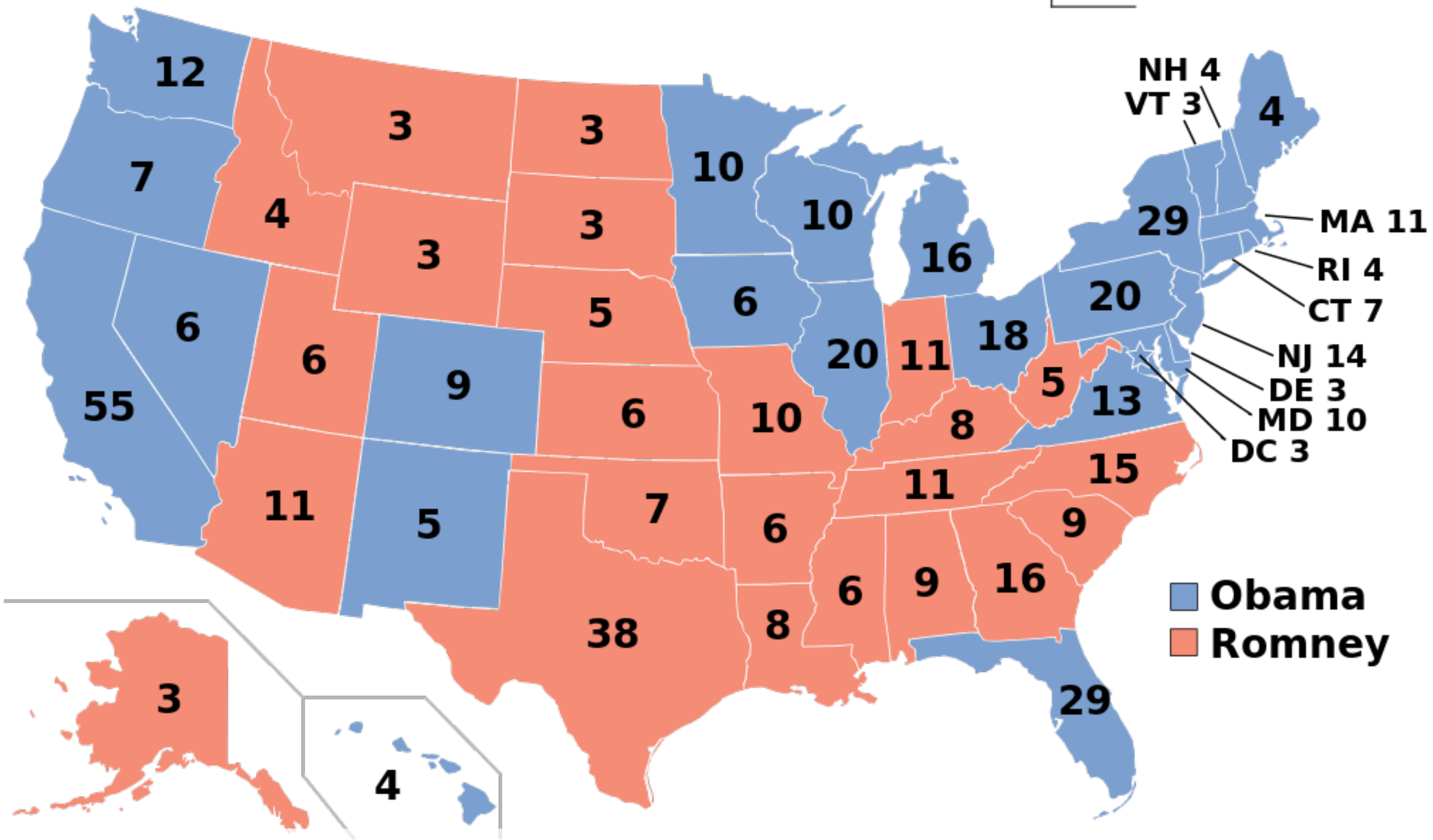
→ Identify

→ Compare



→ Summarize

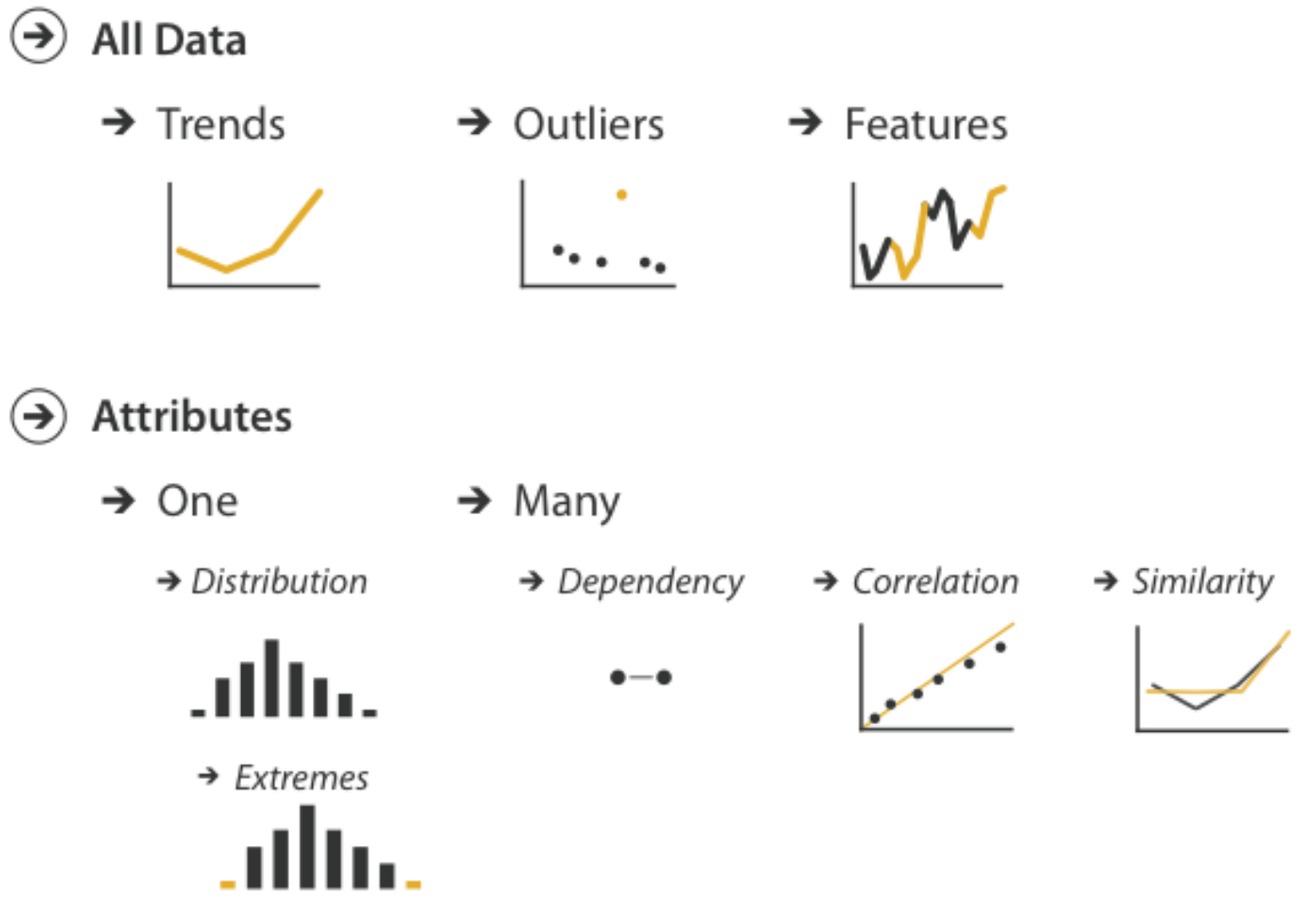
→ Identify → Compare → Summarize



2012 election results: https://en.wikipedia.org/wiki/Political_colour

{action, **target**}

pairs



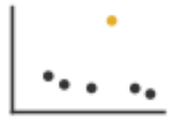
{action, target}

pairs

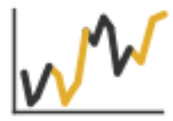
All Data

→ Trends

→ Outliers



→ Features



Attributes

→ One

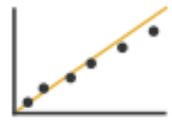
→ *Distribution*

→ *Extremes*

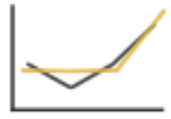
→ Many

→ *Dependency*

→ *Correlation*



→ *Similarity*



Network Data

→ Topology

→ *Paths*

Spatial Data

→ Shape

Perspective:
Connecting Why to How

Why?

Actions

Analyze

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Search

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Network Data

- Topology
- *Paths*

Spatial Data

- Shape

{action, target}

Interaction

Visual Encoding

How?

Encode

Arrange

- Express
- Separate

- Order
- Align

- Use

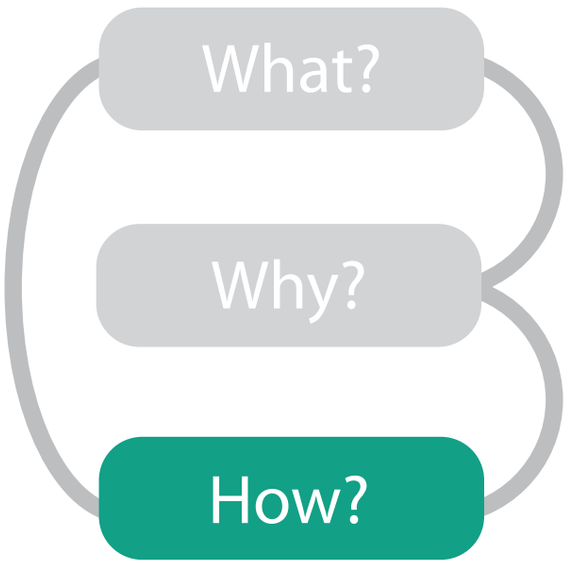
Map
from categorical and ordered attributes

- Color
  - *Hue*
  - *Saturation*
  - *Luminance*

- Size, Angle, Curvature, ...

- Shape

- Motion
  Direction, Rate, Frequency, ...



Visual Encoding

How?

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Map
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- Color
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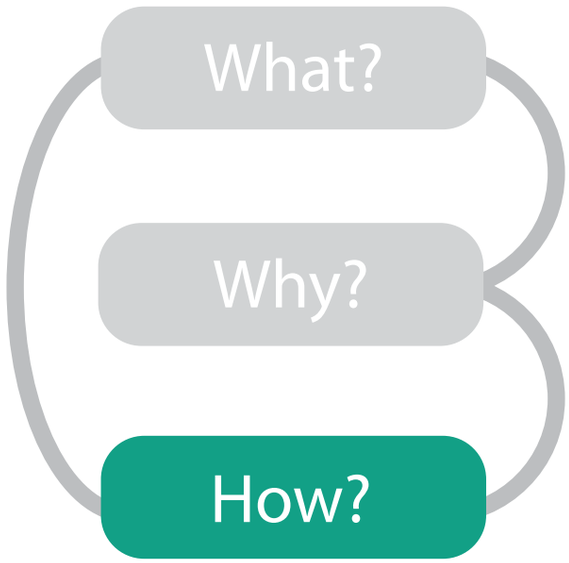
  - *Saturation*
  - *Luminance*
- Size, Angle, Curvature, ...
- Shape
- Motion
  Direction, Rate, Frequency, ...

