CS-5630 / CS-6630 Visualization for Data Science
Views

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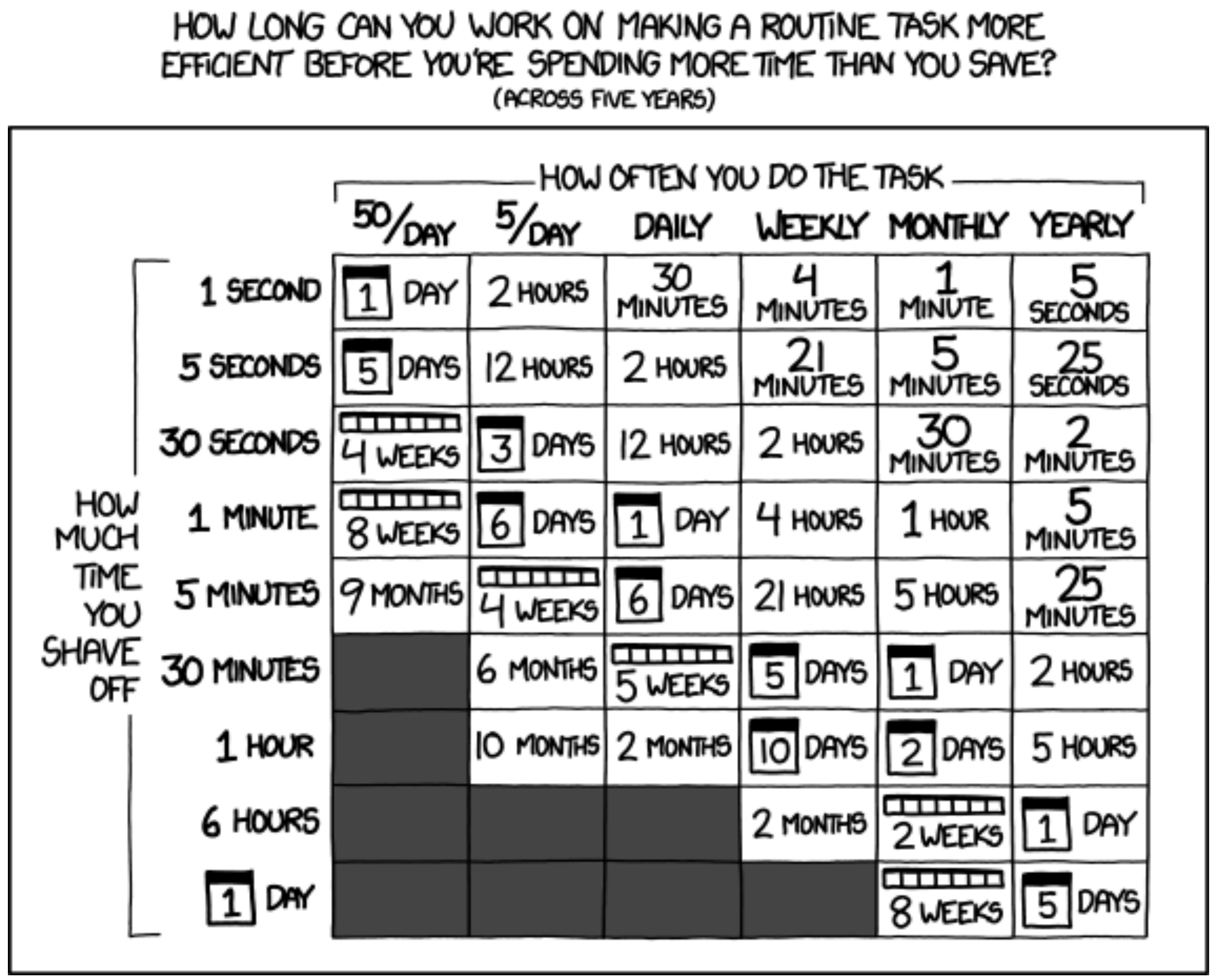


[xkcd]

Multiple Views

Eyes over Memory:

Trade-off of display space and working memory

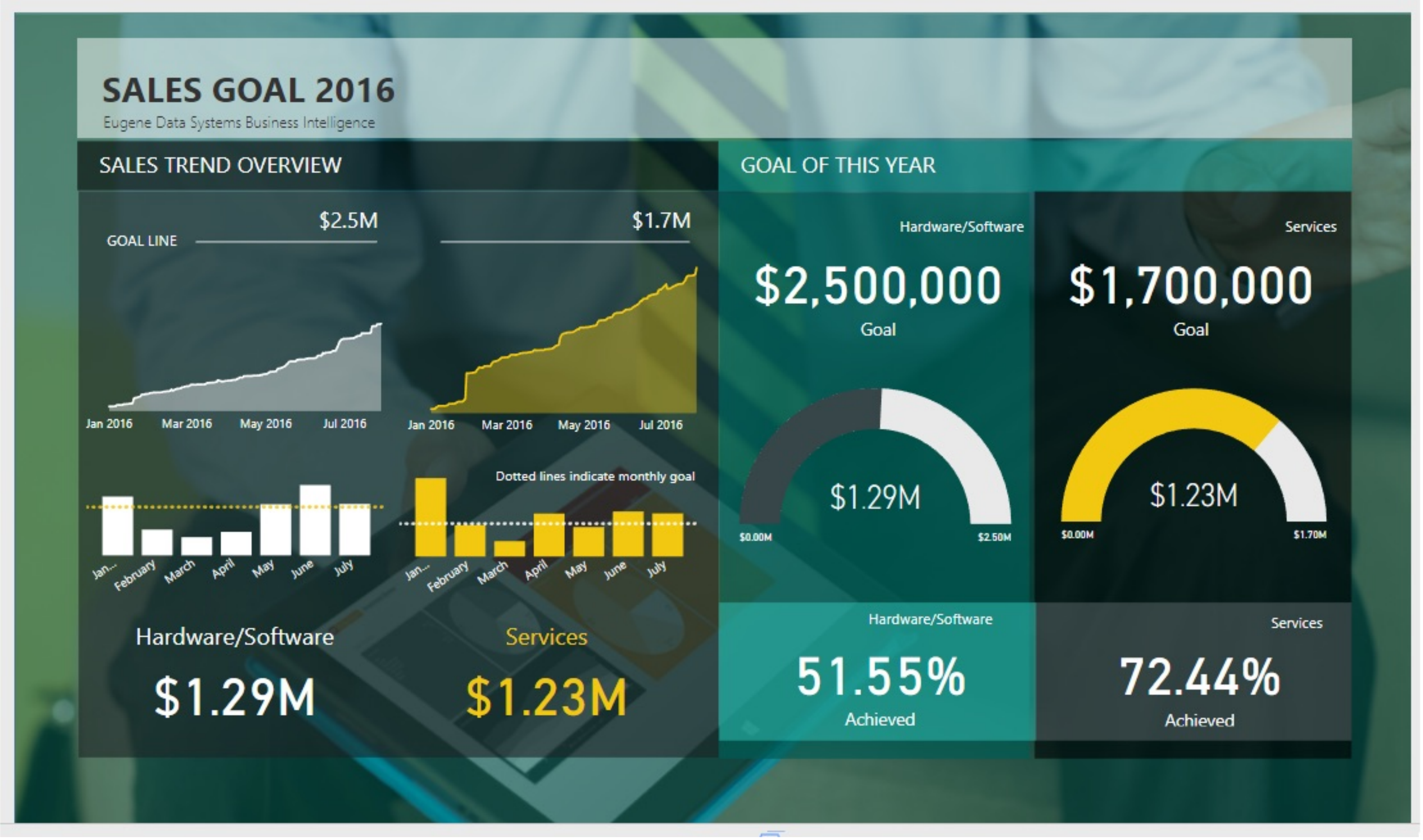
Linked Views

Multiple Views that are simultaneously visible and linked together such that actions in one view affect the others.

Dashboards

Multiple views for "data driven decision making"

"a visual display of data used to monitor conditions and/or facilitate understanding"



What Do We Talk About When We Talk About Dashboards?
Alper Sarikaya, Michael Correll, Lyn Bartram, Melanie Tory, and Danyel Fisher. IEEE Transactions on Visualization and Computer Graphics, 29(1): 682–692. 2019.

Mandatory Reading

What Do We Talk About When We Talk About Dashboards?

Alper Sarikaya, Michael Correll, Lyn Bartram, Melanie Tory, and Danyel Fisher

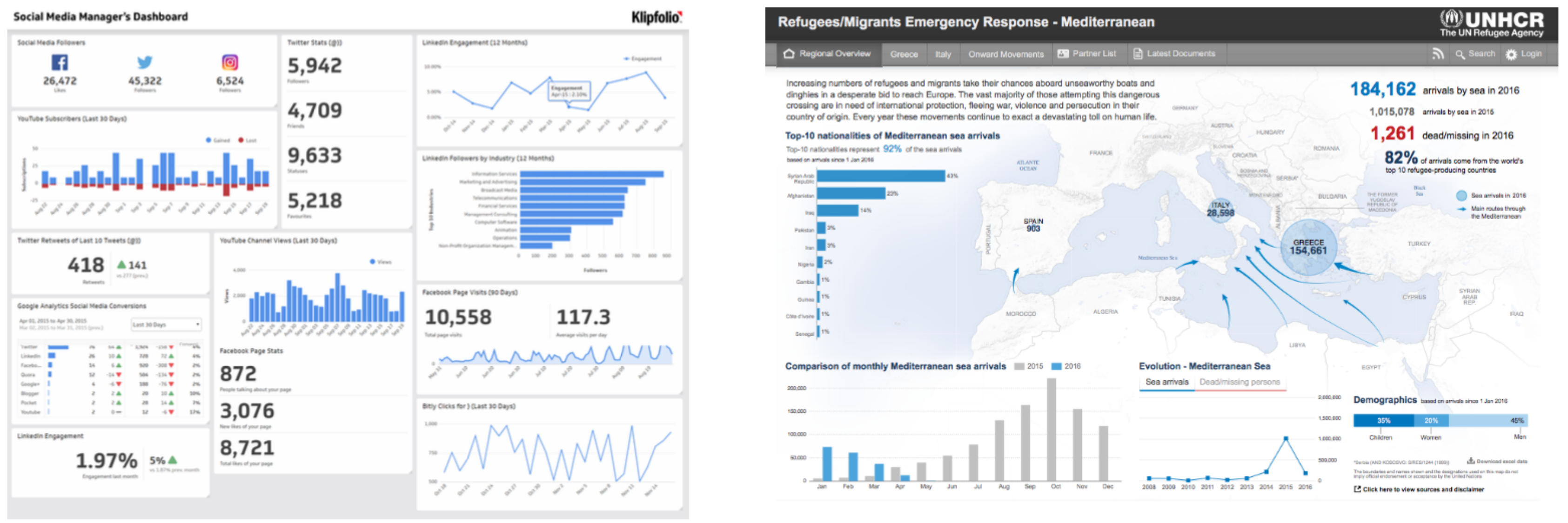


Fig. 1: Klipfolio's Social Media Manager Dashboard (DB065 from our example corpus, left) is a traditional dashboard, with large numbers representing key metrics, and tiled graphs of real-time data. The UNCHR Refugees/Migrants Emergency Response dashboard (DB117, right) also is a juxtaposition of key metrics and simple visualizations, but includes annotations and guided narrative elements. Are both dashboards? Do design principles meant for one transfer to the other?

Abstract—Dashboards are one of the most common use cases for data visualization, and their design and contexts of use are considerably different from exploratory visualization tools. In this paper, we look at the broad scope of how dashboards are used in practice through an analysis of dashboard examples and documentation about their use. We systematically review the literature surrounding dashboard use, construct a design space for dashboards, and identify major dashboard types. We characterize dashboards by their design goals, levels of interaction, and the practices around them. Our framework and literature review suggest a number of fruitful research directions to better support dashboard design, implementation, and use.

Index Terms—Dashboards, literature review, survey, design space, open coding

1 Introduction

Visualization dashboards are ubiquitous. They are built and employed by nearly every industry, non-profit, and service organization to support data-driven decision making. They are used by students to track learning, and by individuals to monitor energy consumption and personal health. Despite their prevalence, the visualization research community has rarely given dashboards their due consideration, with few exceptions [46]. Are dashboards simply an extension of known visualization design principles? Or is there more to their design and use?

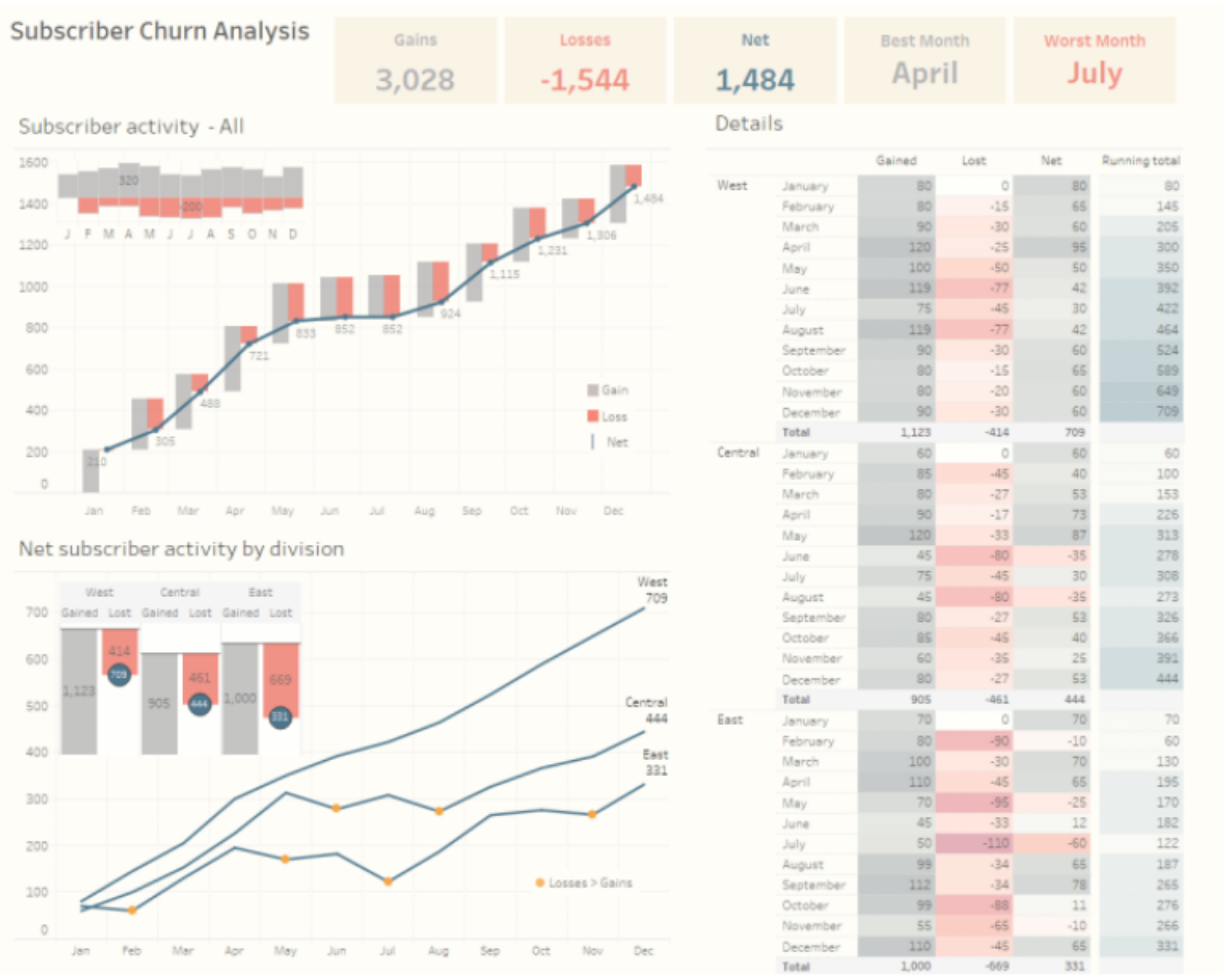
We argue that dashboards are worthy of discussion and research in

gle screen reports. Uniquely, compared to visualization modalities for presentation and exploration, dashboards bring together challenges of at-a-glance reading, coordinated views, tracking data and both private and shared awareness. Designers of dashboards must be mindful of literacy, contextually appropriate representations and visual language, and social framing. We identify dashboards as a distinct area of visualization that offers impactful directions for future research.

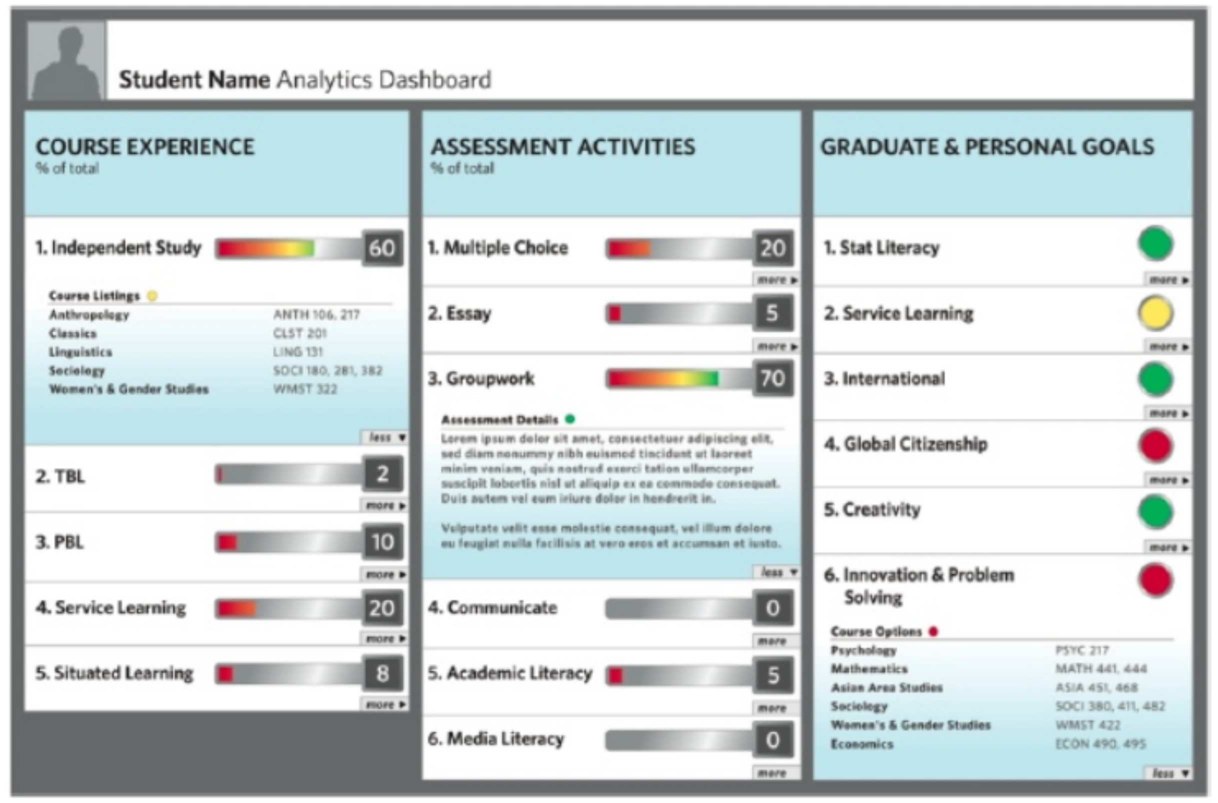
We took a two-pronged approach to understanding practices around dashboard design and use. We conducted an exploratory survey of

https://alper.datav.is/publications/dashboards/

Types of Dashboards



(a) Strategic Dashboard (DB001)



(b) Tactical Dashboard (DB106)

(c) Operational Dashboard (DB102)

(d) Social Dashboard (DB028)

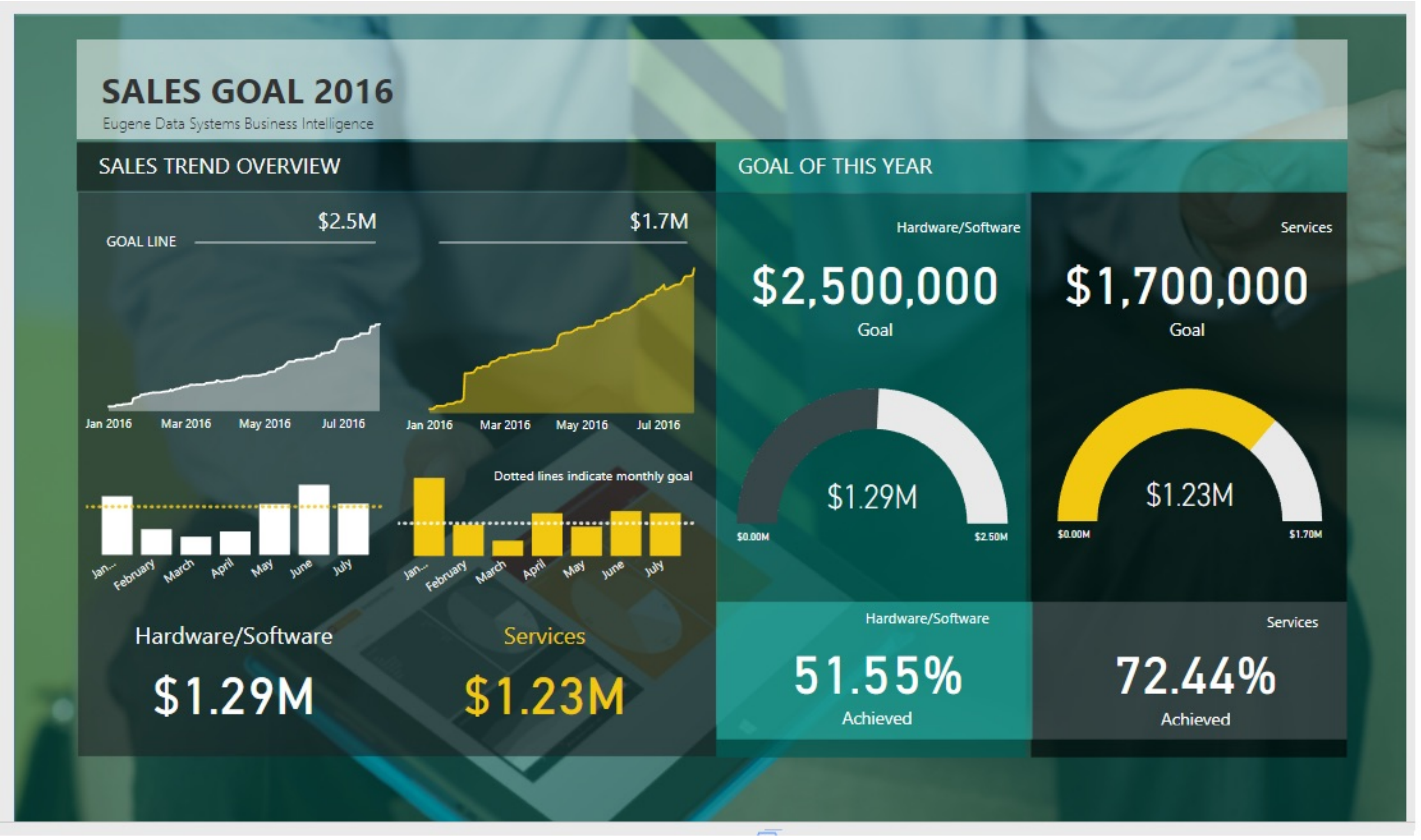
Dashboard Design Elements

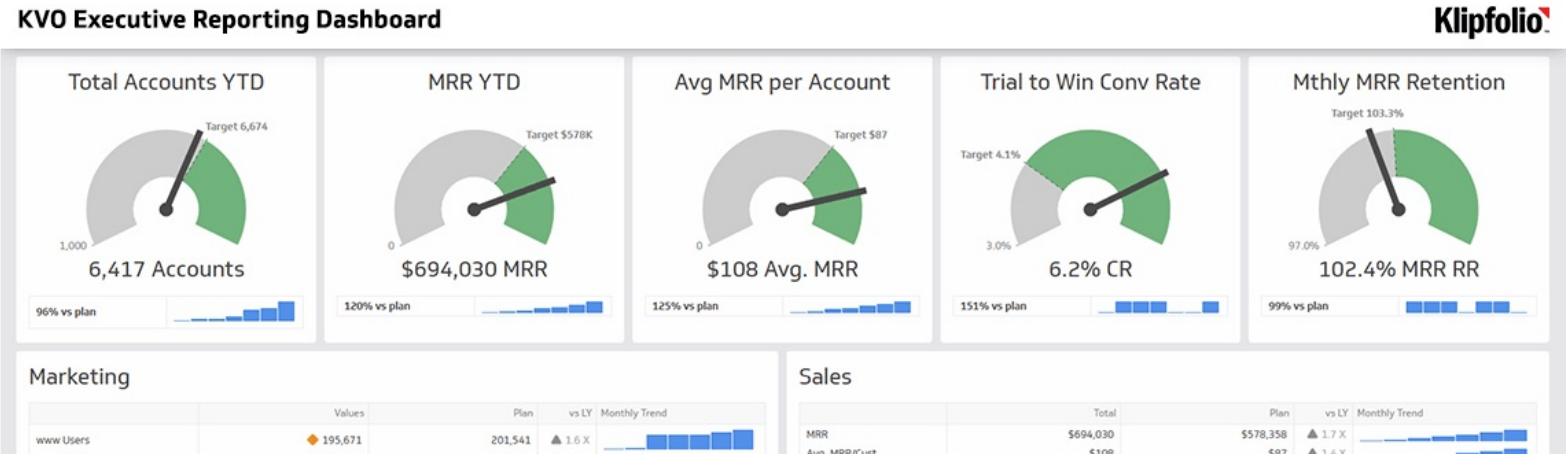
Key Performance Indicators (KPIs)

- Often shown as numbers

Gauge

- Numerical value + context / reference point
  - what is the goal?
  - are we in “danger zone”?
  - what’s the minimum?





COVID-19 Dashboards

Overview of COVID-19 Surveillance

Data are updated weekly on Thursdays. Most of the tables, charts, and maps in this report are interactive. Tables can be sorted by clicking on column headings. Maps and charts can be sorted, zoomed, selected, etc. using the mouse cursor and data will appear when hovering or clicking the mouse cursor. Controls will appear at the top right corner of charts when the mouse cursor is placed on the chart. The data used to create the charts on this dashboard are also available for download. Case and laboratory data that can be queried is available on IBIS.