Manipulate

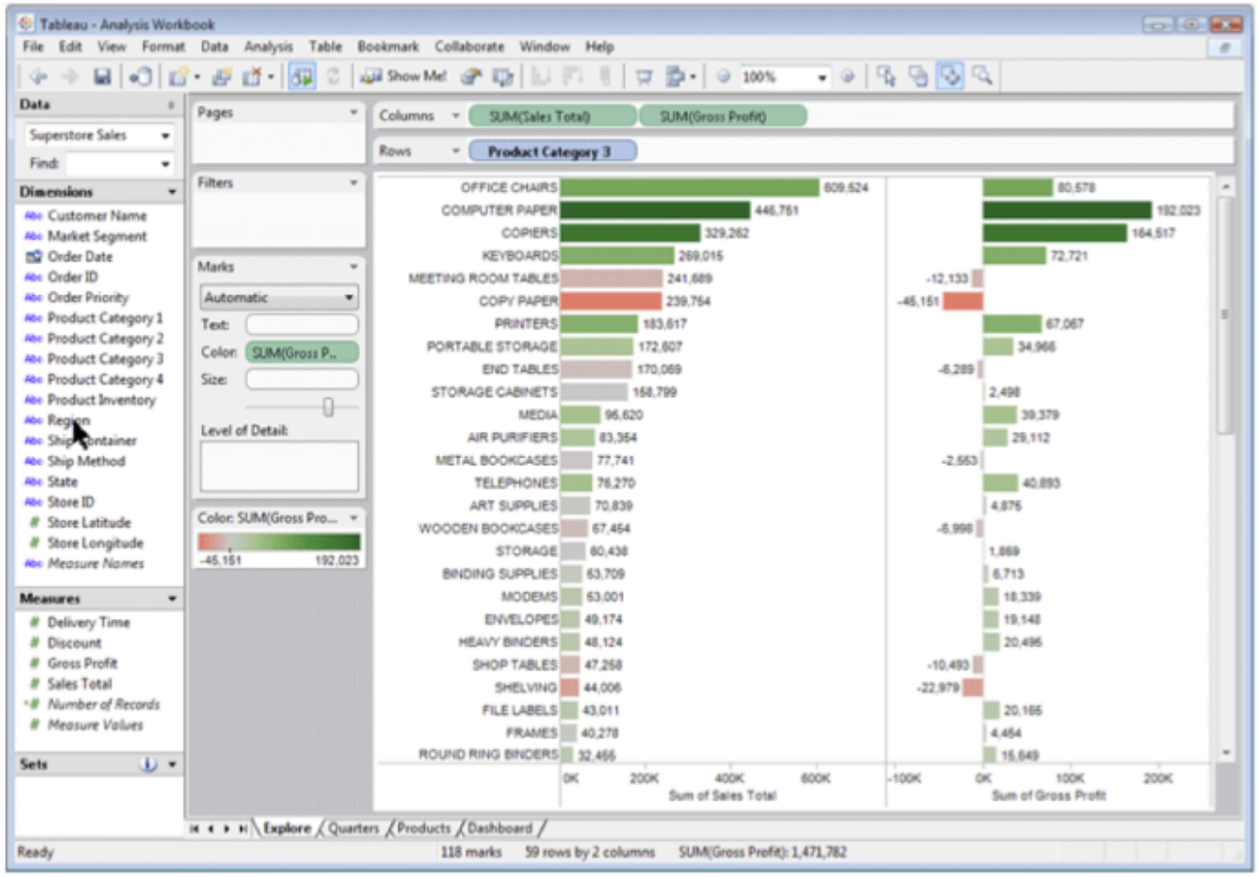
Change

Select

Navigate



Interaction:
Change Views Over Time



Change Encoding

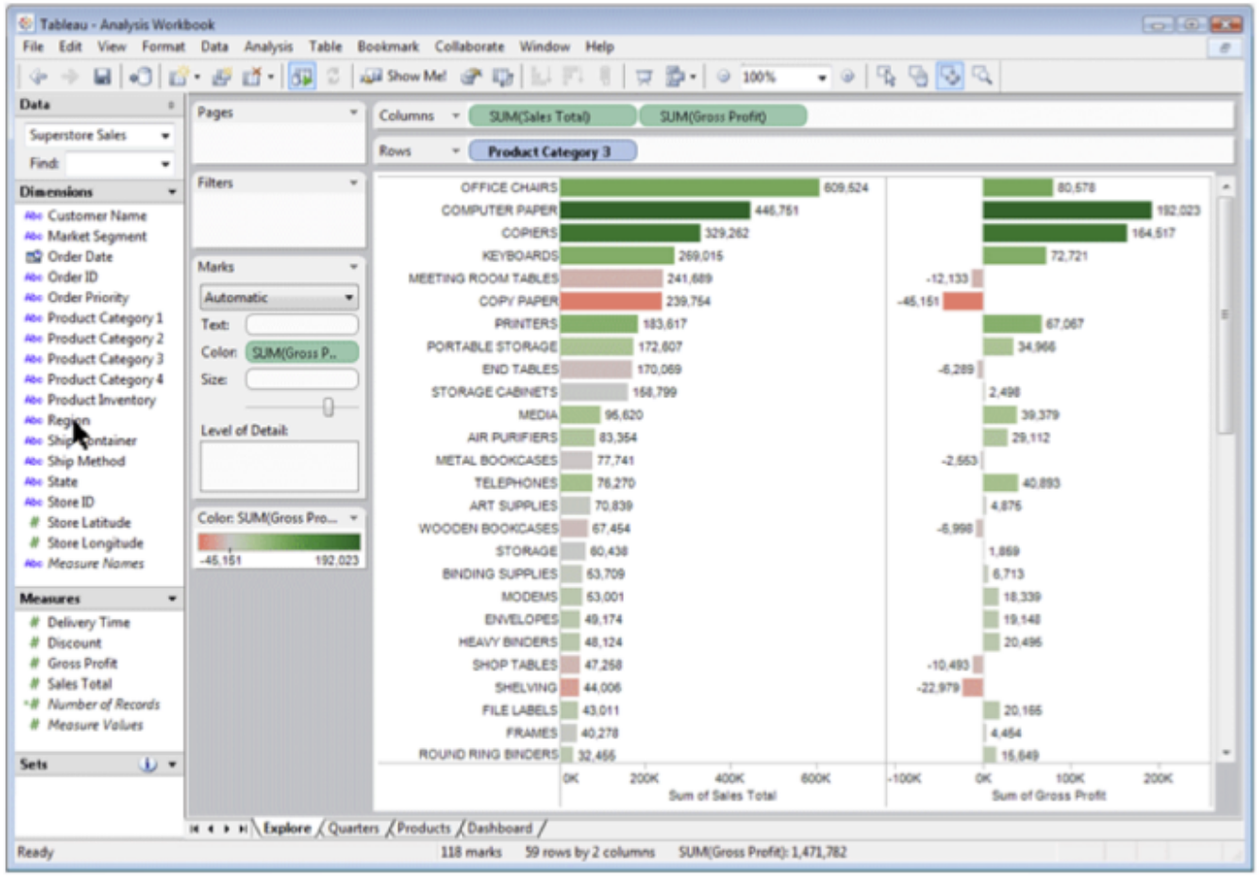


Tableau - Analysis Workbook
File Edit View Format Data Analysis Table Bookmark Collaborate Window Help
Show Me!
100%
Data
Superstore Sales
Find:
Dimensions
Customer Name
Market Segment
Order Date
Order ID
Order Priority
Product Category 1
Product Category 2
Product Category 3
Product Category 4
Product Inventory
Region
Ship Container
Ship Method
State
Store ID
Store Latitude
Store Longitude
Measure Names
Measures
Delivery Time
Discount
Gross Profit
Sales Total