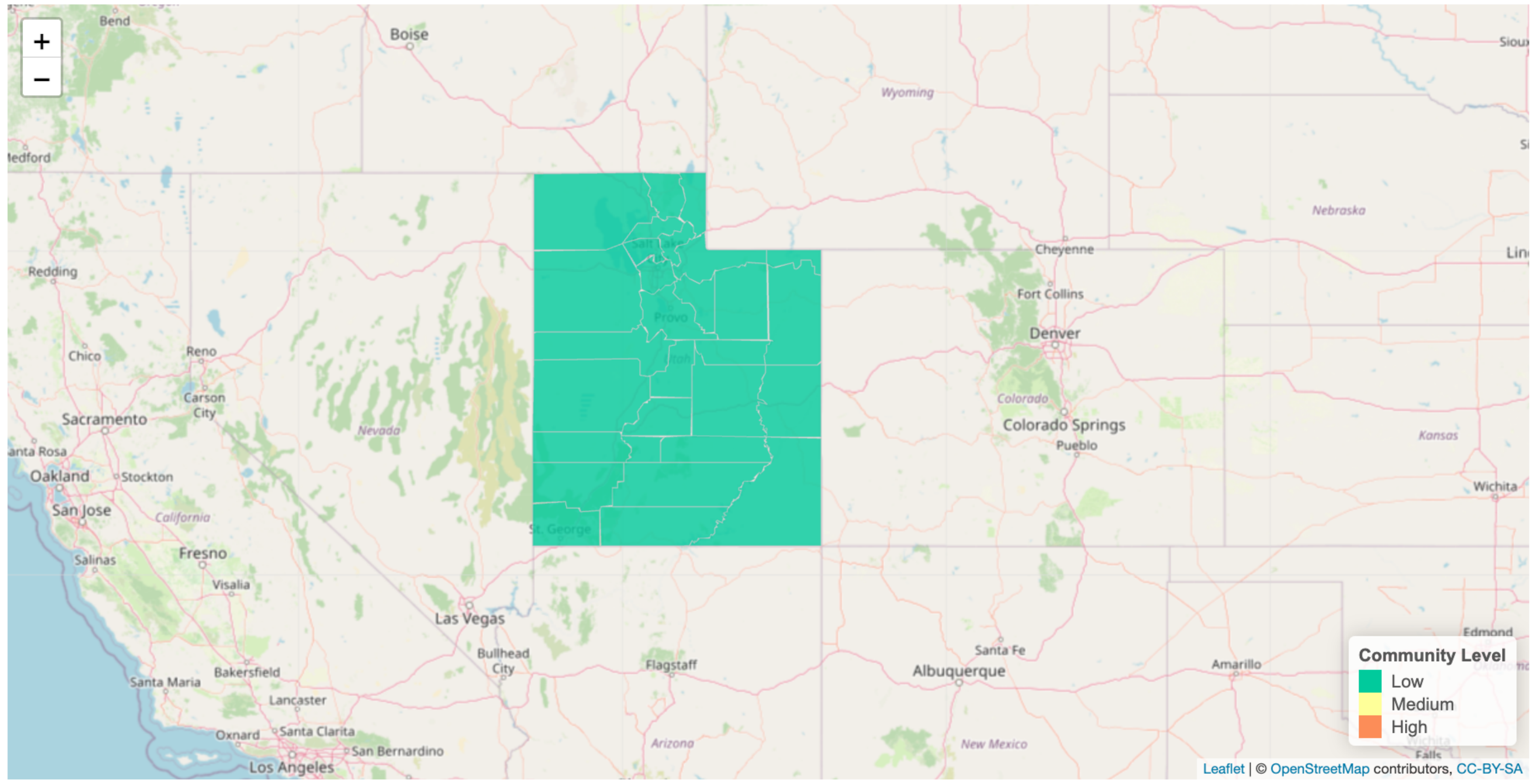
Weekly Report Date: **October 20, 2022.**

1,043,353	38,937	5,047	20.6%	1.79%	2,331,857
COVID-19 Cases	COVID-19 Hospitalizations	COVID-19 Deaths	Wastewater Sites Elevated or Increasing	7-day Emergency Room Visits with COVID-19	People Received at Least One Vaccine

Total Number of Lab-Confirmed COVID-19 Cases in Utah Residents

Jurisdiction	Cases	Hospitalizations	Deaths
Bear River	56,270	2,313	261
Central Utah	22,103	1,019	173
Davis County	113,795	3,303	430
San Juan	4,668	244	50
Salt Lake County	392,045	16,486	1,740
Southeast Utah	11,393	360	90
Southwest Utah	69,484	3,439	680
Summit County	15,340	370	27
Tooele County	24,025	805	111
TriCounty	14,382	1,253	116
Utah County	219,619	5,900	846
Wasatch County	11,761	208	37
Weber-Morgan	84,293	3,182	479
Under Investigation	4,175	55	7
State Total	1,043,353	38,937	5,047

COVID-19 Community Levels by County - CDC***

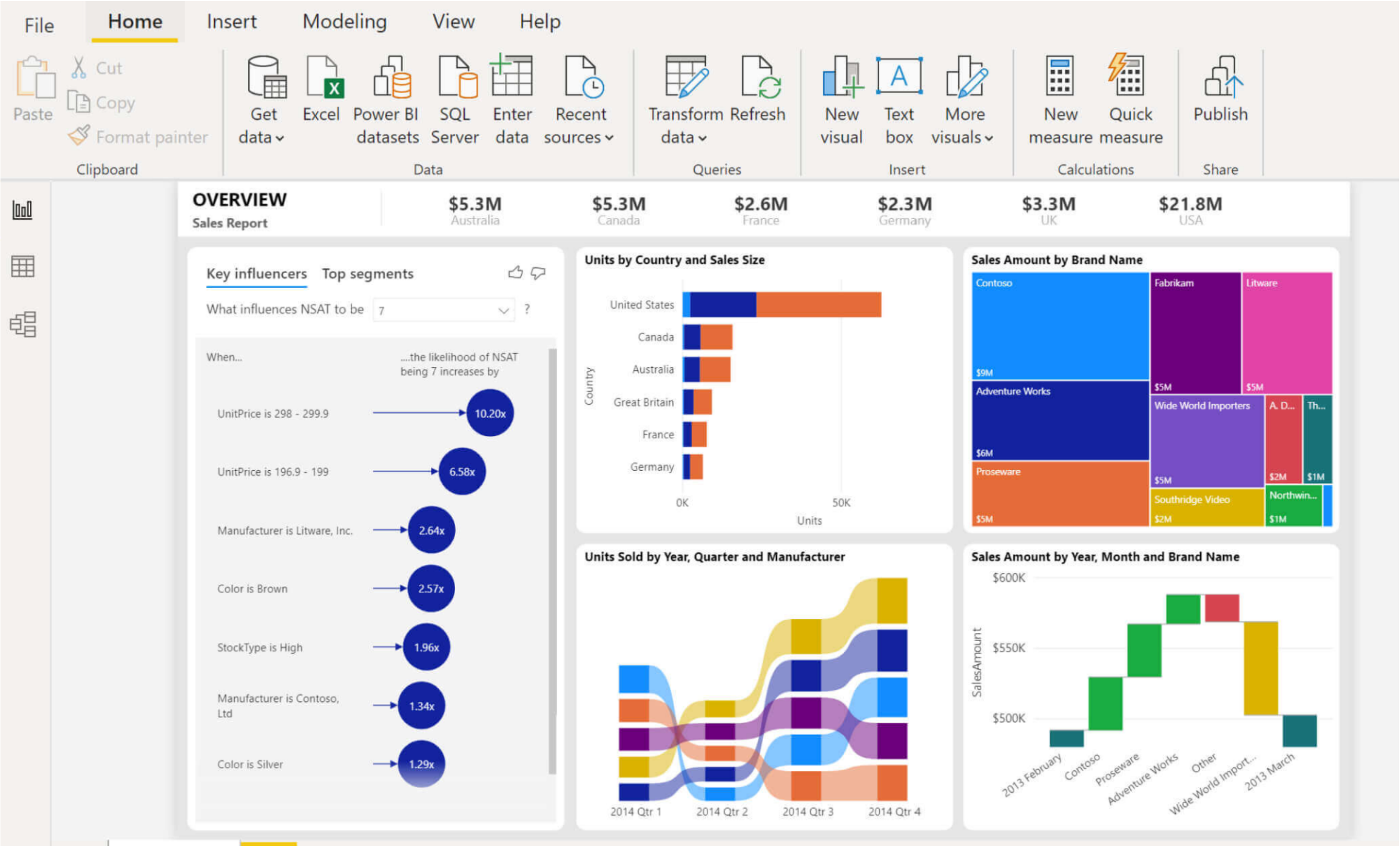


Cases Reported by Indian Health Service and Tribal Nations (these cases are also reflected in case counts by health district)

Reporting Jurisdiction	Cases
Navajo Nation Reservation (Utah) - Utah Navajo Health System	2,359
Uintah and Ouray Reservation: Uintah & Ouray Indian Health Services (IHS)	992
State Total	1,043,353

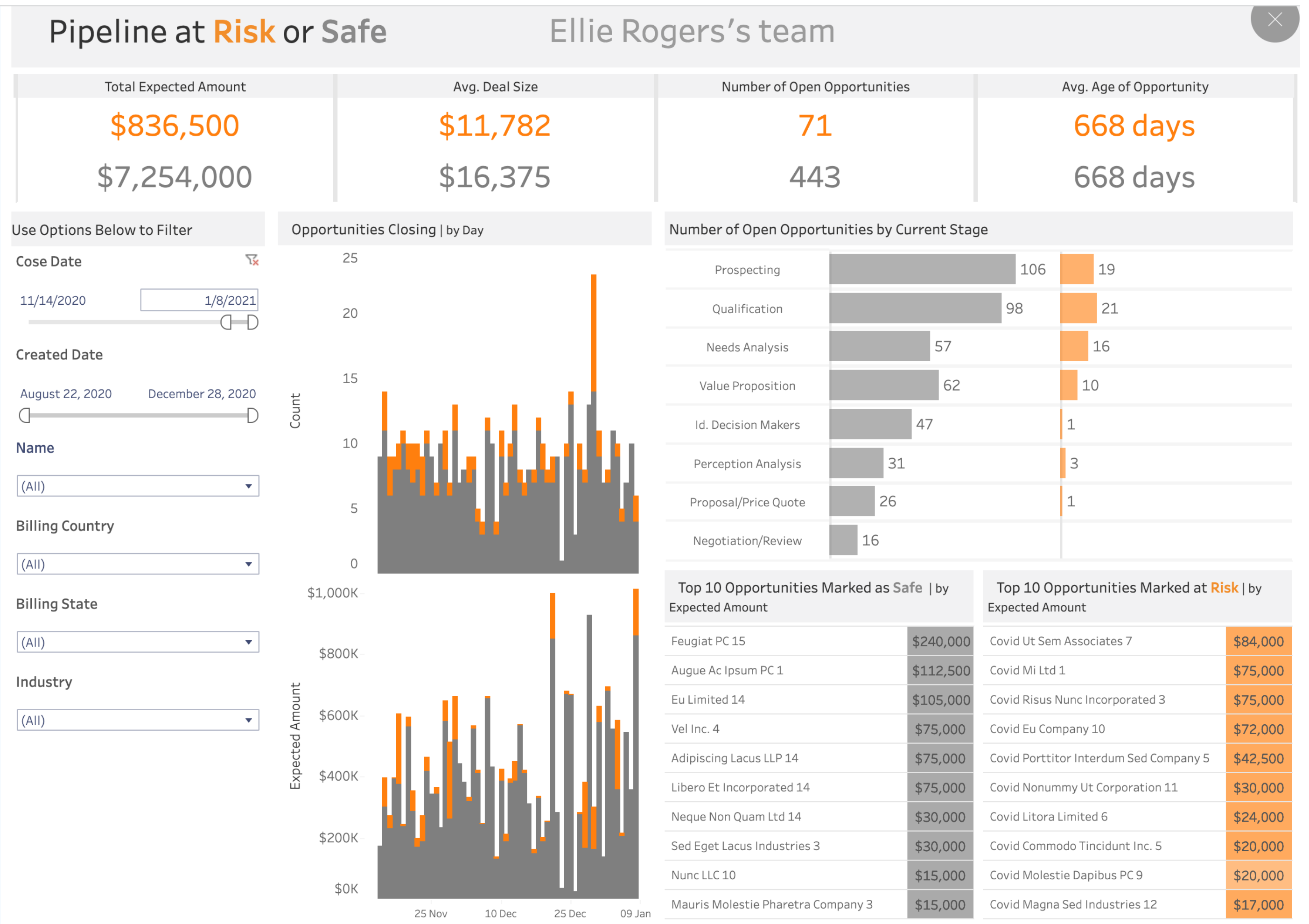
https://vdl.sci.utah.edu/blog/2020/07/20/state-dashboards/