Number of Records
Measure Values
Sets
Pages
Filters
Marks
Automatic
Text:
Color: SUM(Gross P...
Size:
Level of Detail:
Color: SUM(Gross Pro...
-45,151
192,023
Columns
SUM(Sales Total)
SUM(Gross Profit)
Rows
Product Category 3
OFFICE CHAIRS 609,524 80,578
COMPUTER PAPER 446,751 192,023
COPIERS 329,262 164,517
KEYBOARDS 269,015 72,721
MEETING ROOM TABLES 241,689 -12,133
COPY PAPER 239,754 -45,151
PRINTERS 183,617 67,067
PORTABLE STORAGE 172,607 34,966
END TABLES 170,069 -6,289
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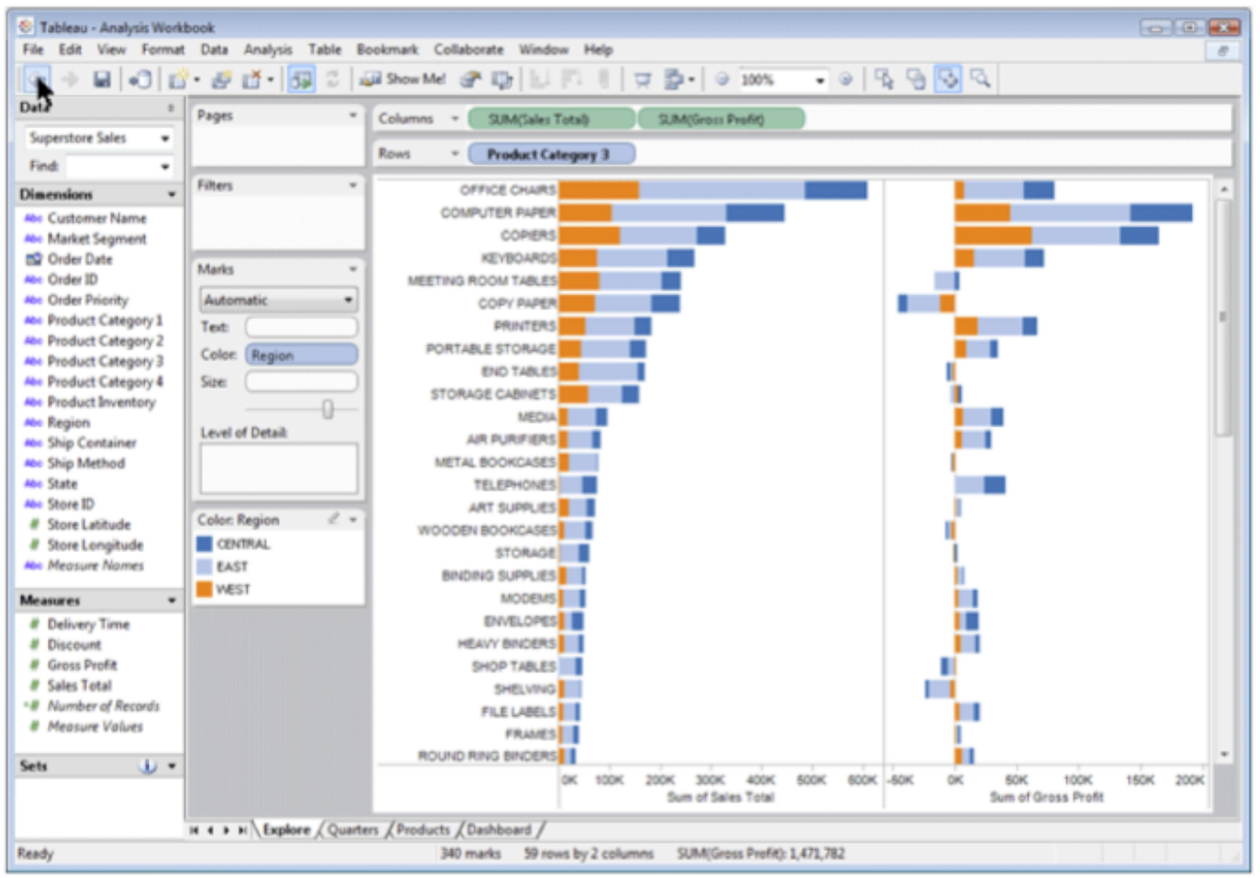
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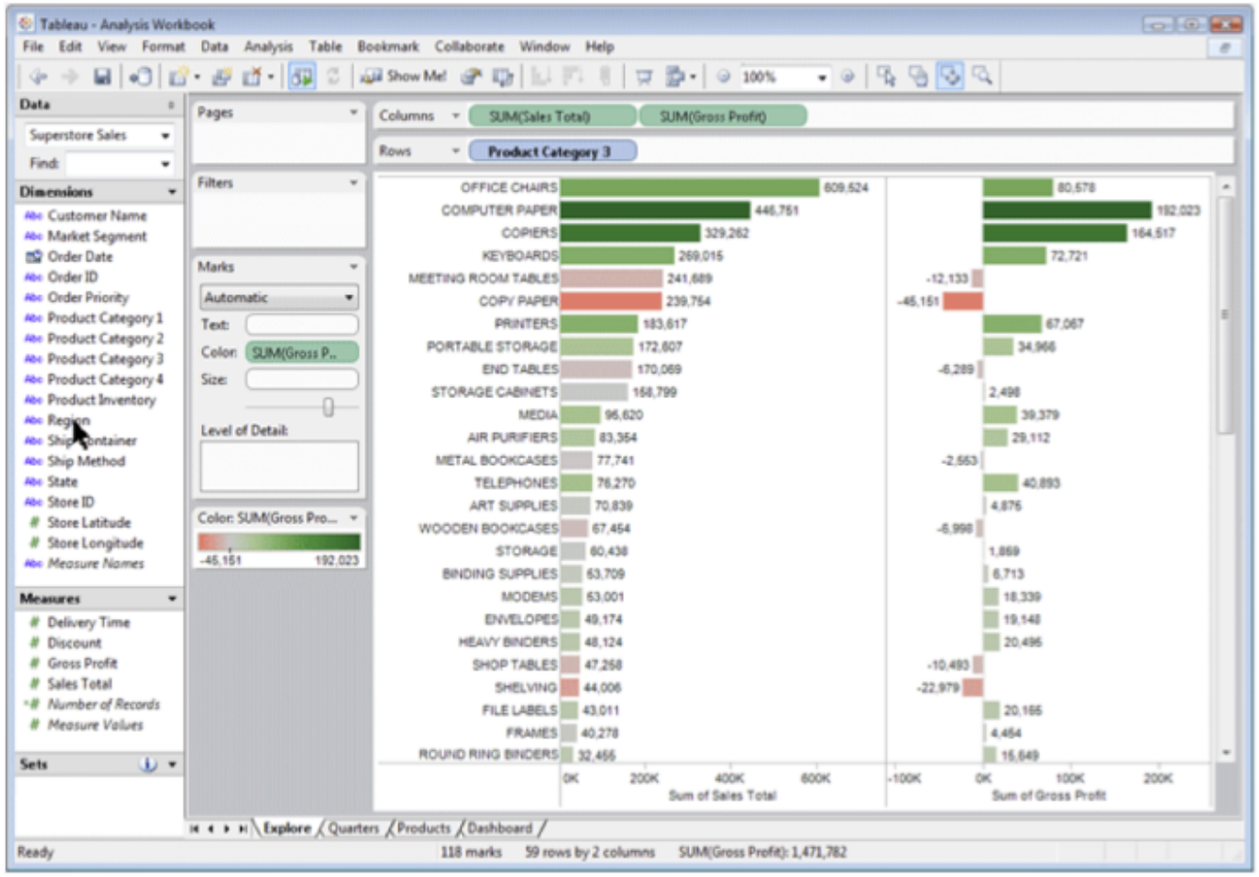