Dashboarding Tools

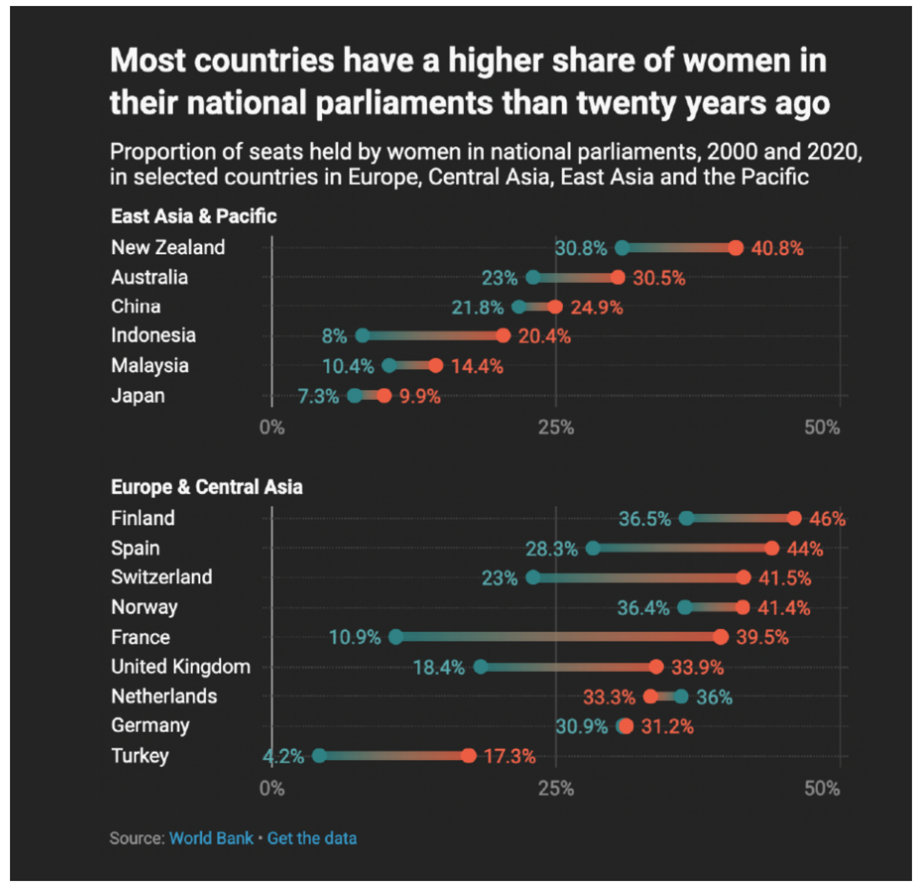


Microsoft Power BI

Plot.ly



Tableau



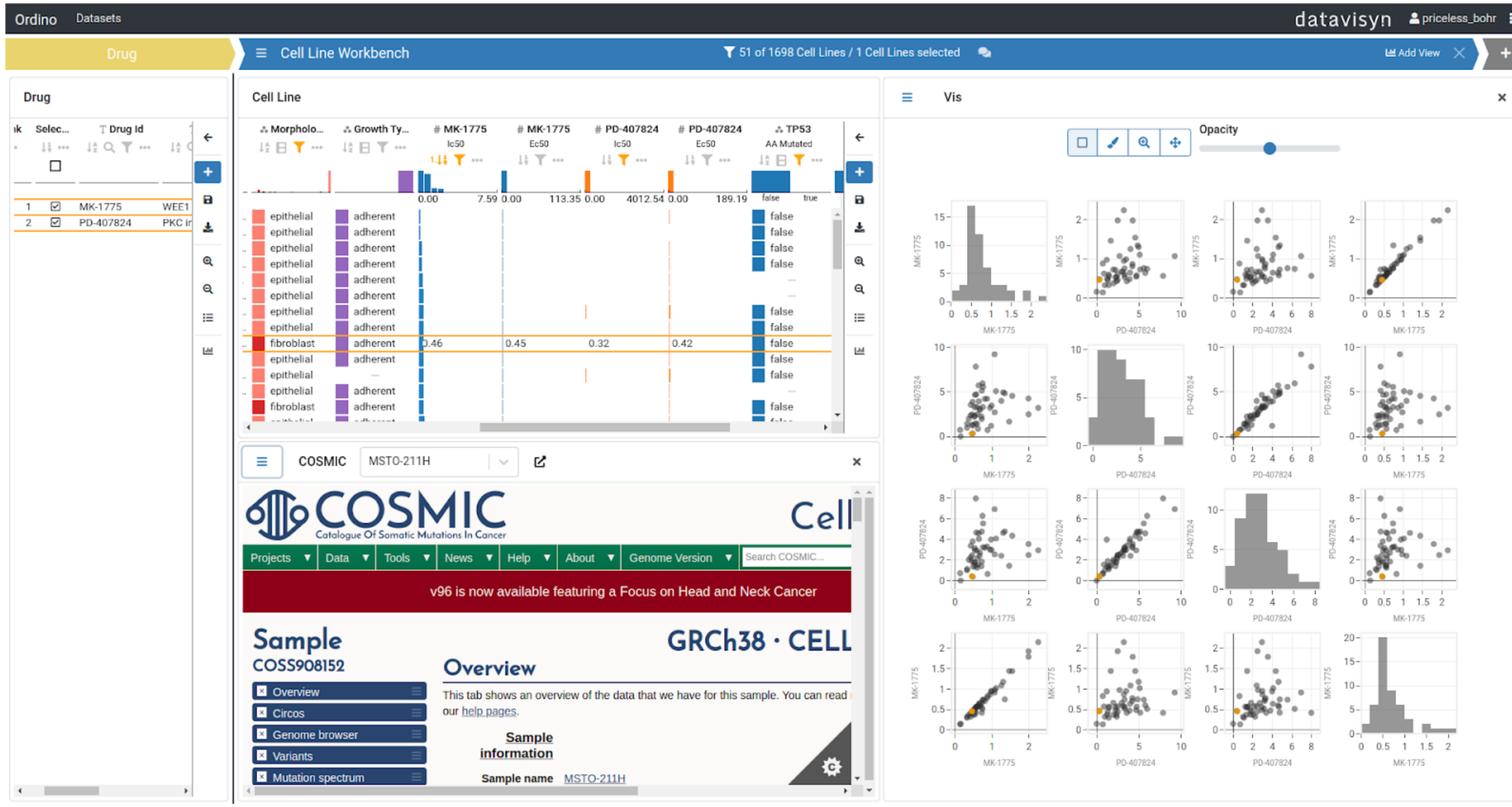
Datawrapper

Dashboards vs Analytical Multiple Views (MVs)

Exploratory vs Overview on current state

MVs have flexibility and complexity

- Choose view composition
- Choose data
- Choose visualization
- Custom Filters, etc.



Example of an Analytical Multiple Views (MVs) by datavisyn

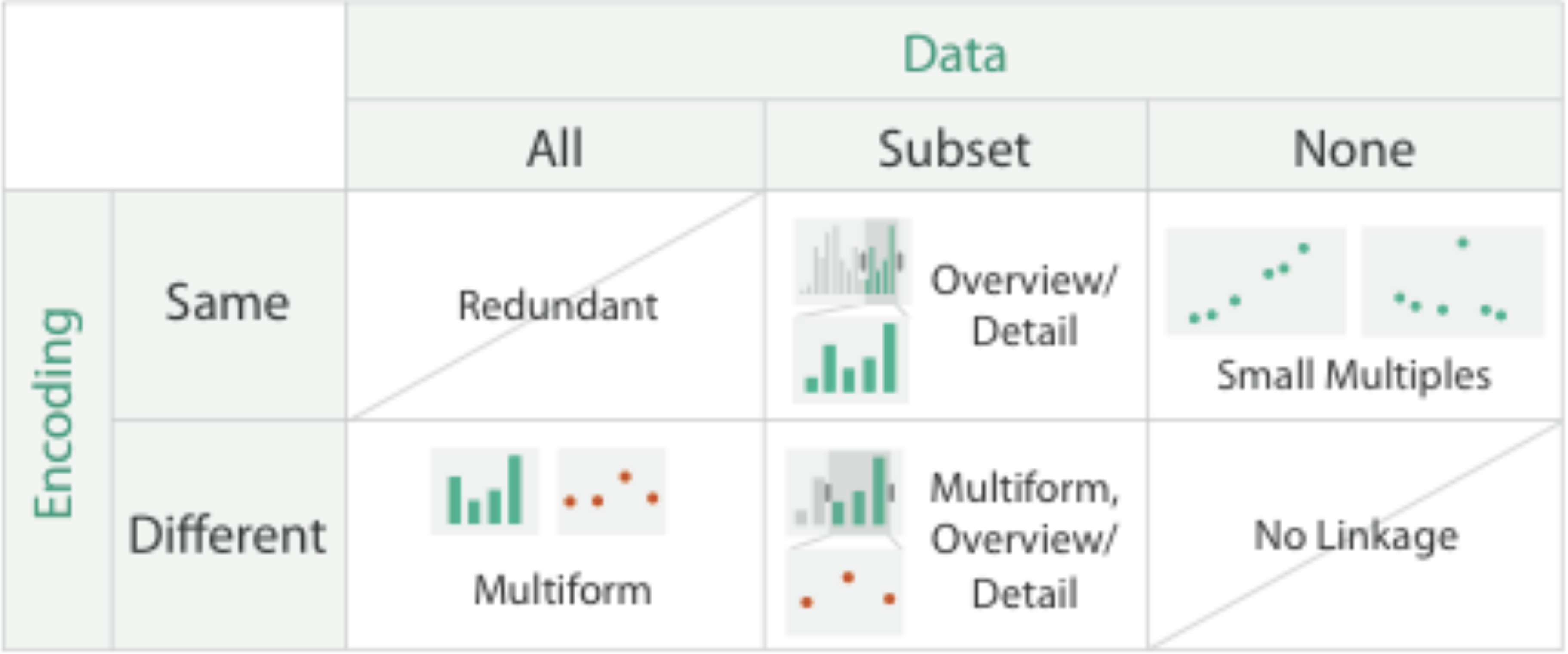
Systematic Analysis

Shared Encoding?

Shared Data?

All or Subset?

Shared Navigation?



Linked Views Options

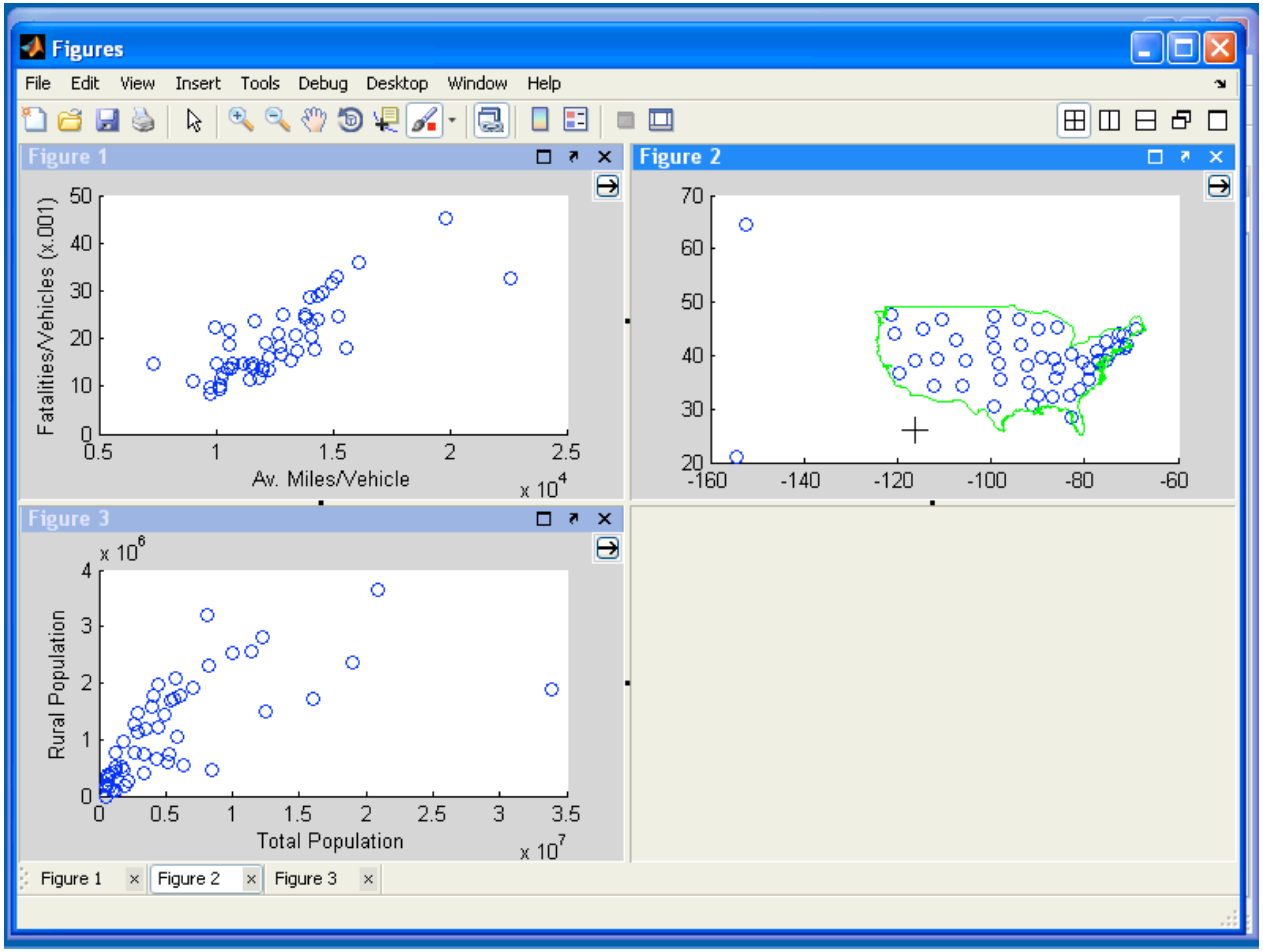
highlighting: to link, or not

navigation: to share, or not

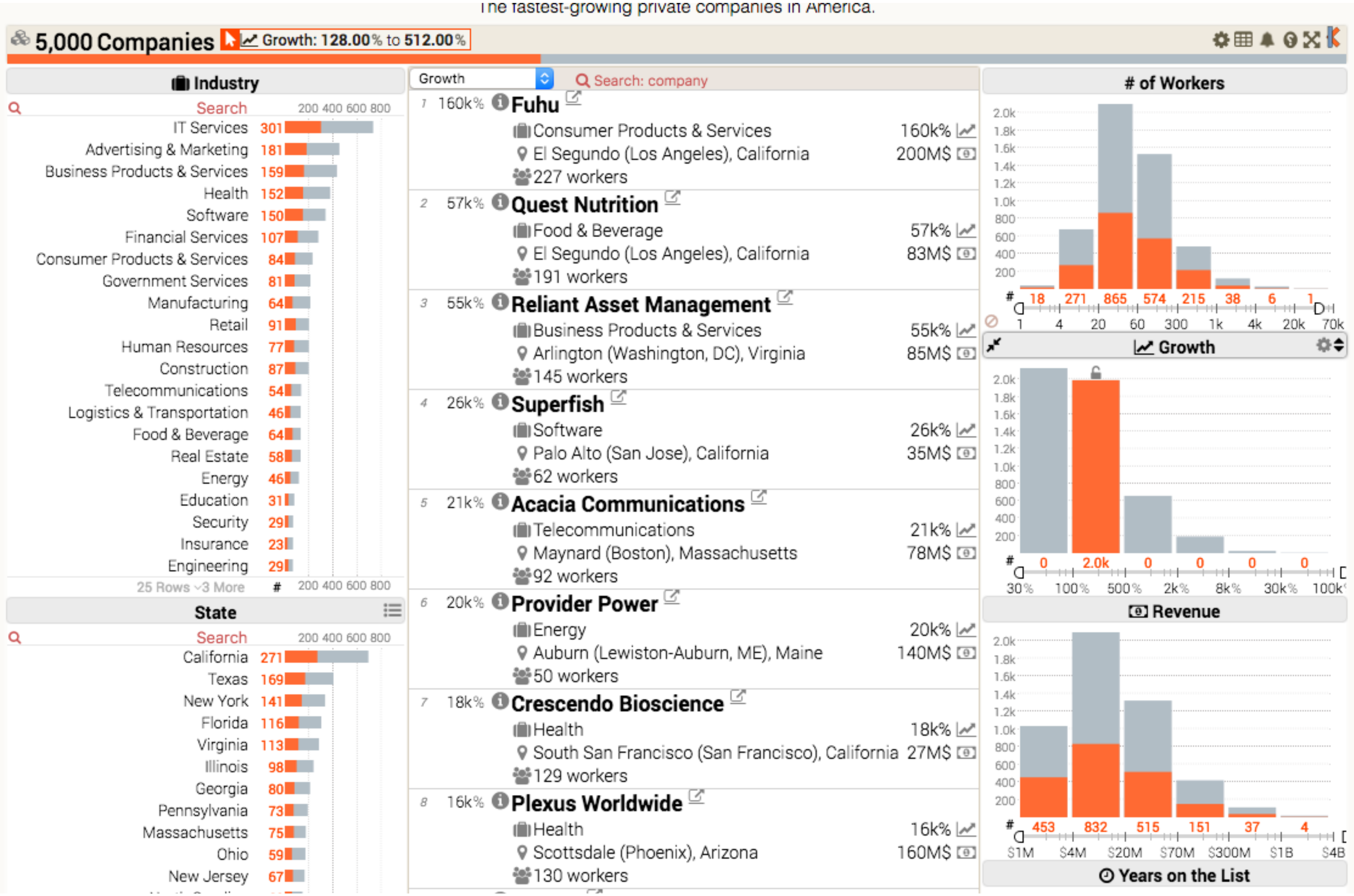
encoding: same or multiform

dataset: share all, subset, or none

Linked Highlighting



Linked Highlighting



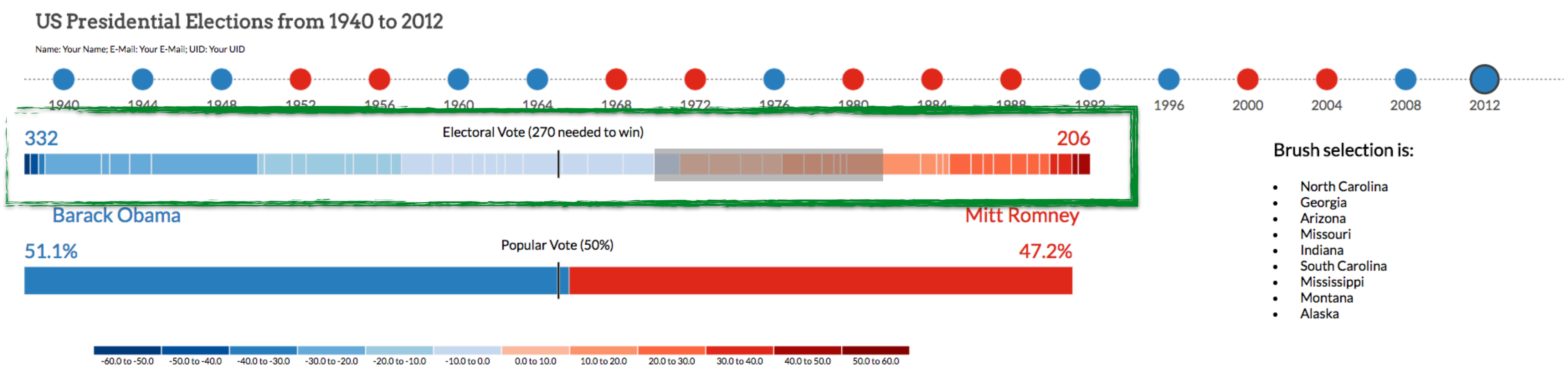
Multiform Views

difference visual encodings are used between the views

- implies shared data
- either all data
- or subset of data (overview + detail)

rational:
single, monolithic view has strong limits on the number of attributes that can be shown simultaneously

different views support different tasks

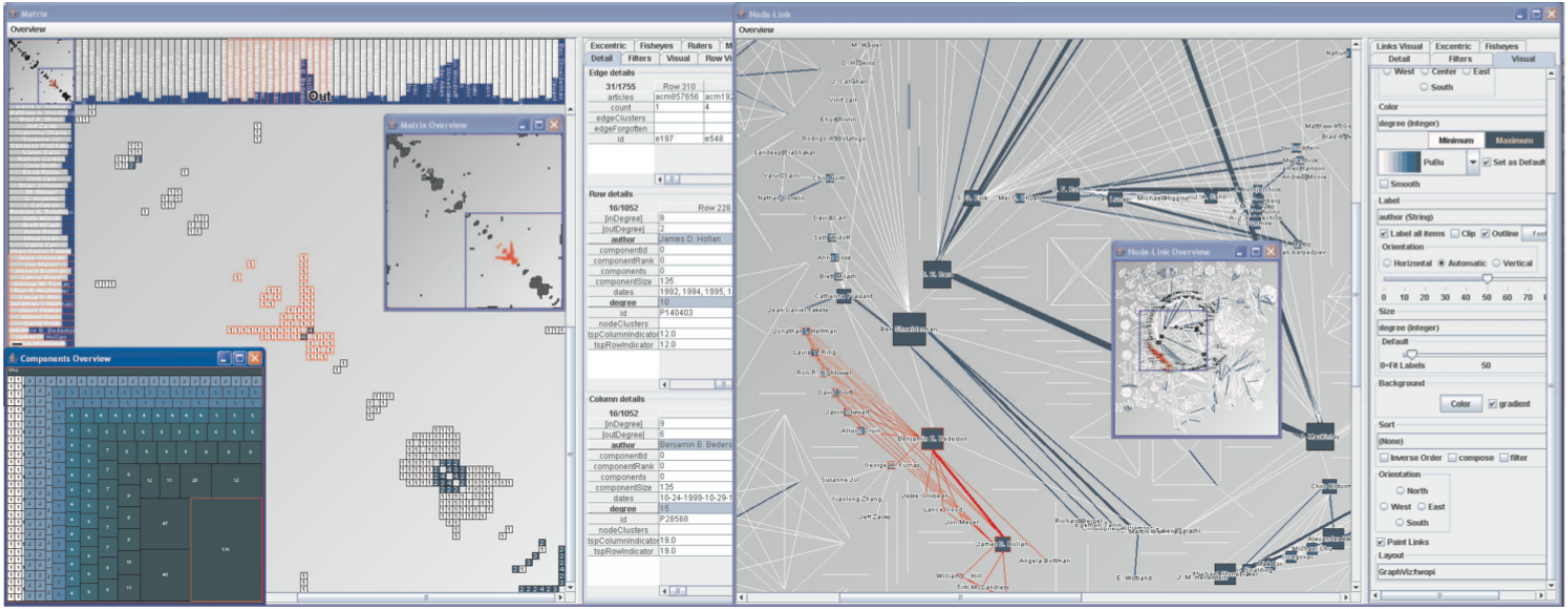


Multiform

Different Views

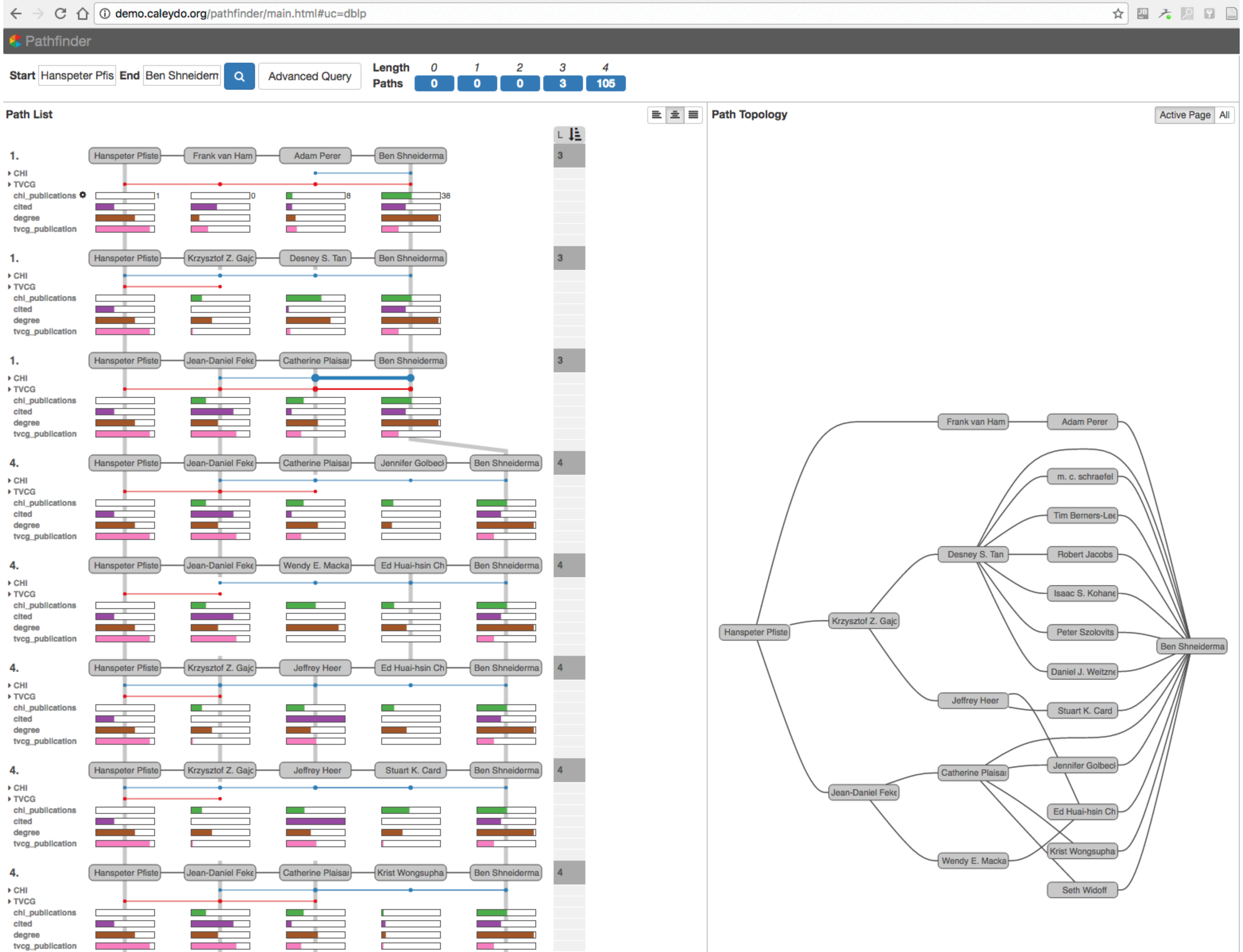
here also same data

MatrixExplorer



Same Data - Different Idioms (Multiform)