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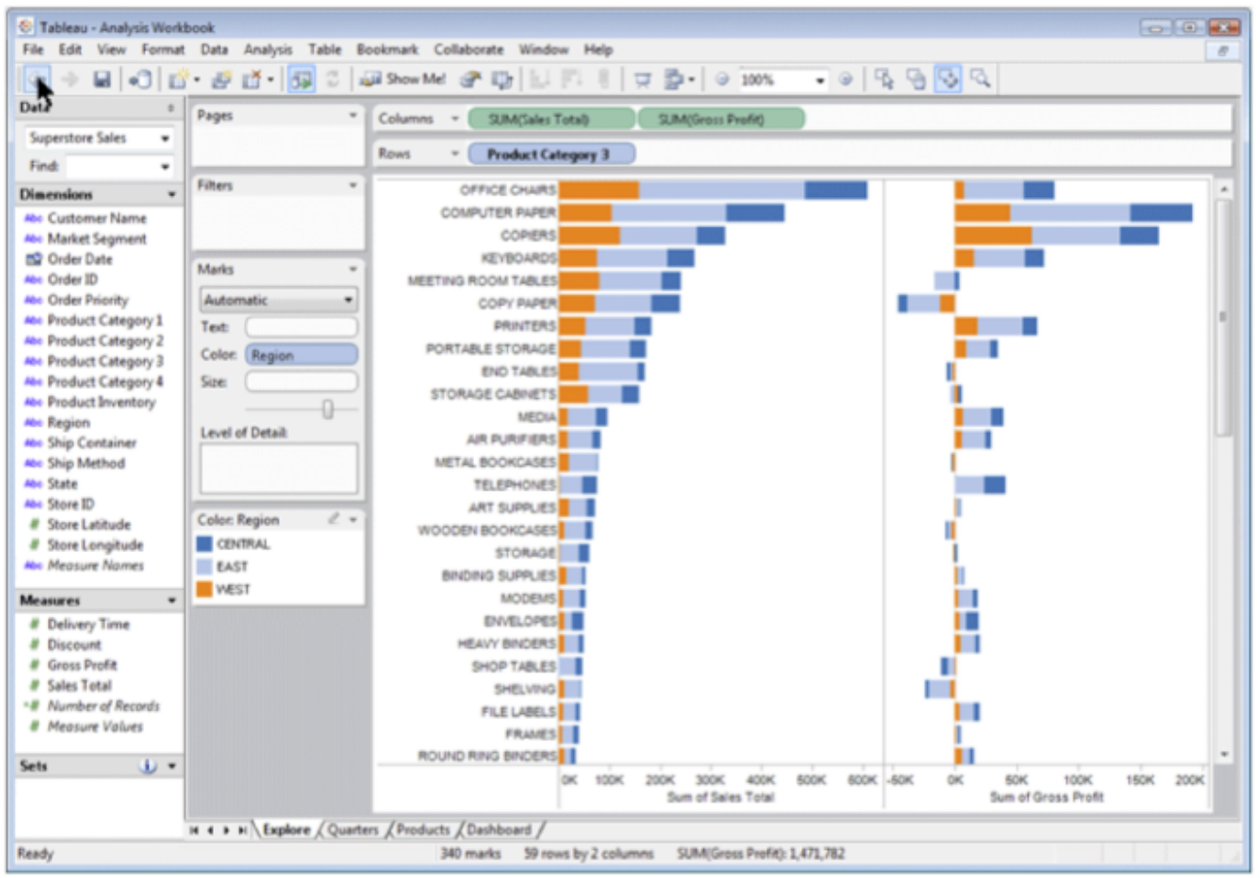
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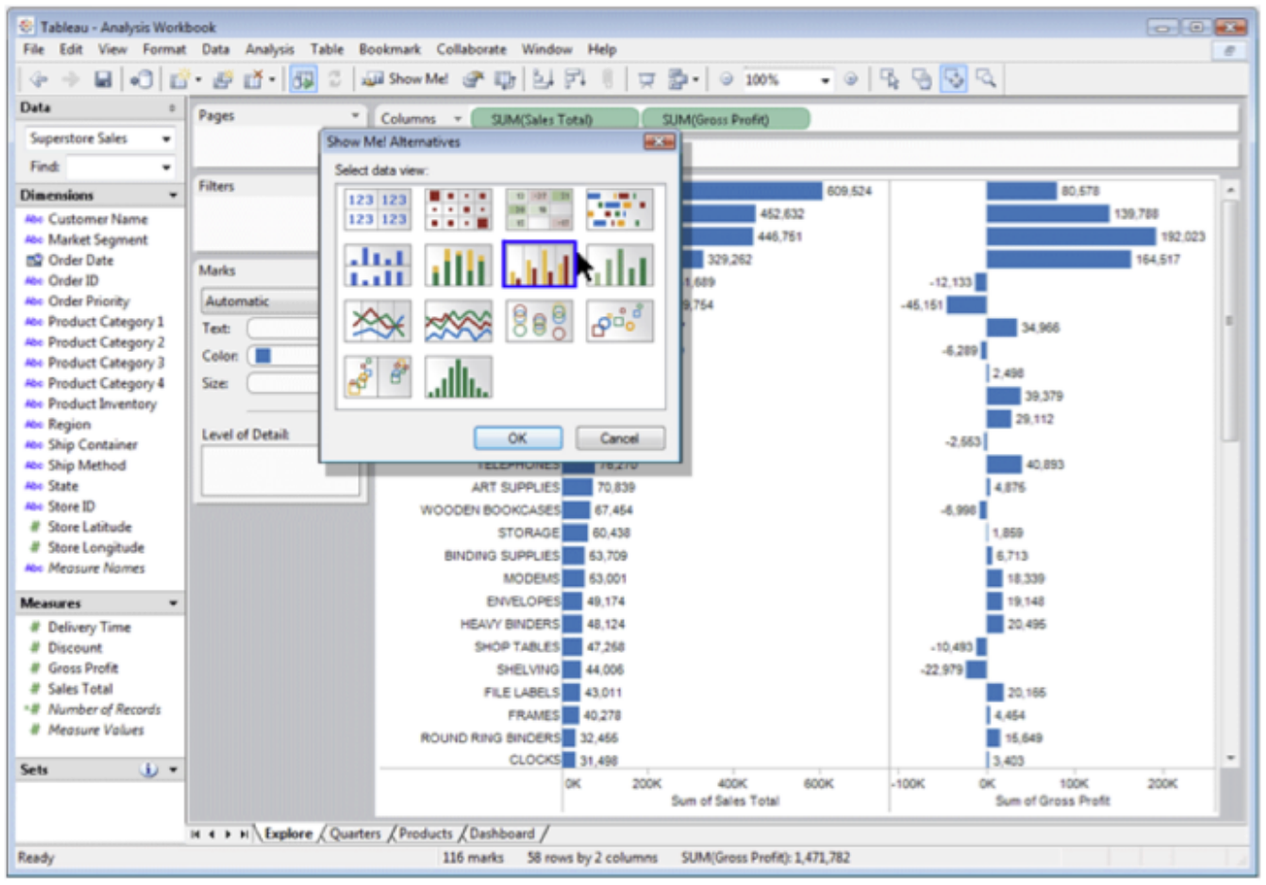
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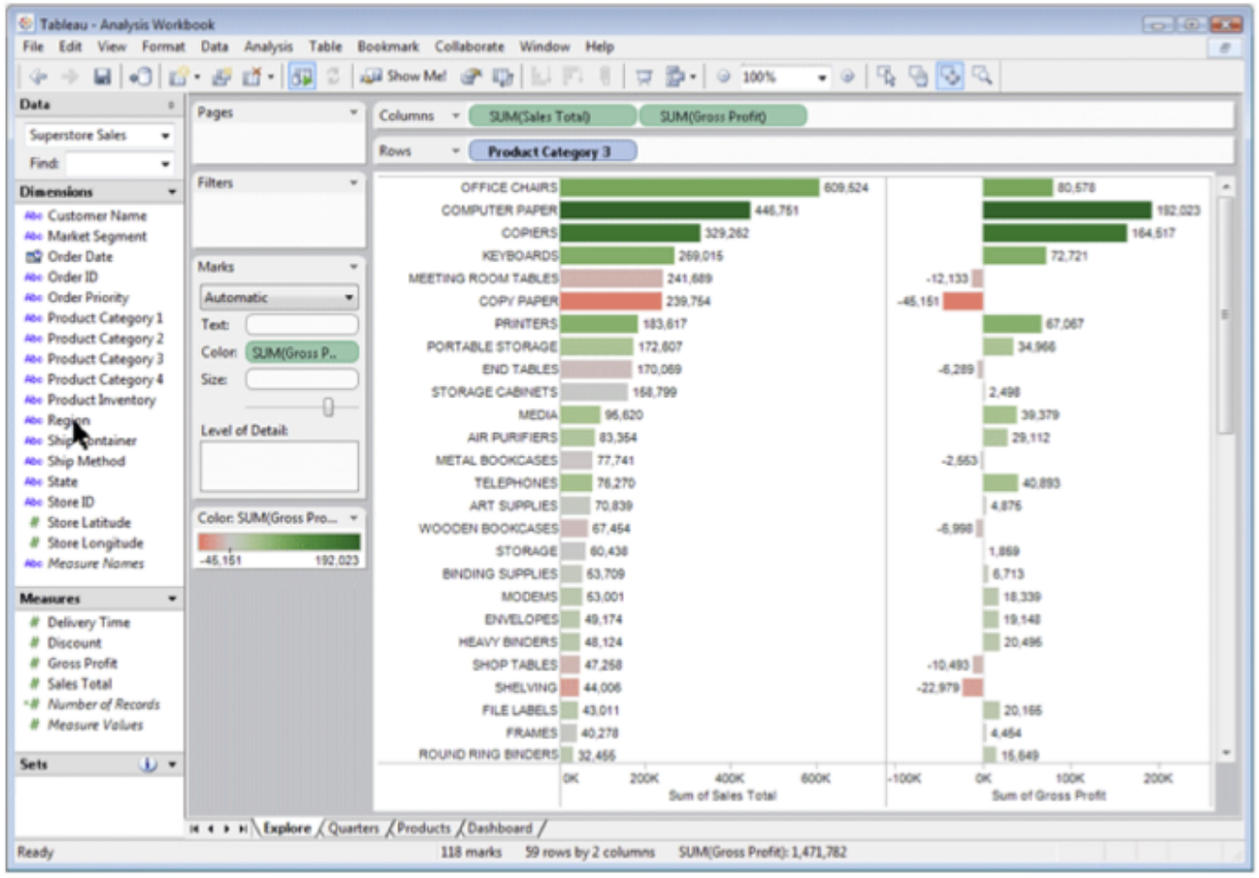
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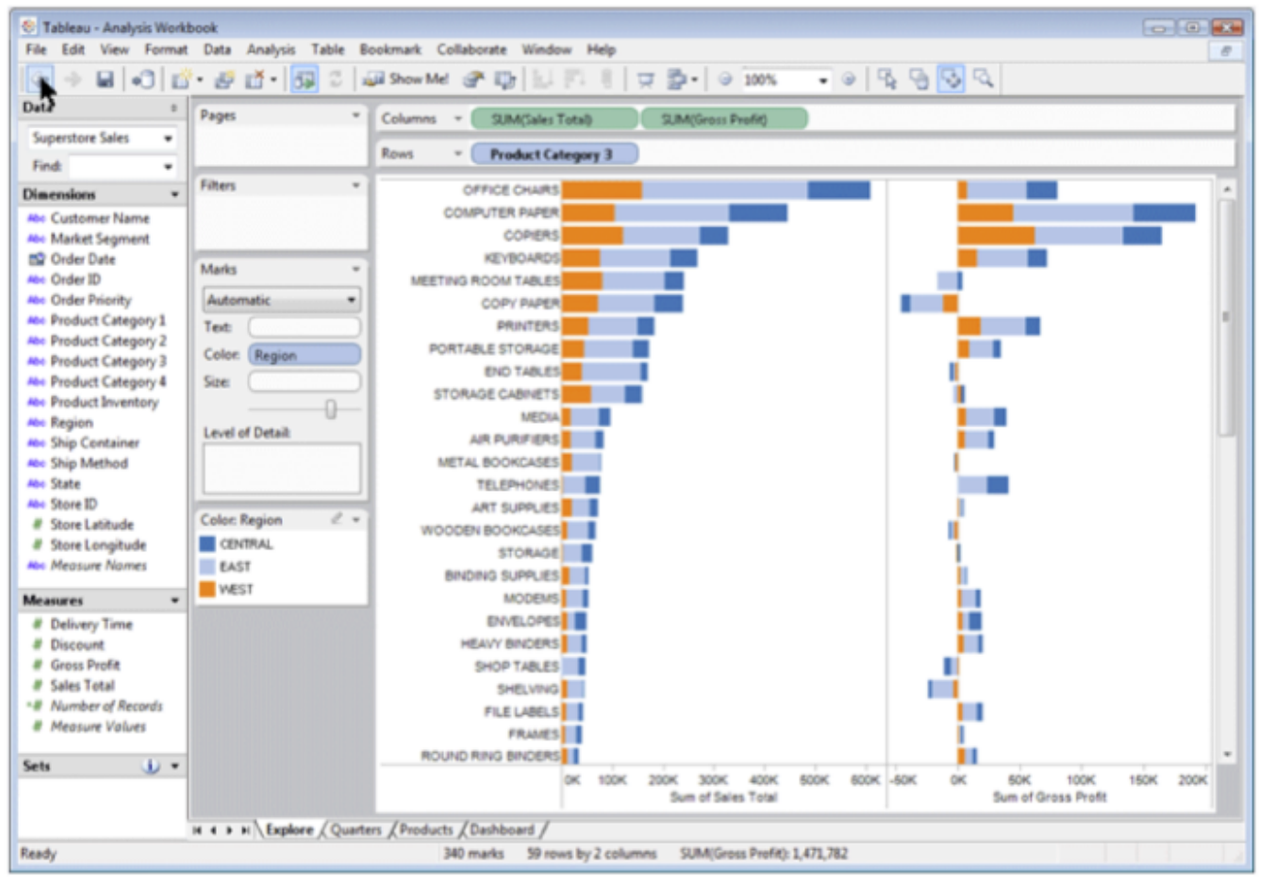
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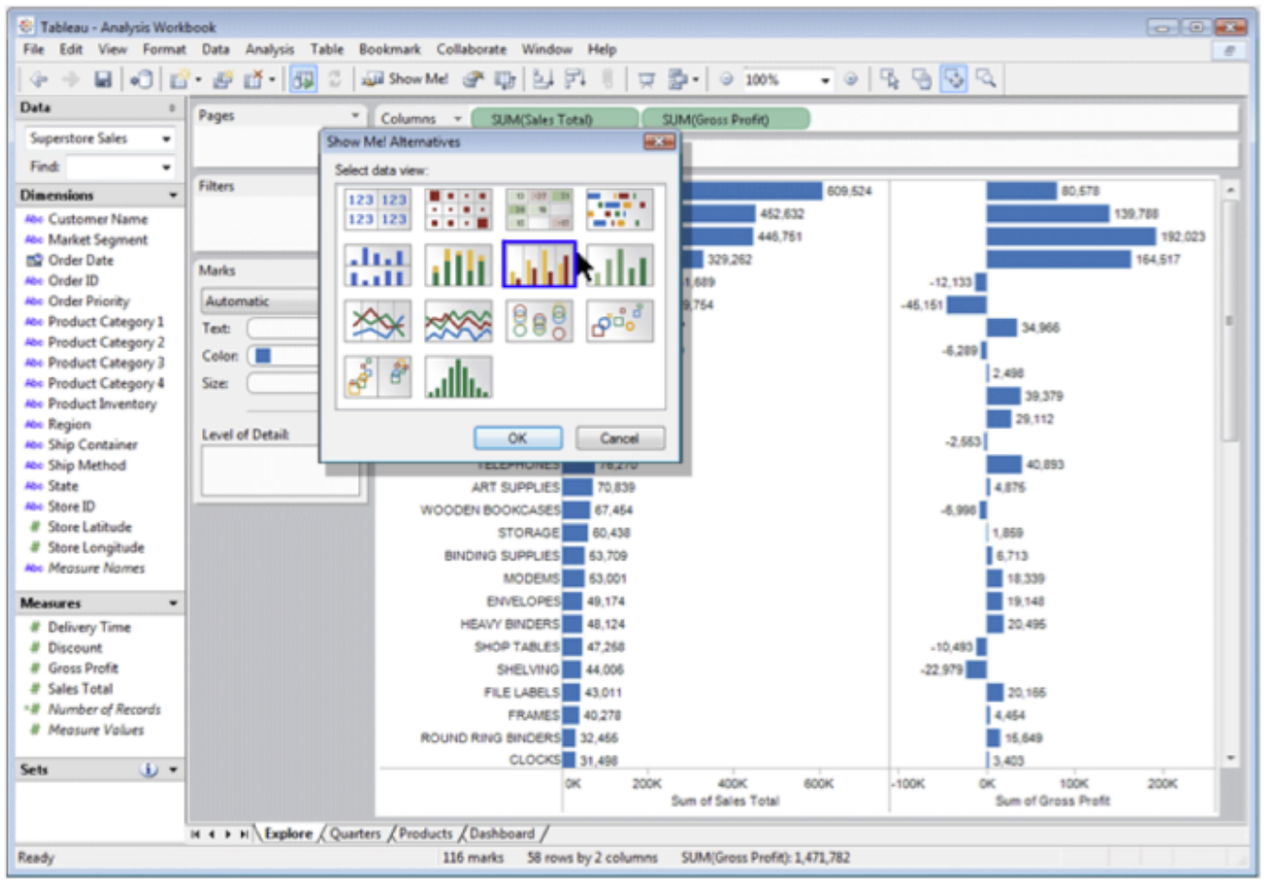
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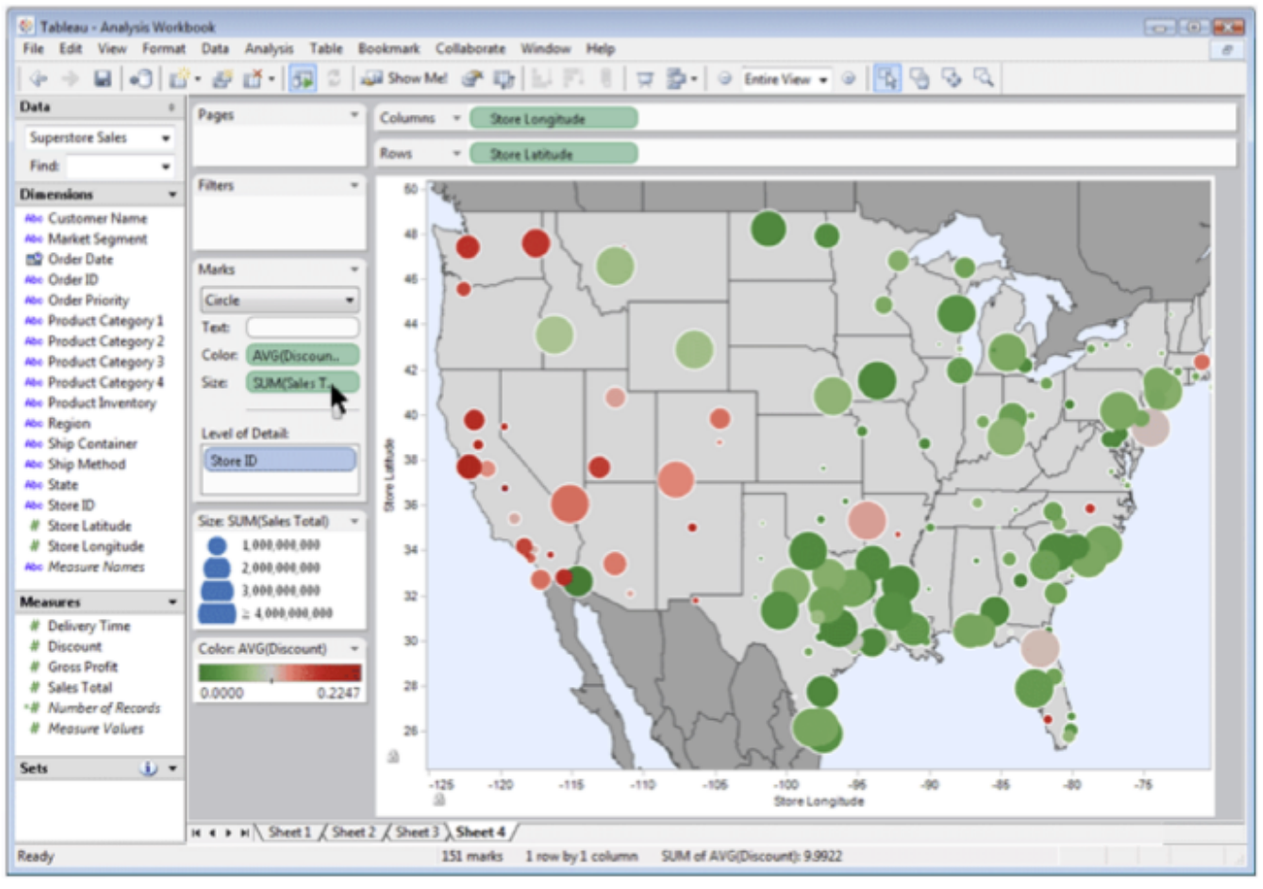
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Animating Transitions