Henry 2006


demo.caleydo.org/pathfinder/main.html#uc=dblp
Pathfinder
Start Hanspeter Pfis End Ben Shneiderm
Advanced Query
Length 0 1 2 3 4
Paths 0 0 0 3 105
Path List
Path Topology
Active Page All
Hanspeter Pfiste
Frank van Ham
Adam Perer
Ben Shneiderma
Krzysztof Z. Gajc
Desney S. Tan
Jean-Daniel Feke
Catherine Plaisai
Jennifer Golbeci
Wendy E. Macka
Ed Huai-hsin Ch
Jeffrey Heer
Stuart K. Card
Krist Wongsupha
m. c. schraefel
Tim Berners-Lee
Robert Jacobs
Isaac S. Kohane
Peter Szolovits
Daniel J. Weitzne
Seth Widoff
CHI
TVCG
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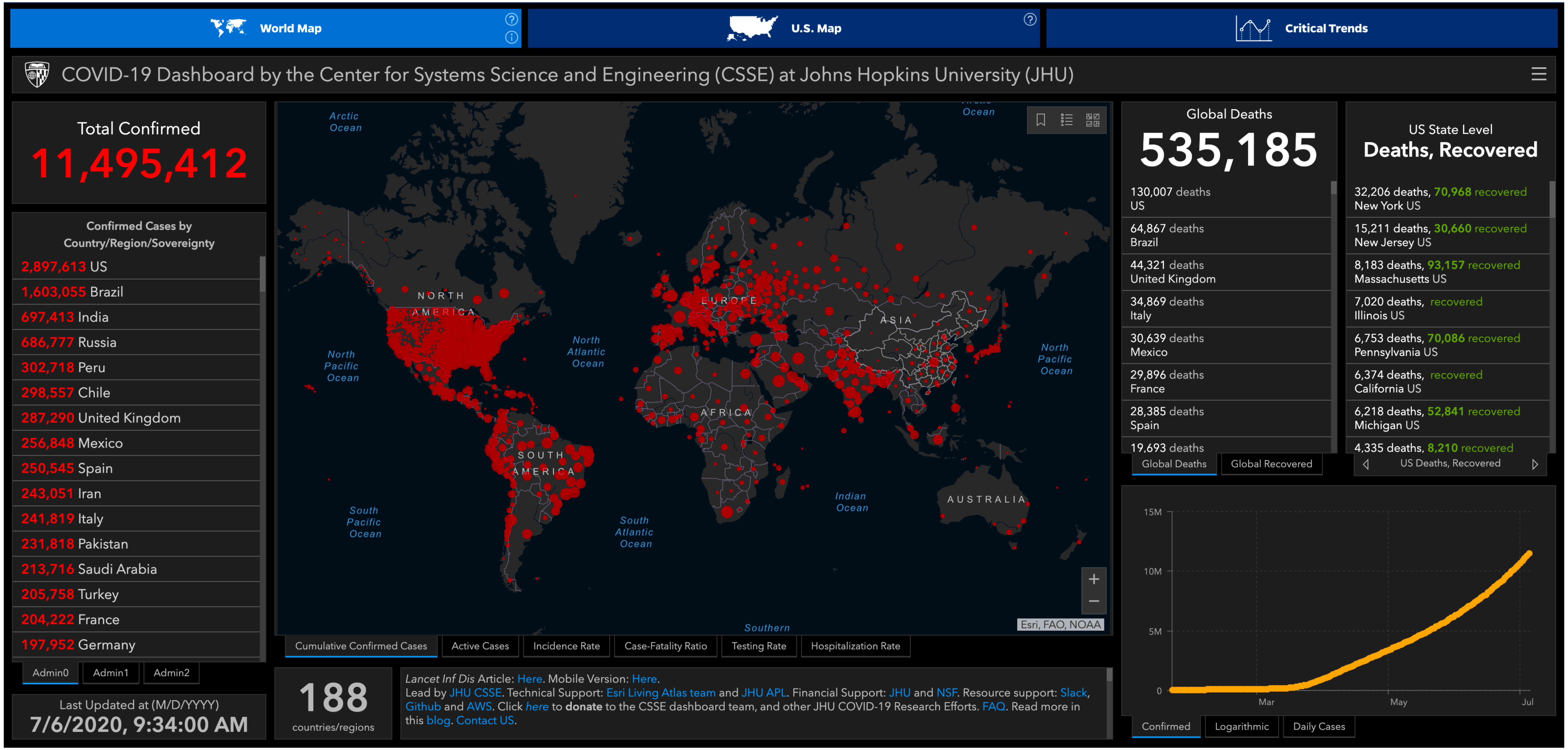
Design Critique

Johns Hopkins COVID-19 Dashboard

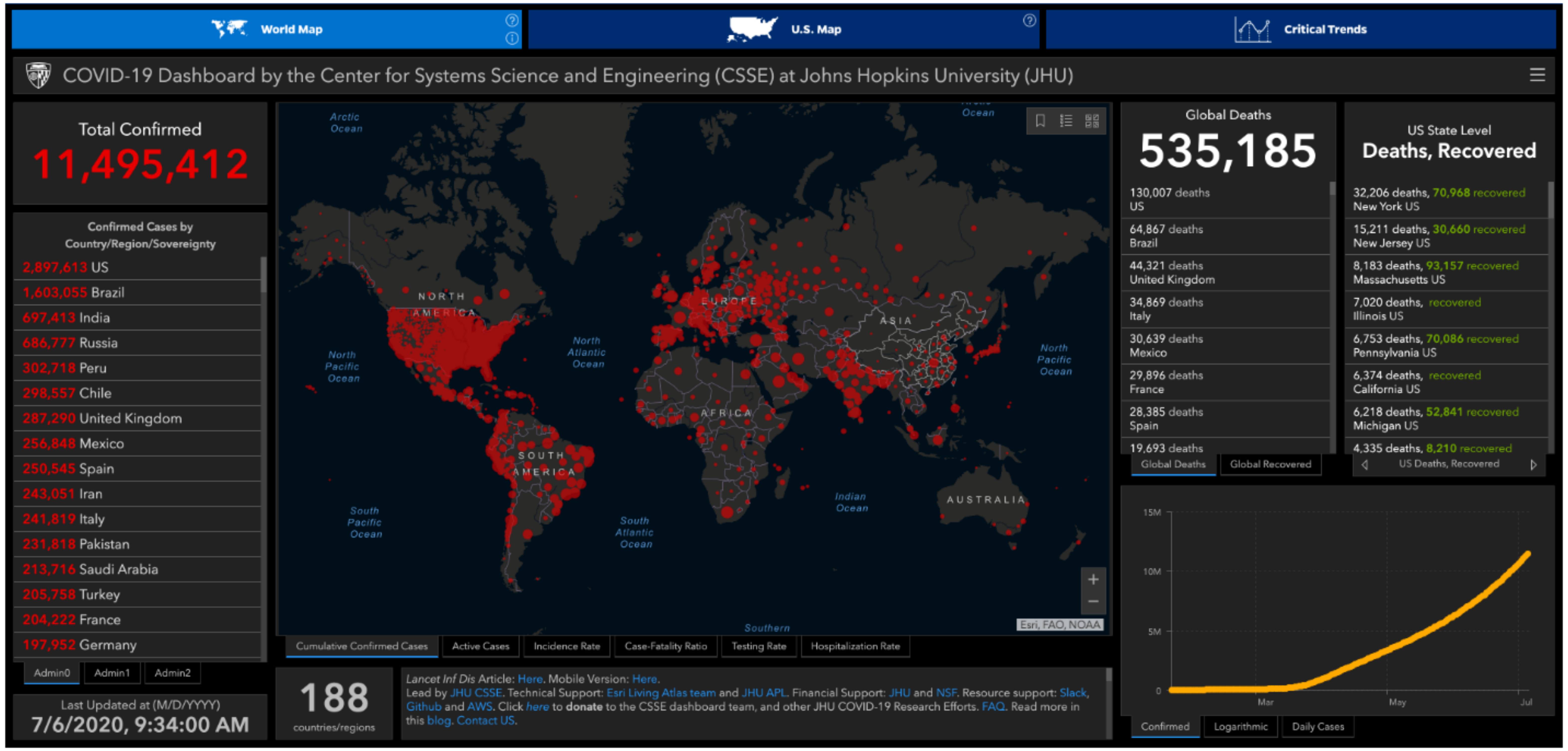


The Case Against Dashboards (when Visualizing a Pandemic)

Alexander Lex

July 6, 2020

tldr: Using dashboards comes with risks: they leave out critical context by over-simplifying and hence give false certainty. A more nuanced approach including interpreation by experts, and showing multiple perspectives is needed when visualizing data for something as complex as the COVID-19 pandemic.



Source: Screenshot of https://coronavirus.jhu.edu/map.html, taken on July 6, 2020.

https://vdl.sci.utah.edu/blog/2020/07/06/dashboards/

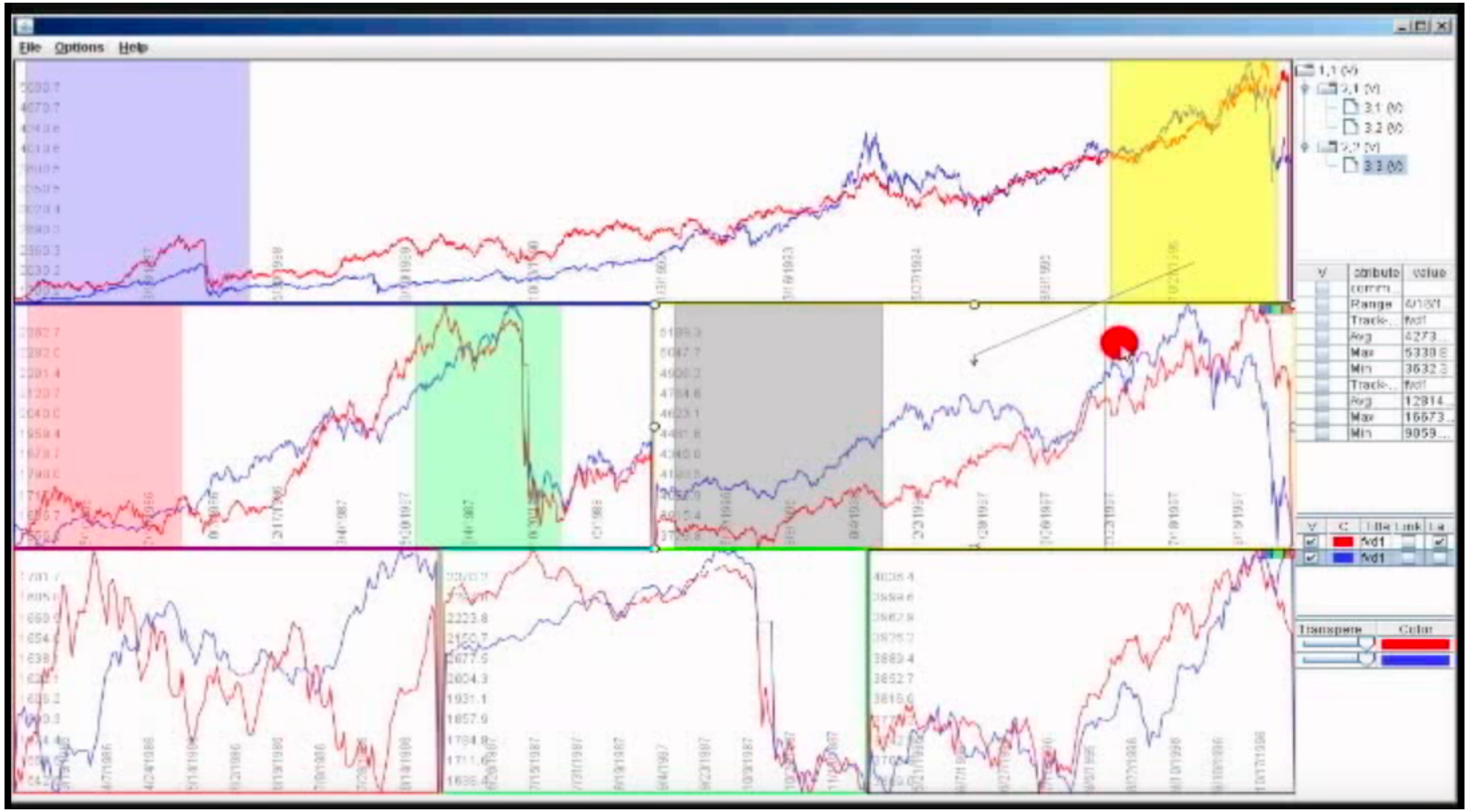
OVERVIEW + DETAIL

one view shows (often summarized) information about entire dataset, while additional view(s) shows more detailed information about a subset of the data

rational

for large or complex data, a single view of the entire dataset cannot capture fine details

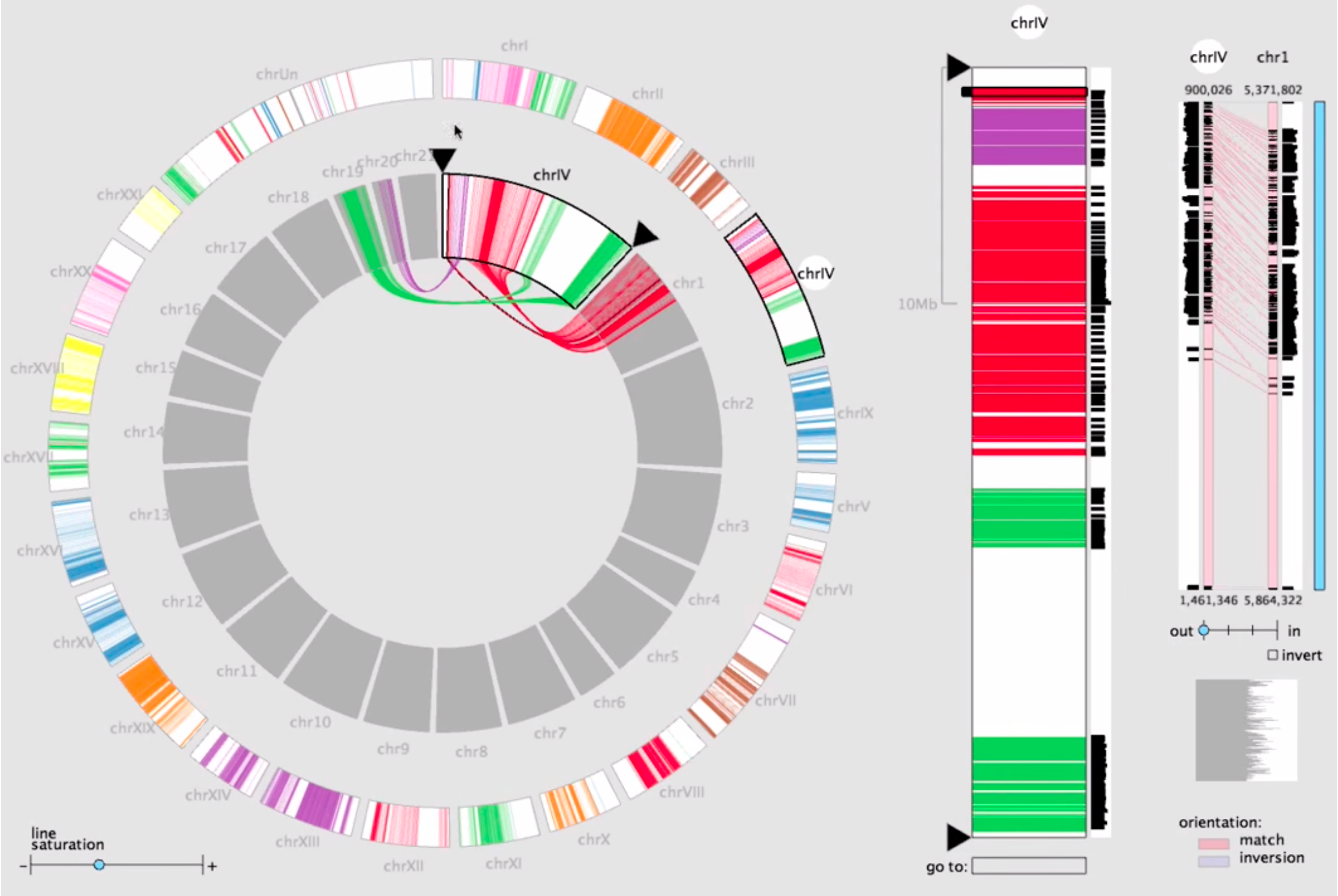
Stack Zooming



Same Data - Same Encoding, Different Resolution

[Javed & Emlqvist, PacificVis, 2010]

MizBee

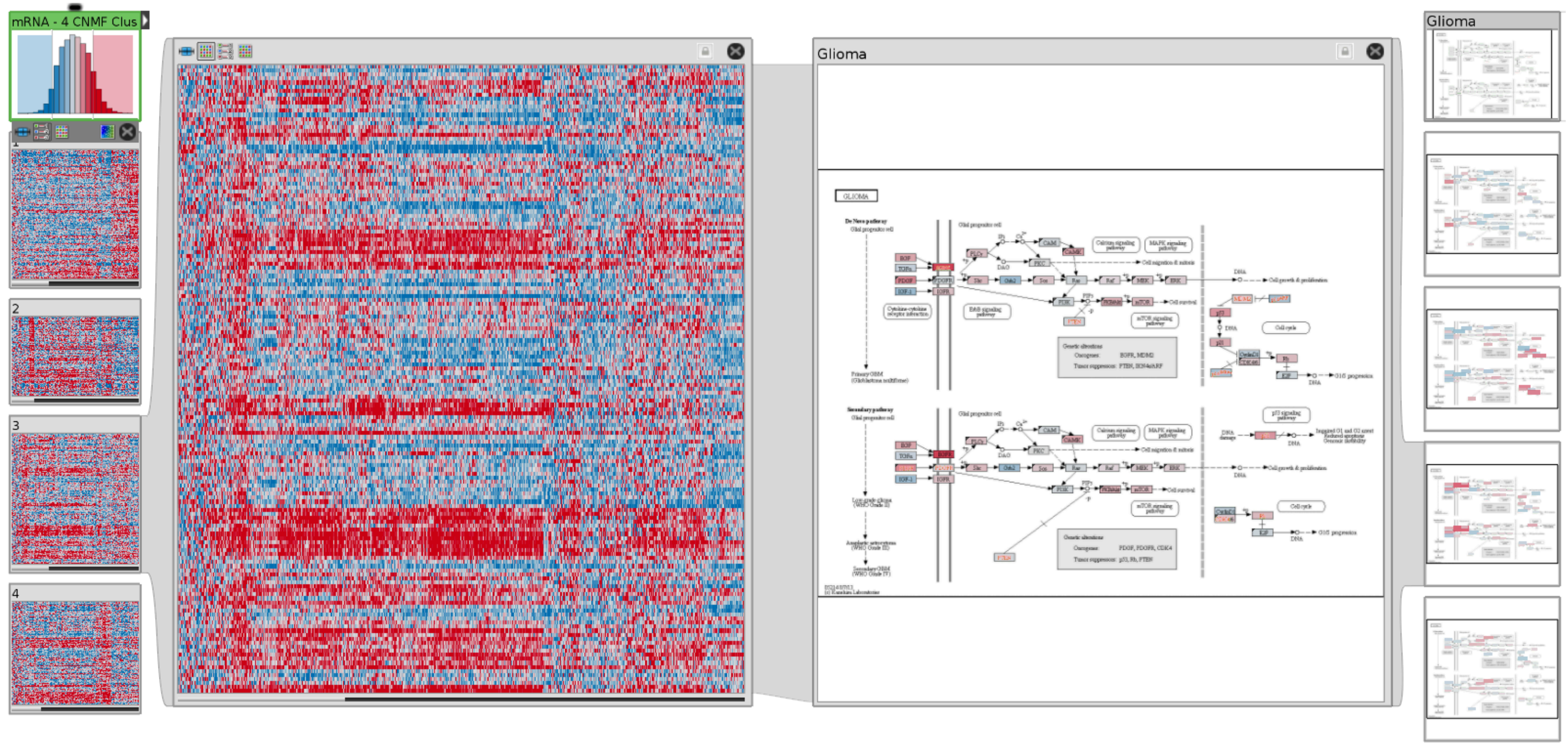


Multiform Overview

& Detail

[Meyer 2009]

StratomeX



SMALL MULTIPLES

each view uses the same visual encoding, but shows a different subset of the data

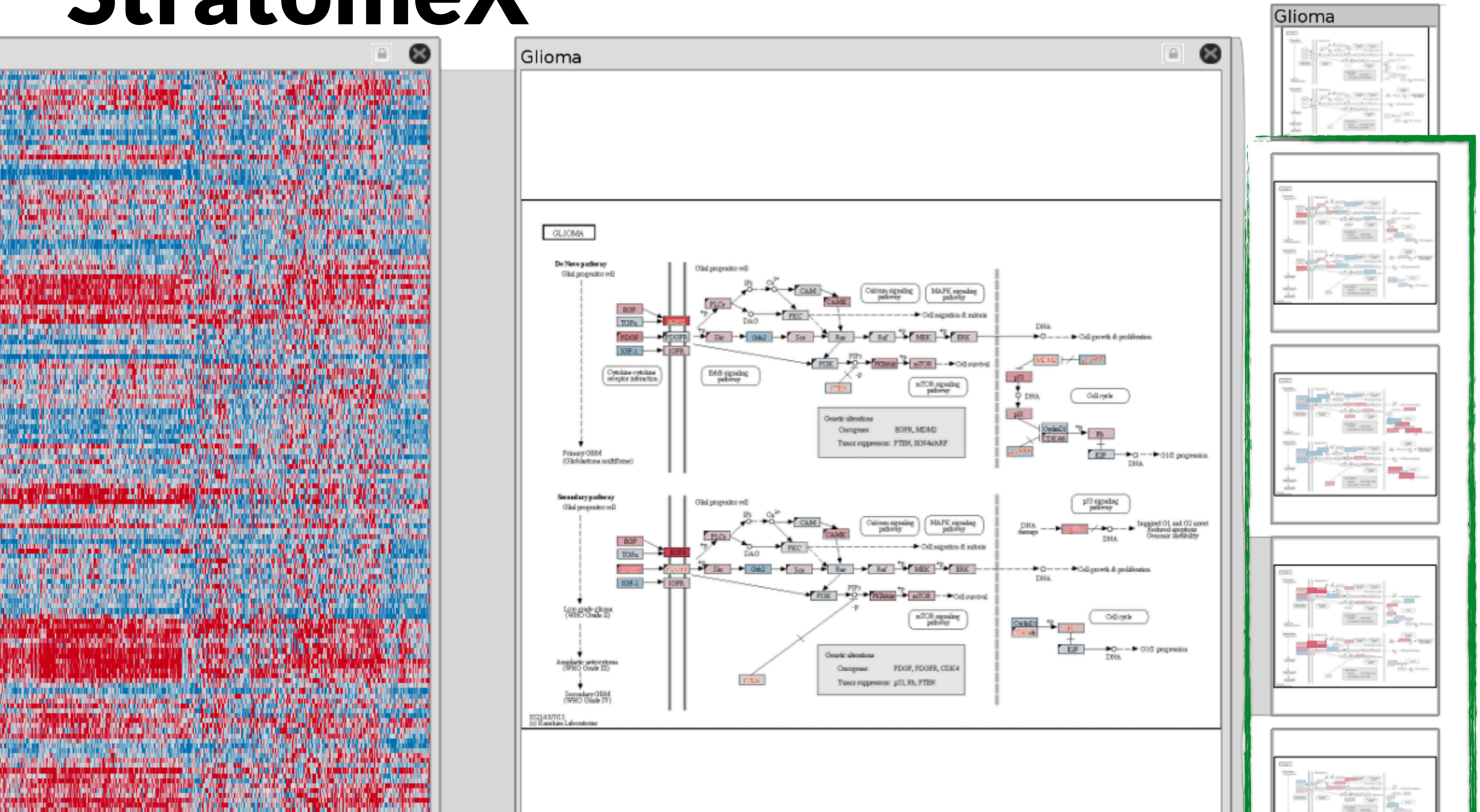
rational

quickly compare different parts of a data set, relying on eyes instead of memory

Small Multiples for Graph Attributes

[Barsky, InfoVis 2008]

StratomeX



Partitioning

PARTITIONING

action on the dataset that **separates the data into groups**

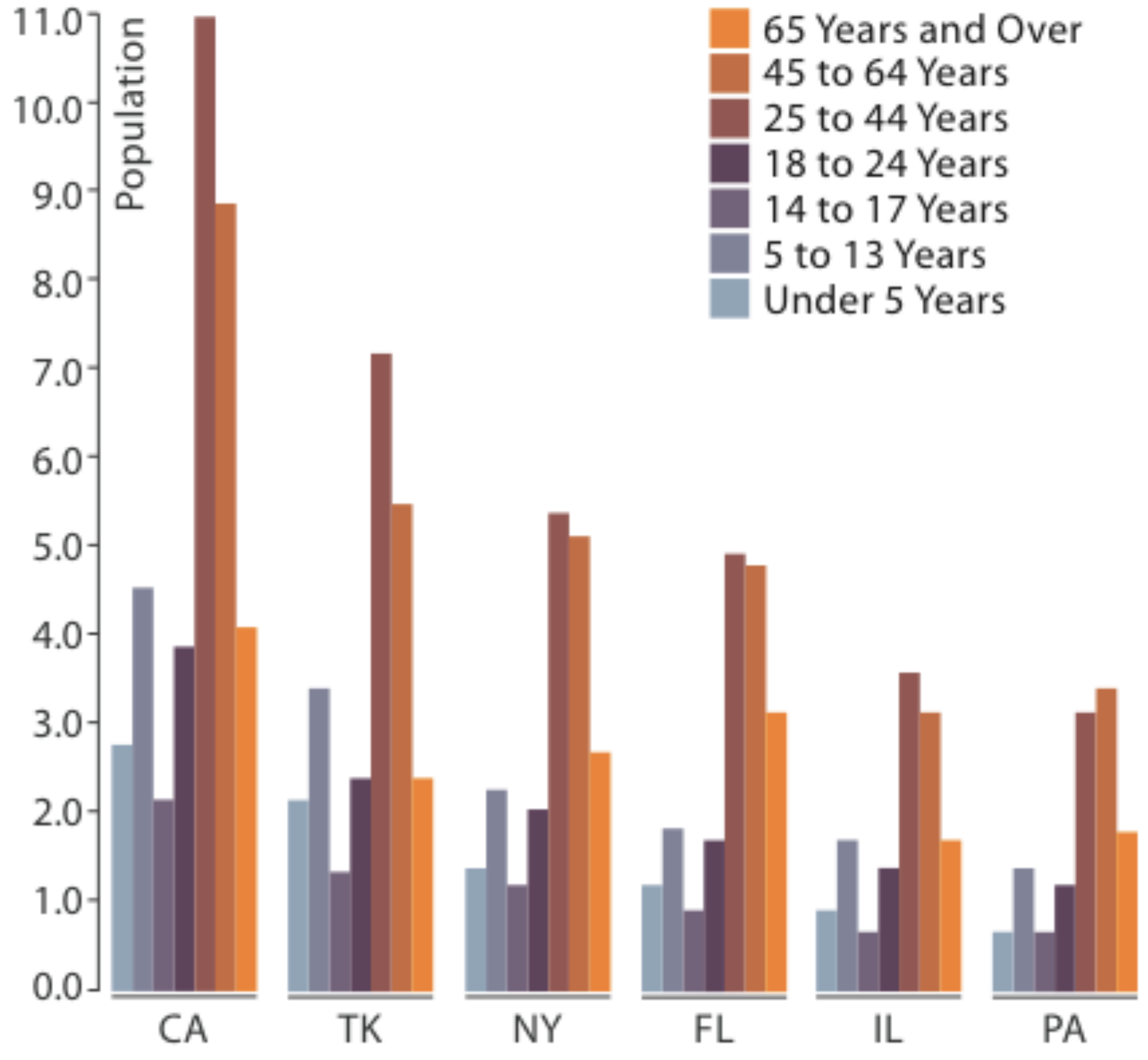
design choices

- how to divide data up between views, given a hierarchy of attributes
- how many splits, and order of splits
- how many views (usually data driven)