Animated Transitions in Statistical Data Graphics

Jeffrey Heer
George G. Robertson

Microsoft Research

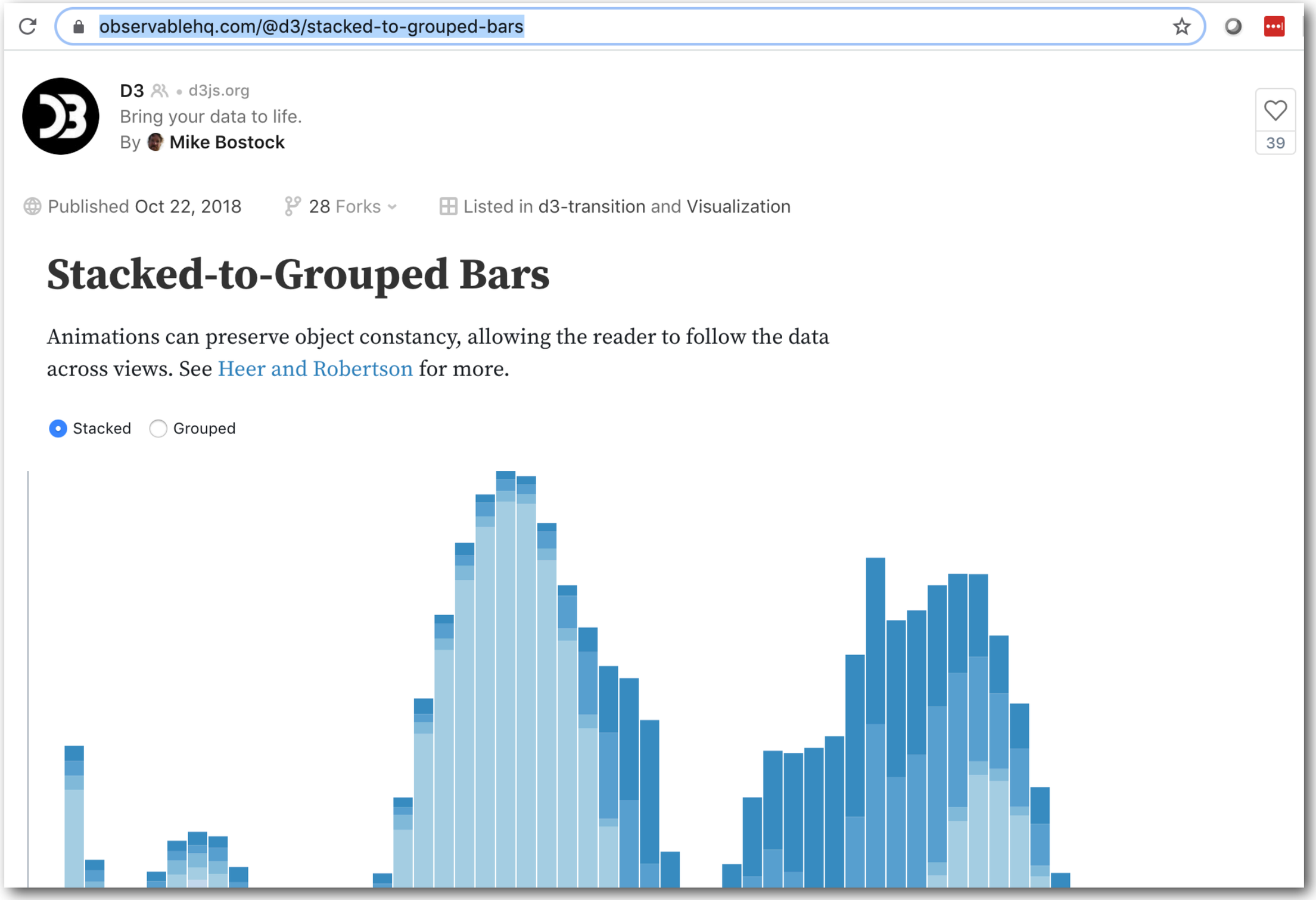
Animating Transitions

Animated Transitions in Statistical Data Graphics

Jeffrey Heer
George G. Robertson

Microsoft Research

Animated Transitions in d3

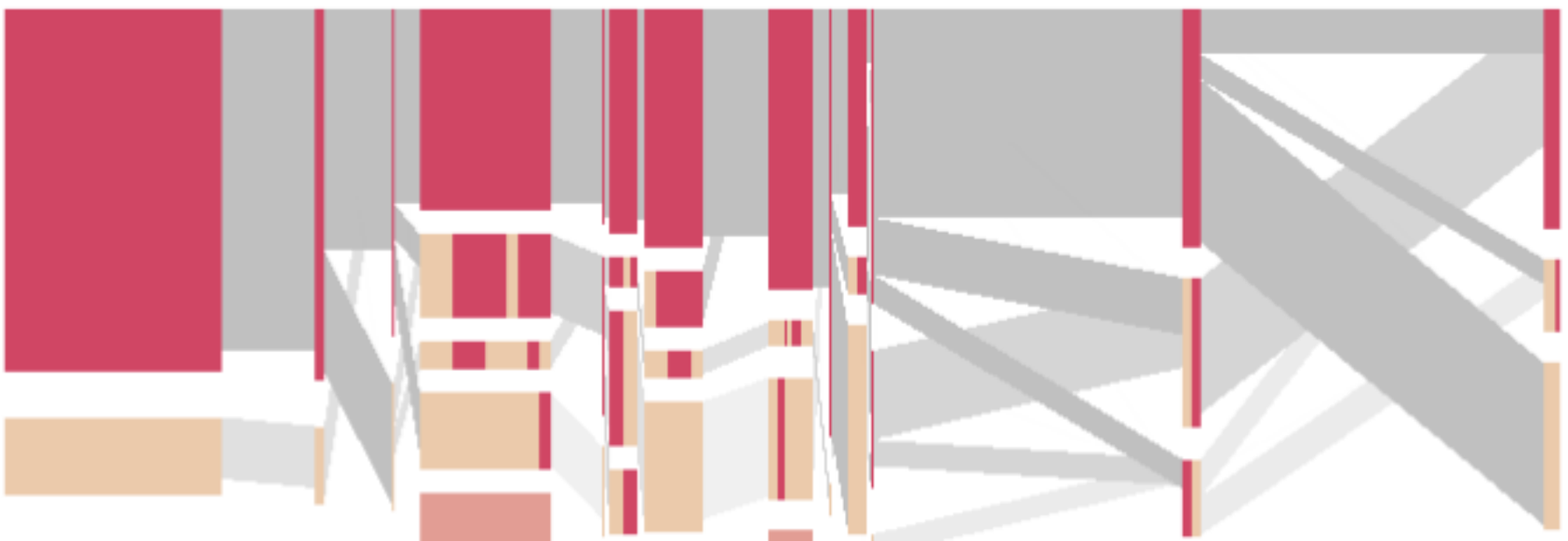


<< BEN FRY

isometricblocks

When comparing the genome of two different people, you'll see single letter changes (called SNPs, pronounced "snips") every few thousand letters. An interesting feature of SNPs is that their ordering has distinct patterns, where sets of consecutive changes are most often found together. There are many methods for looking at this data, so this piece combines several of them into a single visual display. The project is described in greater detail in my dissertation, starting in chapter four.

View 2D 2D Even Spacing 2D Quantitative 3D 3D with LD Units LD Units from above



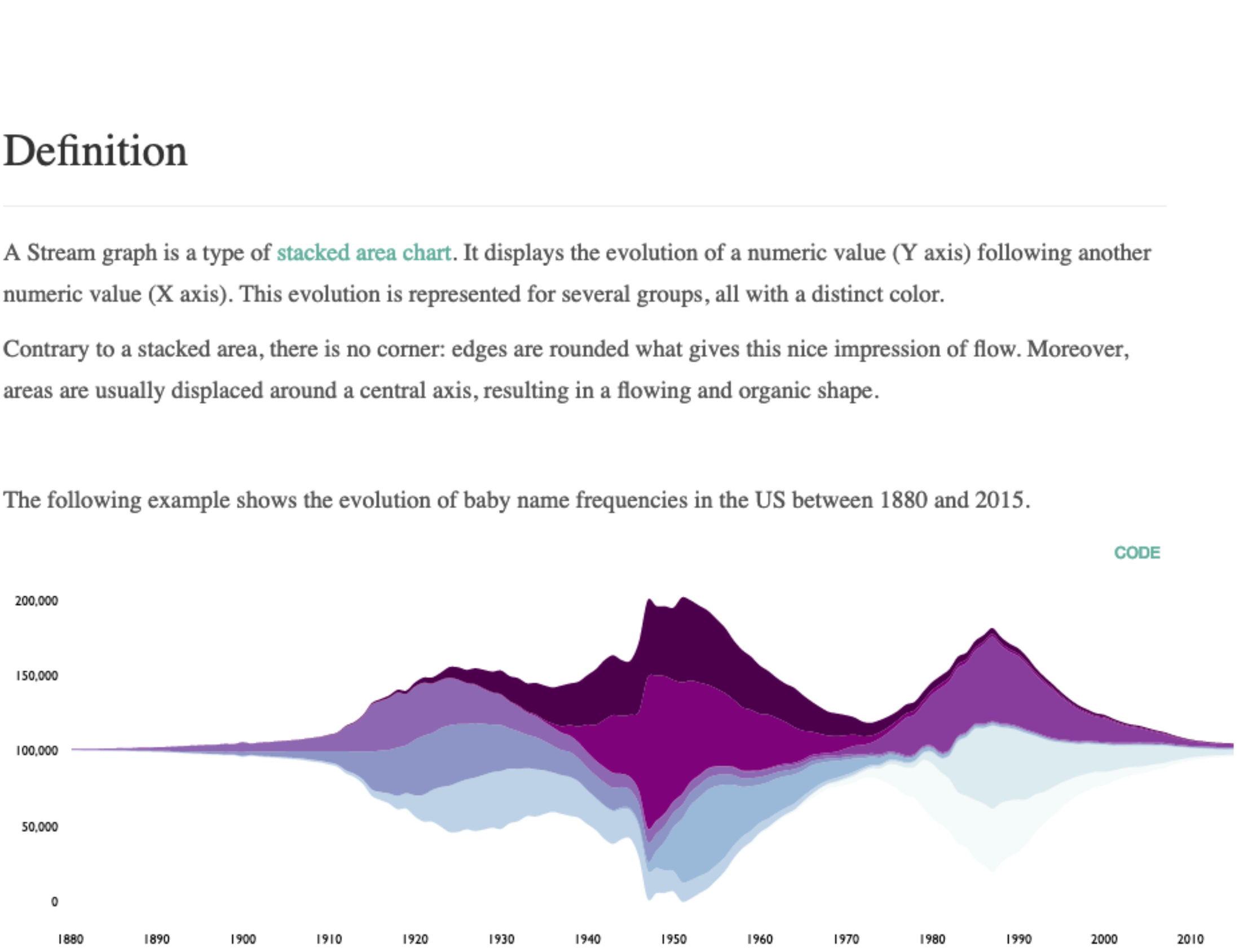
Interaction: Selection and Highlighting

Definition

A Stream graph is a type of stacked area chart. It displays the evolution of a numeric value (Y axis) following another numeric value (X axis). This evolution is represented for several groups, all with a distinct color.

Contrary to a stacked area, there is no corner: edges are rounded what gives this nice impression of flow. Moreover, areas are usually displaced around a central axis, resulting in a flowing and organic shape.

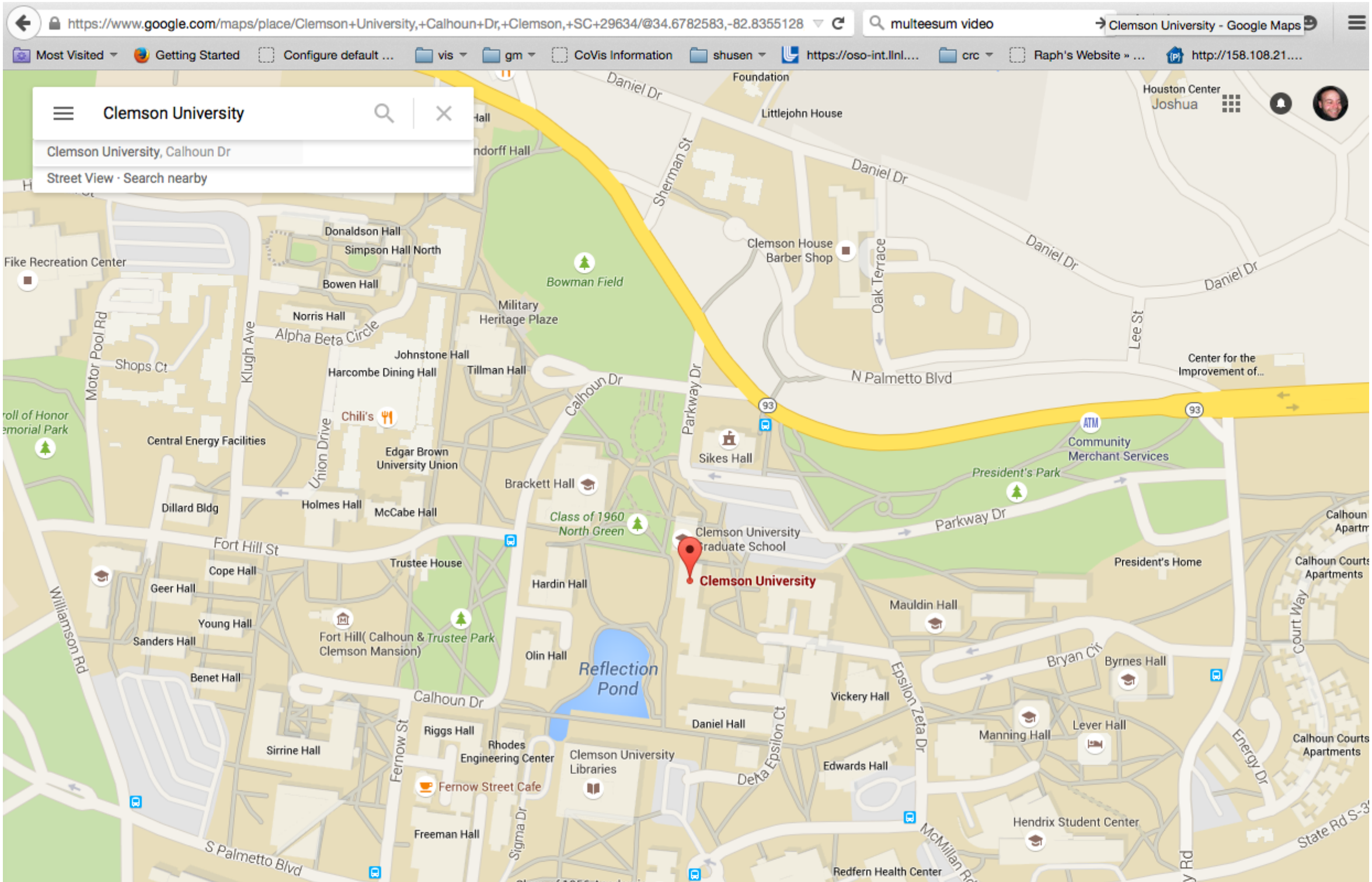
The following example shows the evolution of baby name frequencies in the US between 1880 and 2015.



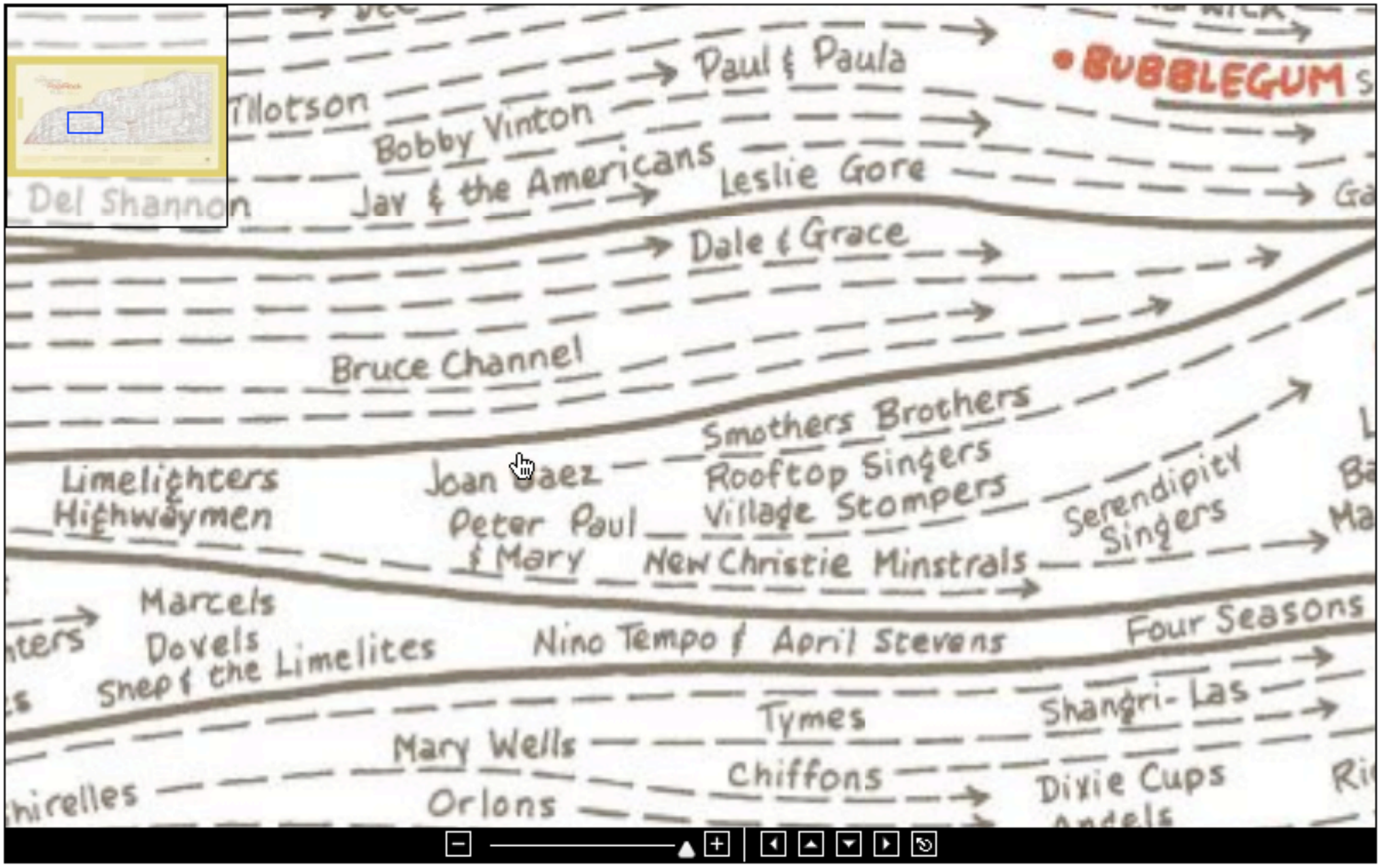
Note: The dataset is available through the babynames R library and a `.csv` version is available on github.

Interaction: Navigation

Pan (and Translate)

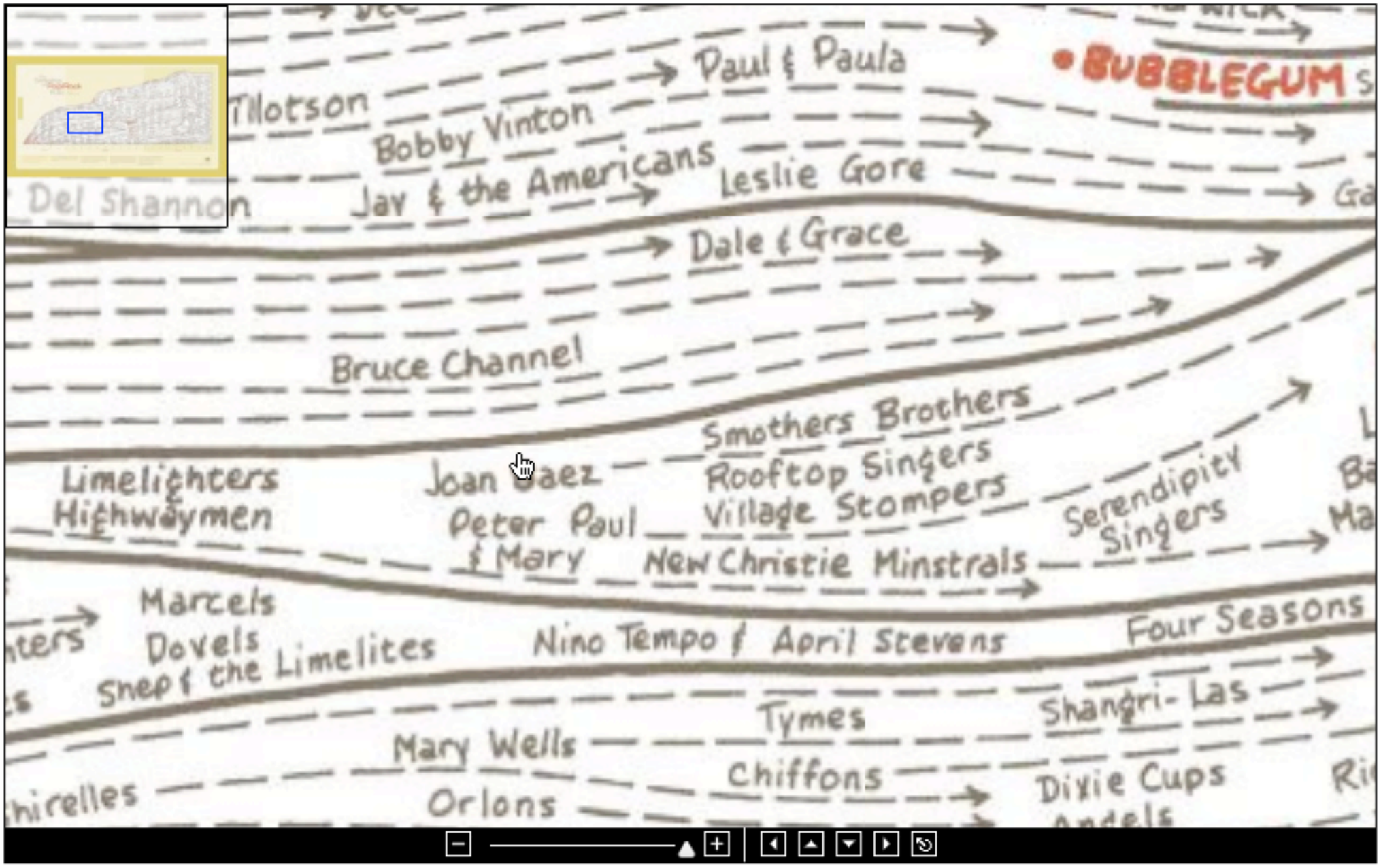


Pan (and Translate)



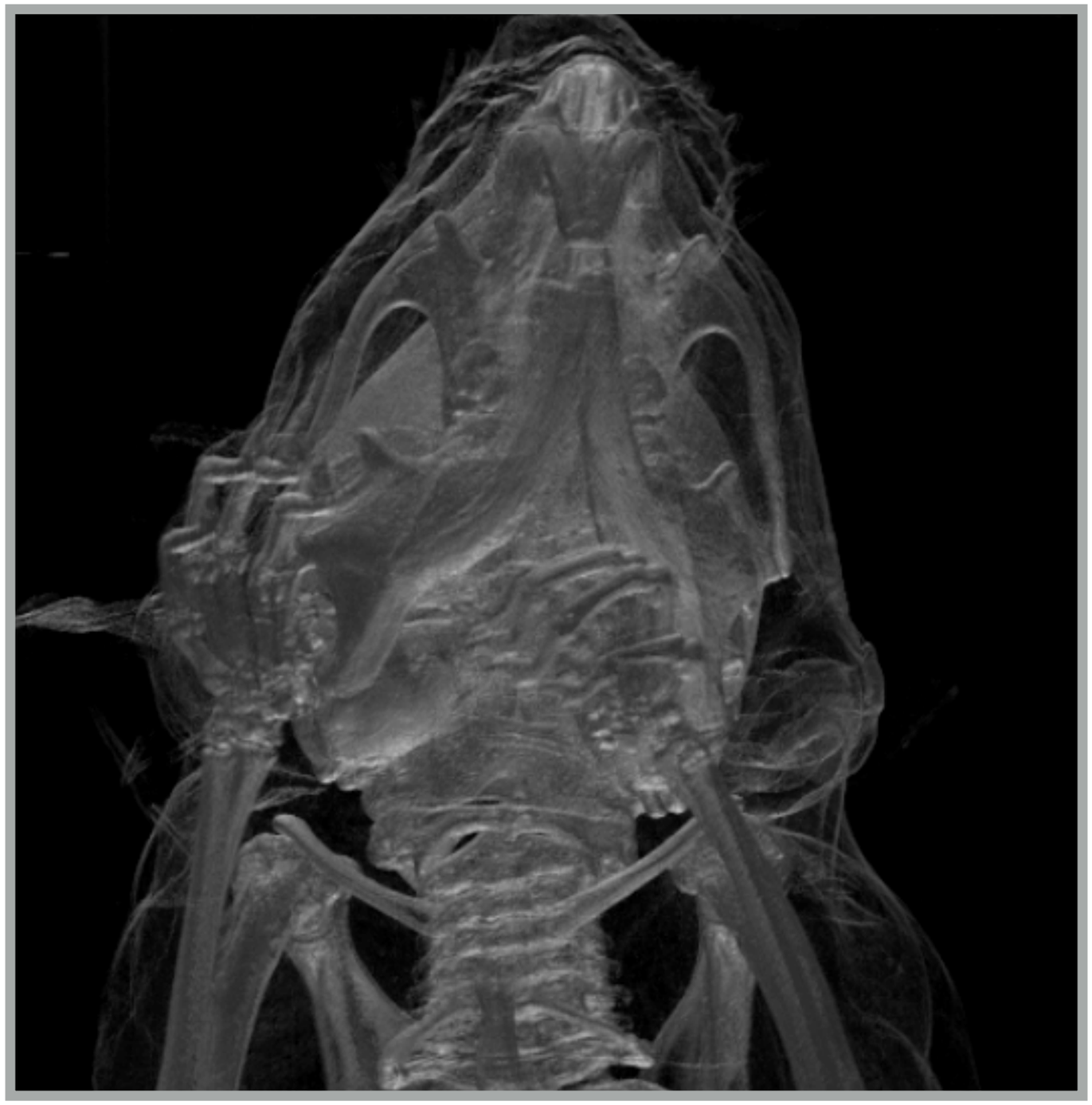
http://www.historyshots.com/rockmusic/

Pan (and Translate)



http://www.historyshots.com/rockmusic/

Rotate



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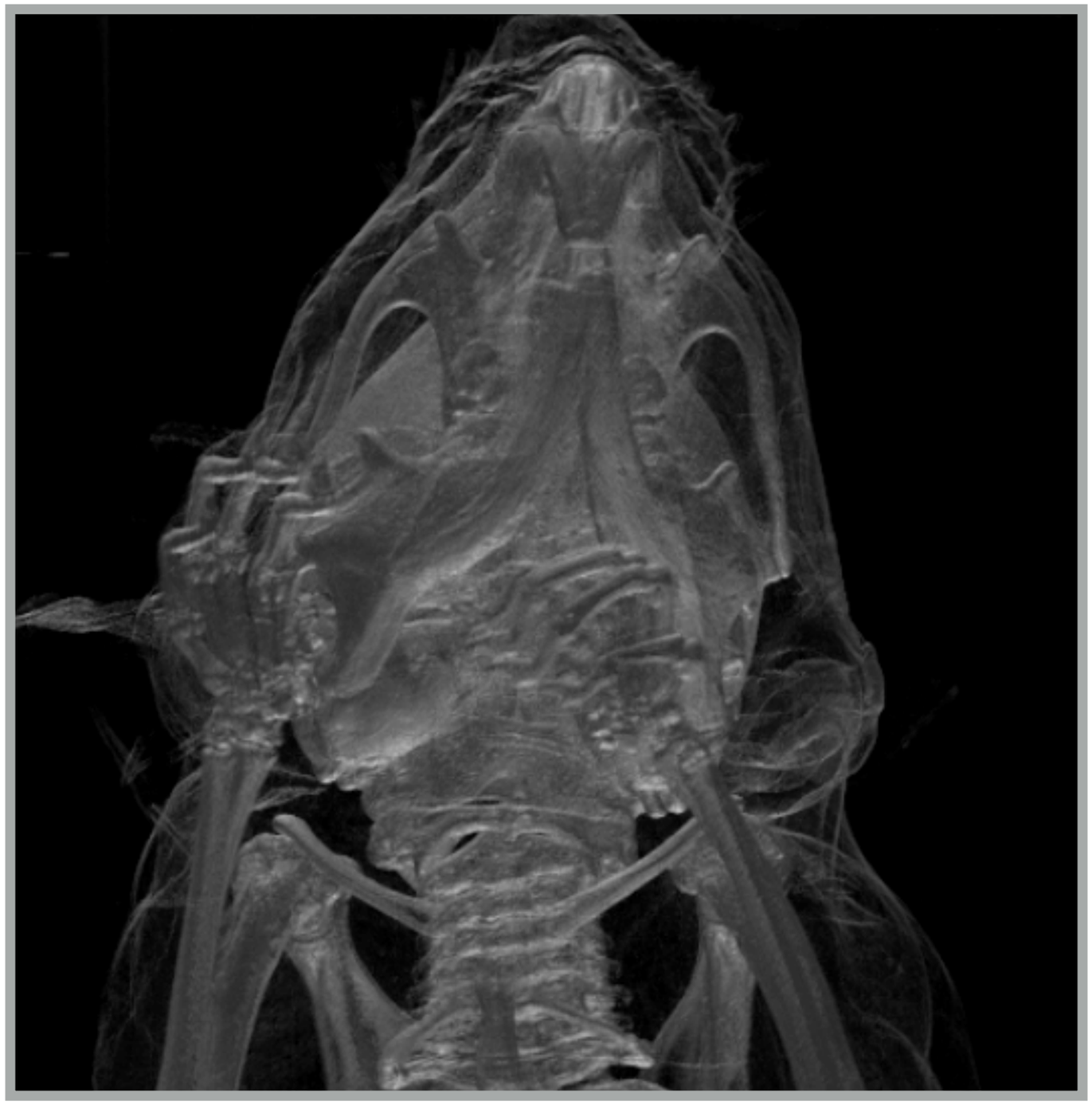
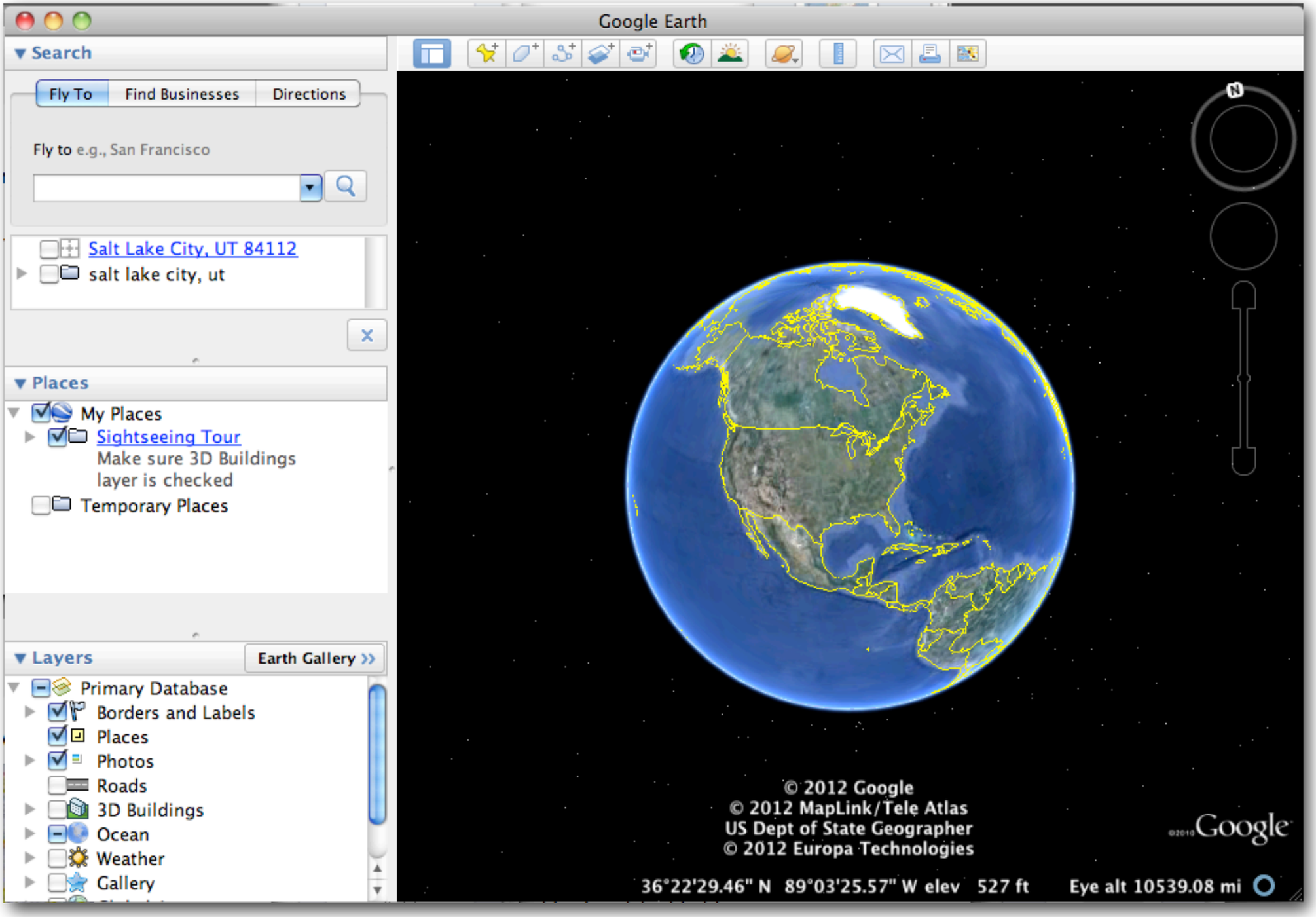
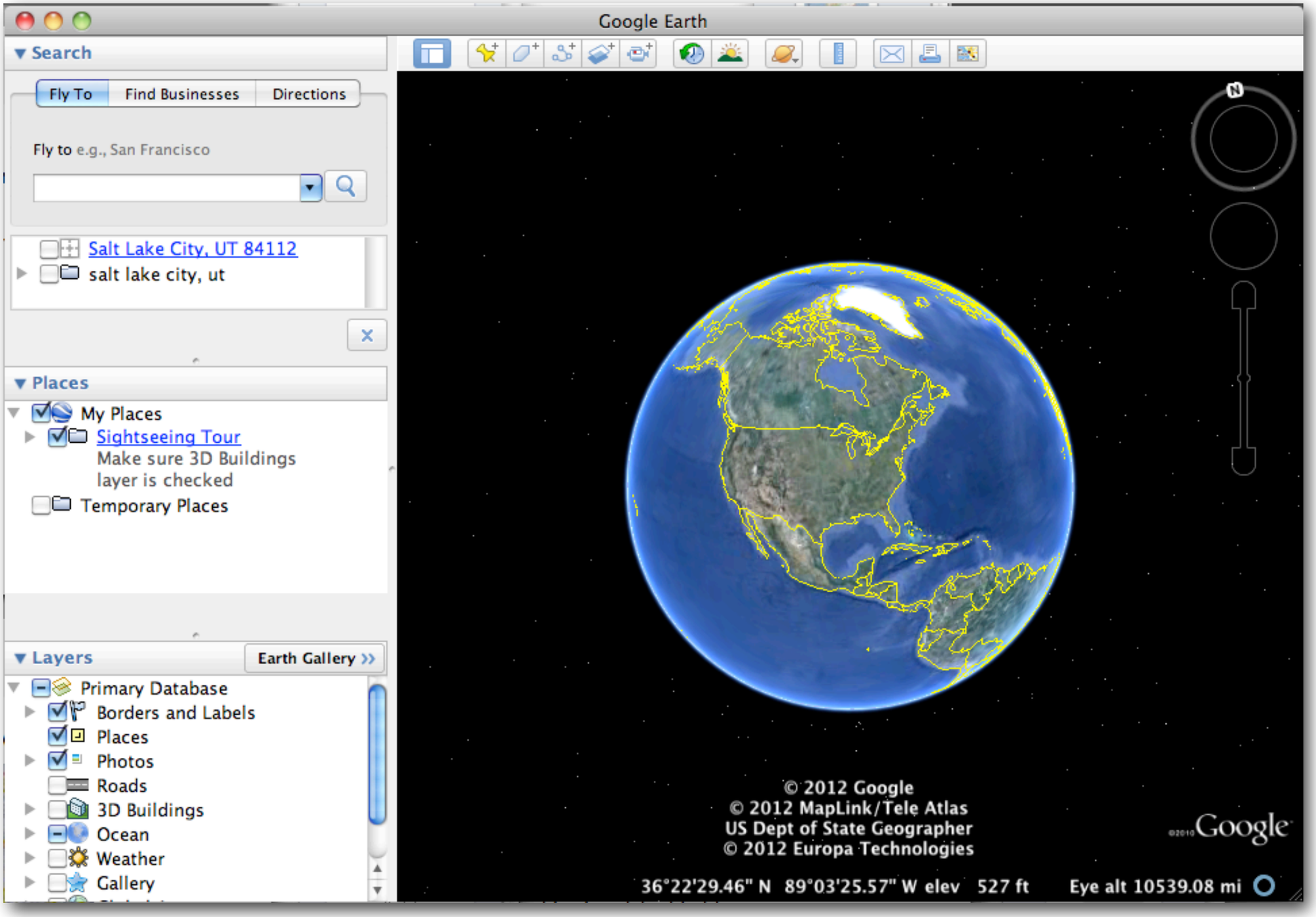


Geometric vs. Semantic Zooming

Geometric Zoom



Geometric Zoom



Semantic Zooming

Semantic Zooming

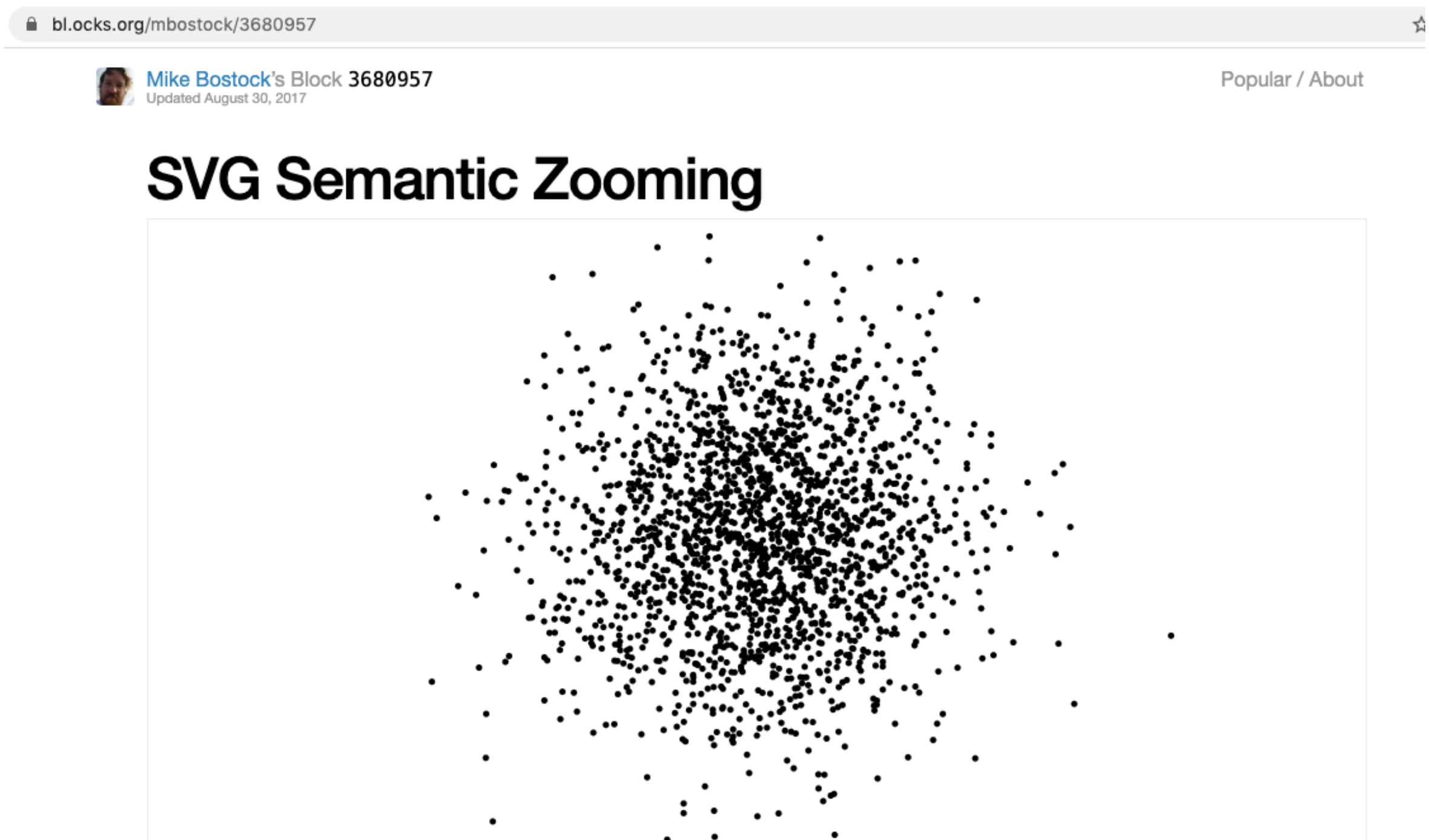
Semantic Zooming

LiveRAC: Interactive Visual Exploration of System Management Time-Series Data

Semantic Zooming

LiveRAC: Interactive Visual Exploration of System Management Time-Series Data

Comparing Geometric and Semantic Zooming in d3



Smooth and efficient zooming and panning

Jarke J. van Wijk Wim A.A. Nuij
Technische Universiteit Eindhoven *

Abstract

Large 2D information spaces, such as maps, images, or abstract visualizations, require views at various level of detail: Close ups to inspect details, overviews to maintain (literally) an overview. Users often switch between these views. We discuss how smooth animations from one view to another can be defined. To this end, a metric on the effect of simultaneous zooming and panning is defined, based on an estimate of the perceived velocity. Optimal is defined as *smooth and efficient*. Given the metric, these terms can be translated into a computational model, which is used to calculate an analytic solution for optimal animations. The model has two free parameters: animation speed and zoom/pan trade-off. A user experiment to find good values for these is described.

CR Categories: I.3.6 [Computer Graphics]: Methodology and Techniques—Interaction techniques; D.2.2 [Software Engineering]: Tools and Techniques—User interfaces

Keywords: Navigation, zooming, panning, scrolling, scale space

1 INTRODUCTION

We consider a simple problem. Suppose, we are developing an interactive cartographic application. The user is presented a map of, say, the US, and can zoom in on regions, states, and cities by picking items from a list or clicking on areas on the screen. We want to offer a smooth animation from one close-up on the map to another. How to define this animation?

One encounters this problem frequently. Cartography is the prime example, but in Information Visualization there is an even stronger need for such smooth animations. Abstract data is typically mapped to 2D graphic representations, such as scatterplots, graph diagrams, or treemaps. Large data sets lead to large imeye views [Furnas 1986]. Here we consider the use of the time dimension for this purpose. In other words, if the user shifts his attention, from overview to detail or from one detail to another, a smooth transition aids in understanding the relation between the two views.

At first sight, interpolation (linear in space, logarithmic in scale) might seem to be sufficient to make the transition from one view to another. However, this solution falls short when the transition has to be made from one close-up to another. For instance, suppose we focus on New York and shift to Los Angeles. Such a simple solution leads to a long animation, where a small strip of the US is shown in detail. A somewhat better solution is to zoom out first, pan across the continent, followed by a zoom in on the city of destination. But how much to zoom out? How much time should the animation take? How to combine zooming and panning? What is the optimal path? How can we define optimal here? The problem is less simple than it seems at first sight.

In this paper we present a solution to this problem, or, in other words, we present a computational model for fast navigation in scale space. After a review of related work in section 2, we analyze the problem in section 3. Central is the definition of a metric on the effect of zooming and panning, derived from an estimate of average velocity. Based on this metric we first present an optimal solution for a simple zoom-out, pan, zoom-in scenario (section 4). Next we consider arbitrary transitions (section 5) and present how an optimal path of a virtual camera can be determined analytically given two projections. In section 6 we present a first user experiment in order to find satisfying values for the two free parameters in the model (animation speed and zoom/pan trade off). Finally, conclusions are drawn and possible extensions are discussed in section 7.

2 BACKGROUND

Smooth Transitions on Zooming

- What's the "best" way to go from one zoomed view to another?

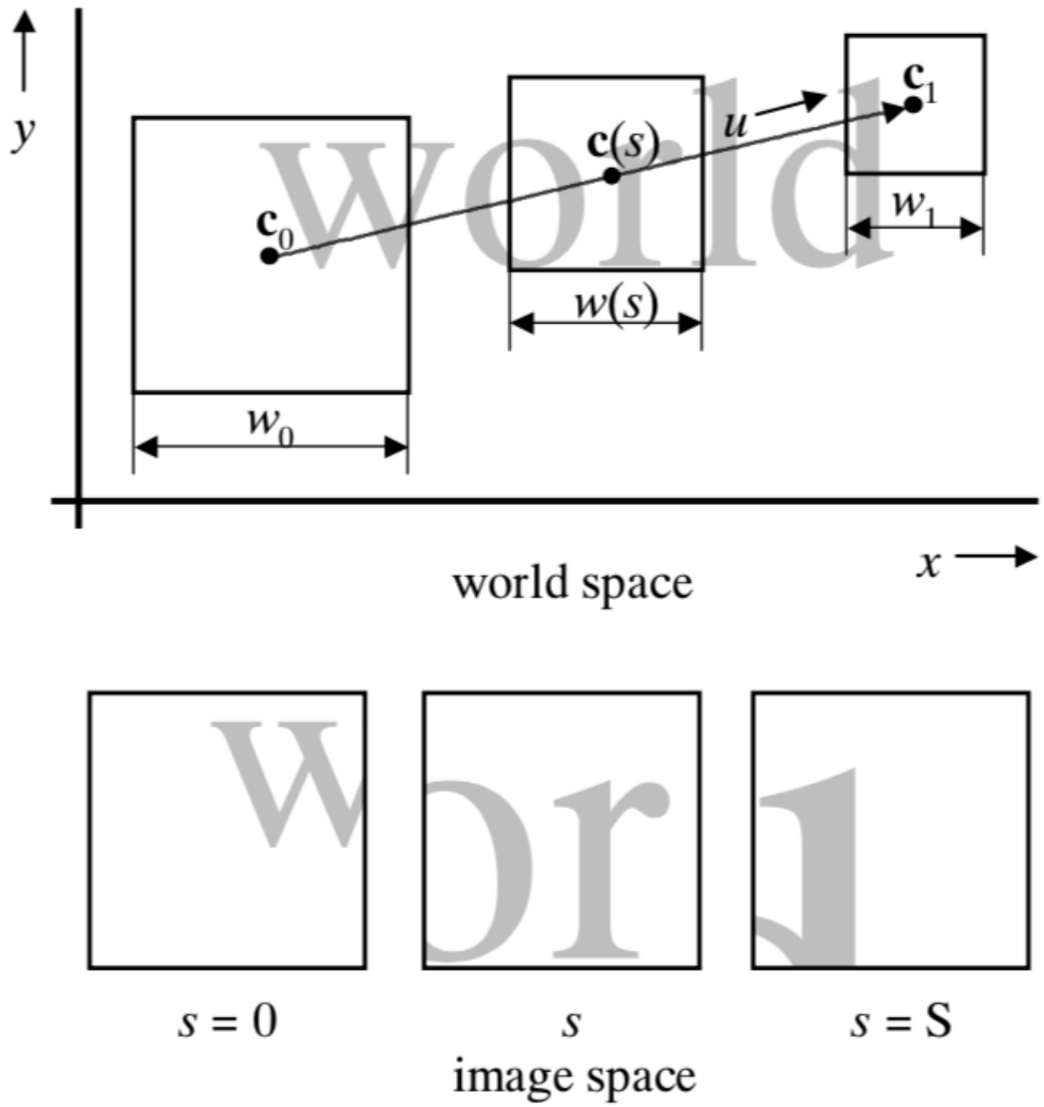


Figure 1: World space and image space

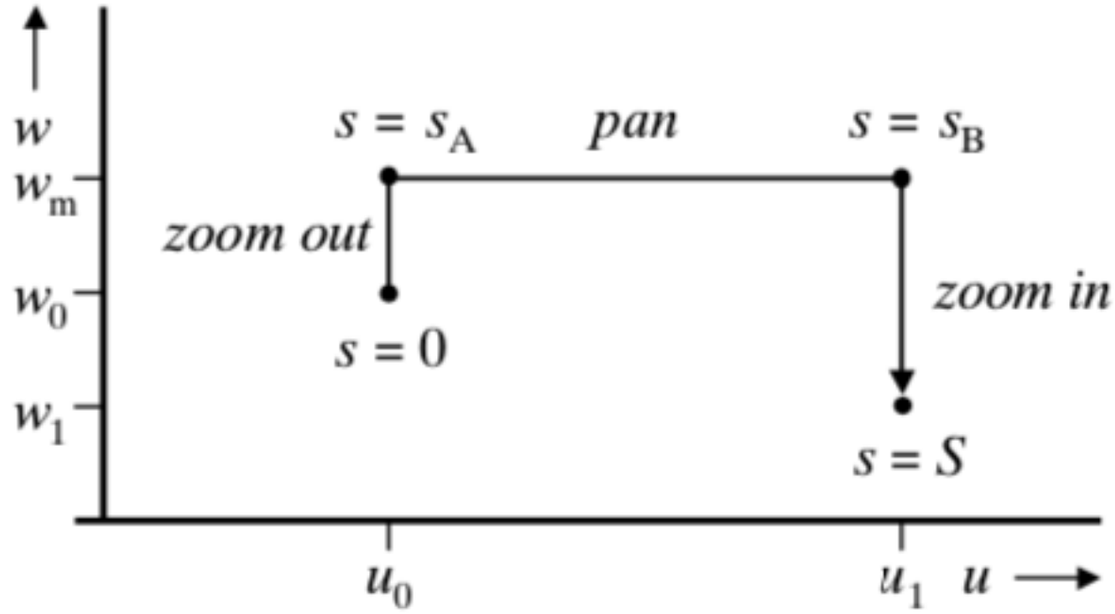


Figure 4: Zoom out, pan, zoom in

https://observablehq.com/@d3/smooth-zooming

Interactions Summary

- Change (over time)
- Selection / Highlighting

- Navigation:
  - Panning, Translate, Rotate
  - Zooming (Geometric / Semantic)

Lec11 Reading

- Munzner, Ch. 12, 6.7, 14

- A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008.

Reminder
Assignment 02

Assigned: Monday, February 6
Due: Monday, February 20, 4:59:59 pm

Reminder
Project Milestone 01

Assigned: Monday, January 25
Due: Wednesday, February 22, 4:59:59 pm