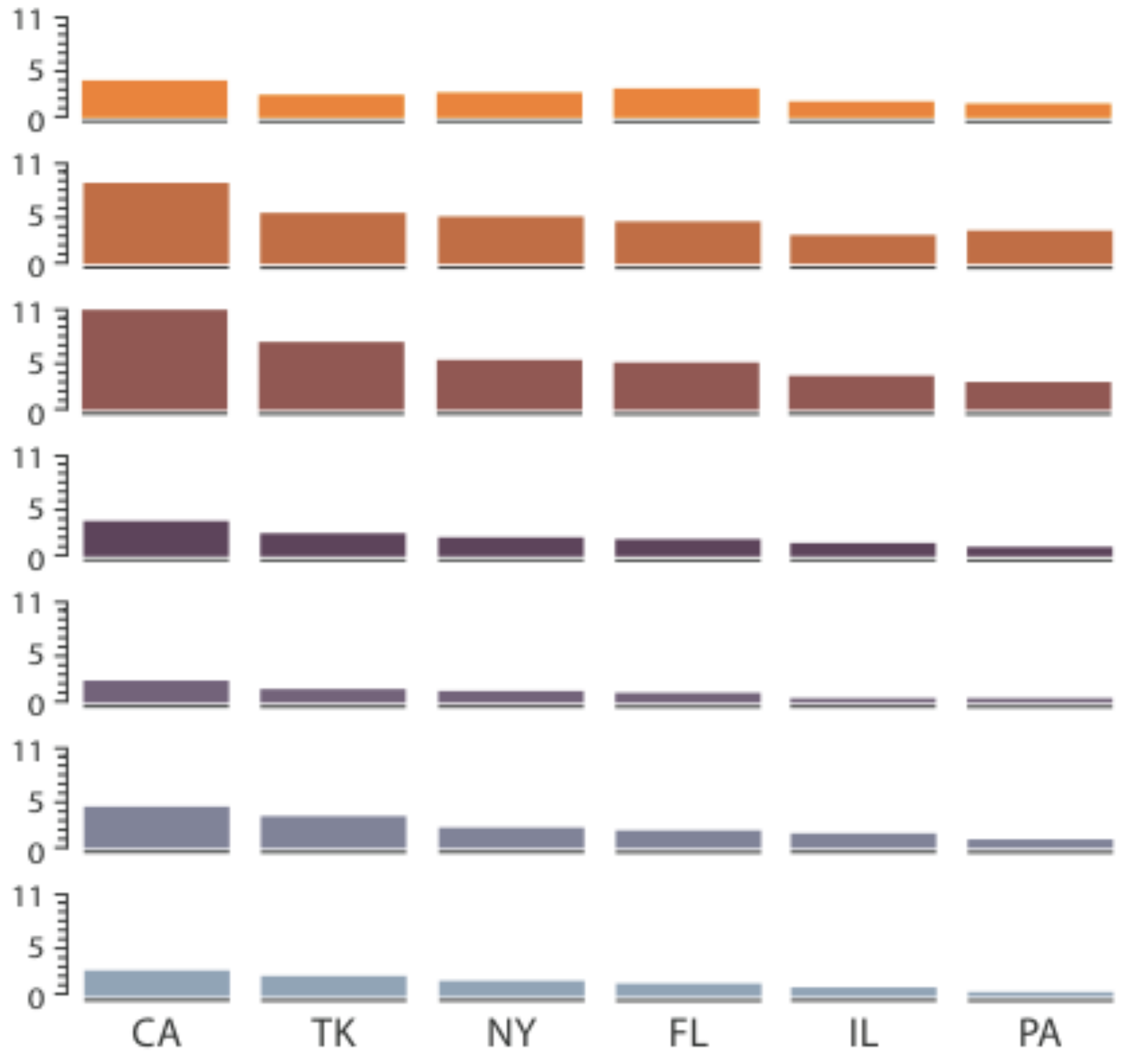
partition attribute(s)

- typically categorical

Partitioning - Age Distribution by State

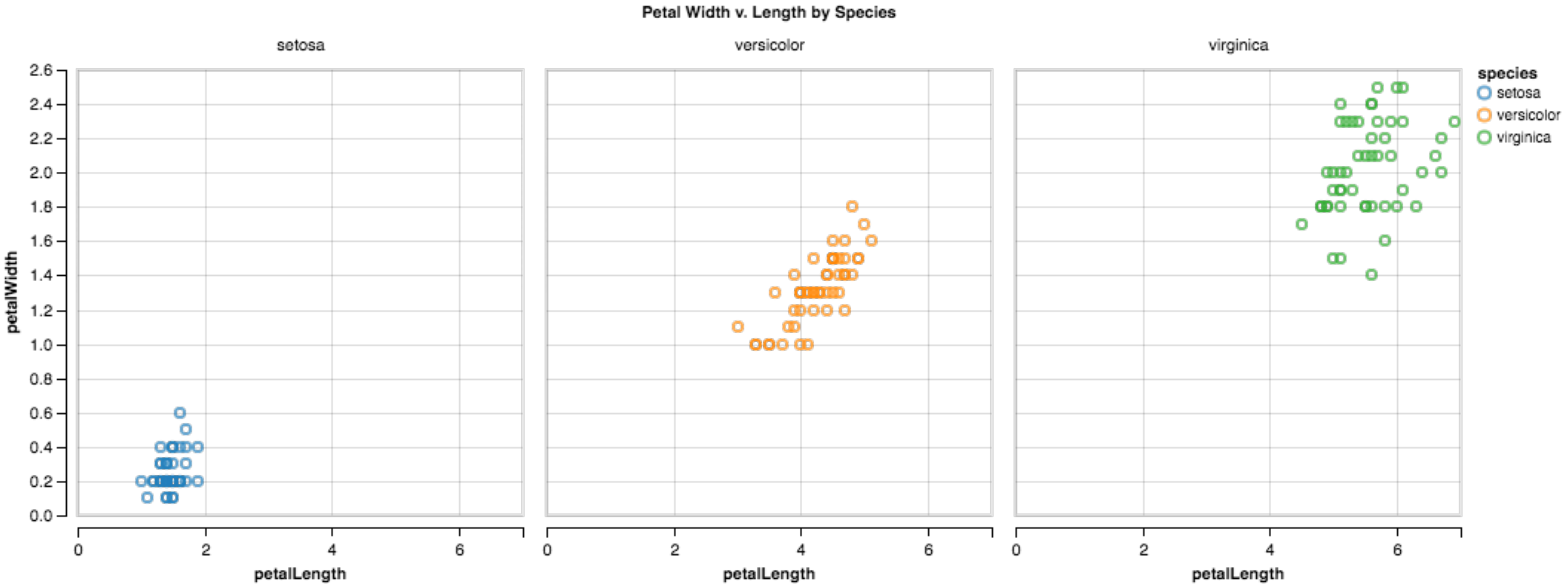


Partitioned by State



Partitioned by Age Group and State

Partition by Category



Trellis Plots

panel variables

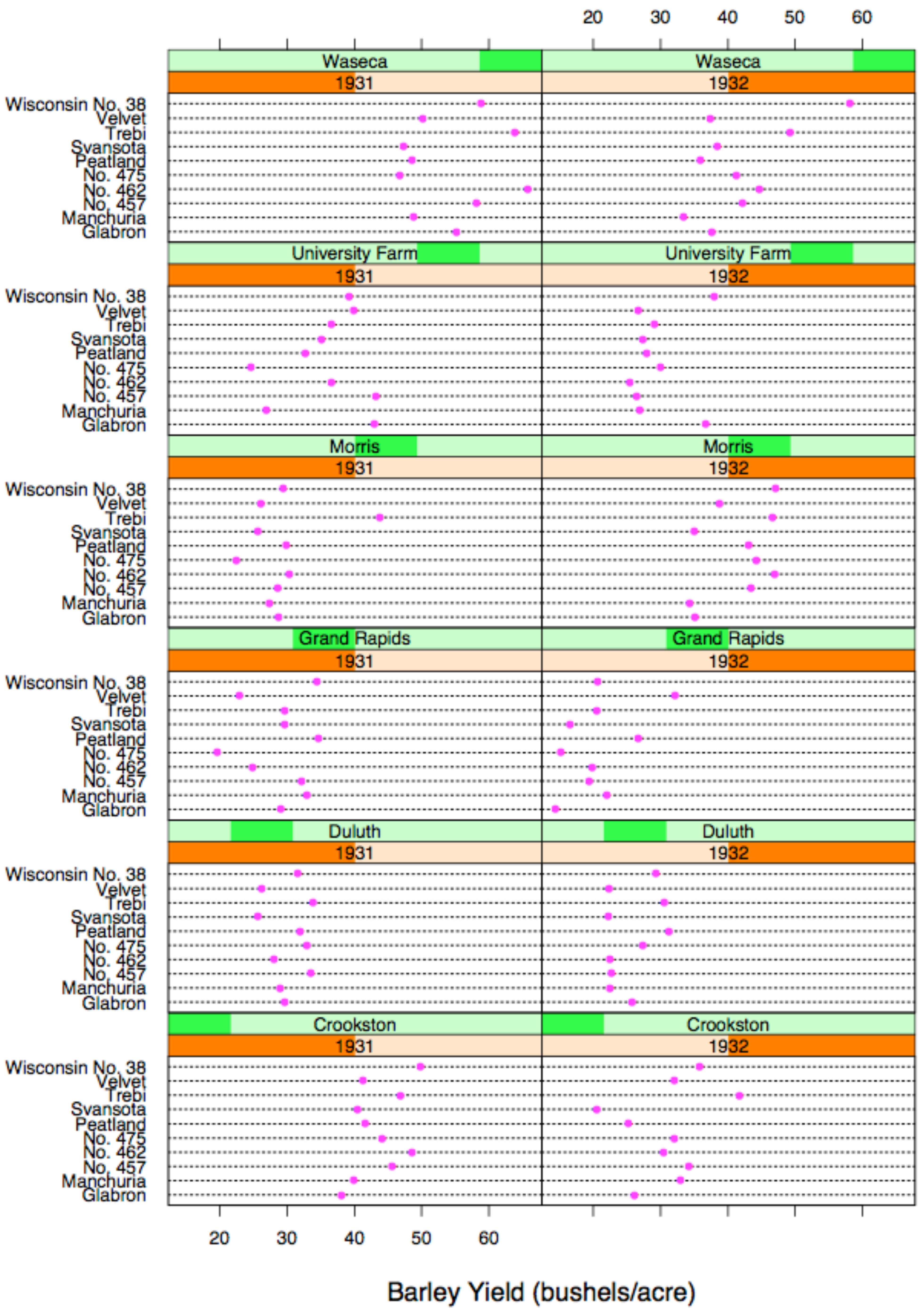
- attributes encoded in individual views

partitioning variables

- partitioning attributes assigned to columns and rows

main-effects ordering

- order partitioning variable based on derived data
- support perception of trends and structure in data



Data

Barley Yields in two years across multiple farms for multiples barley strains

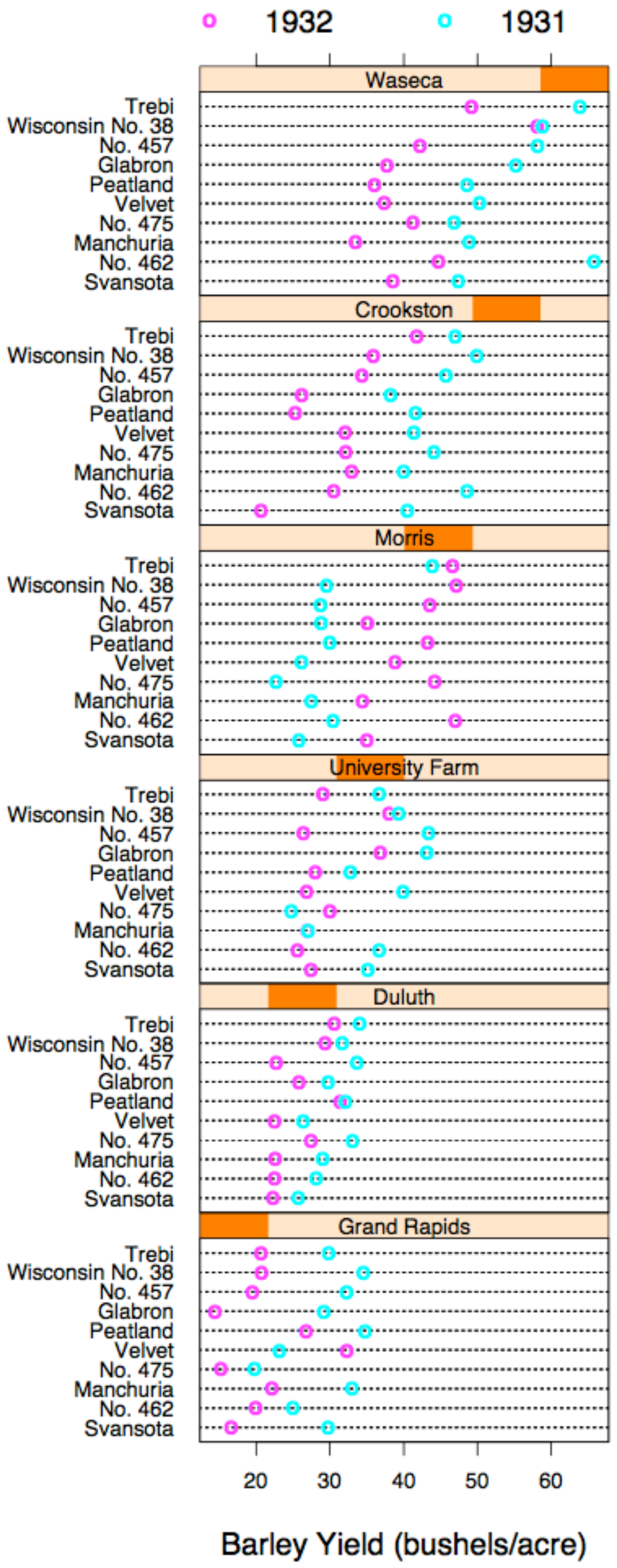
partitioning variables

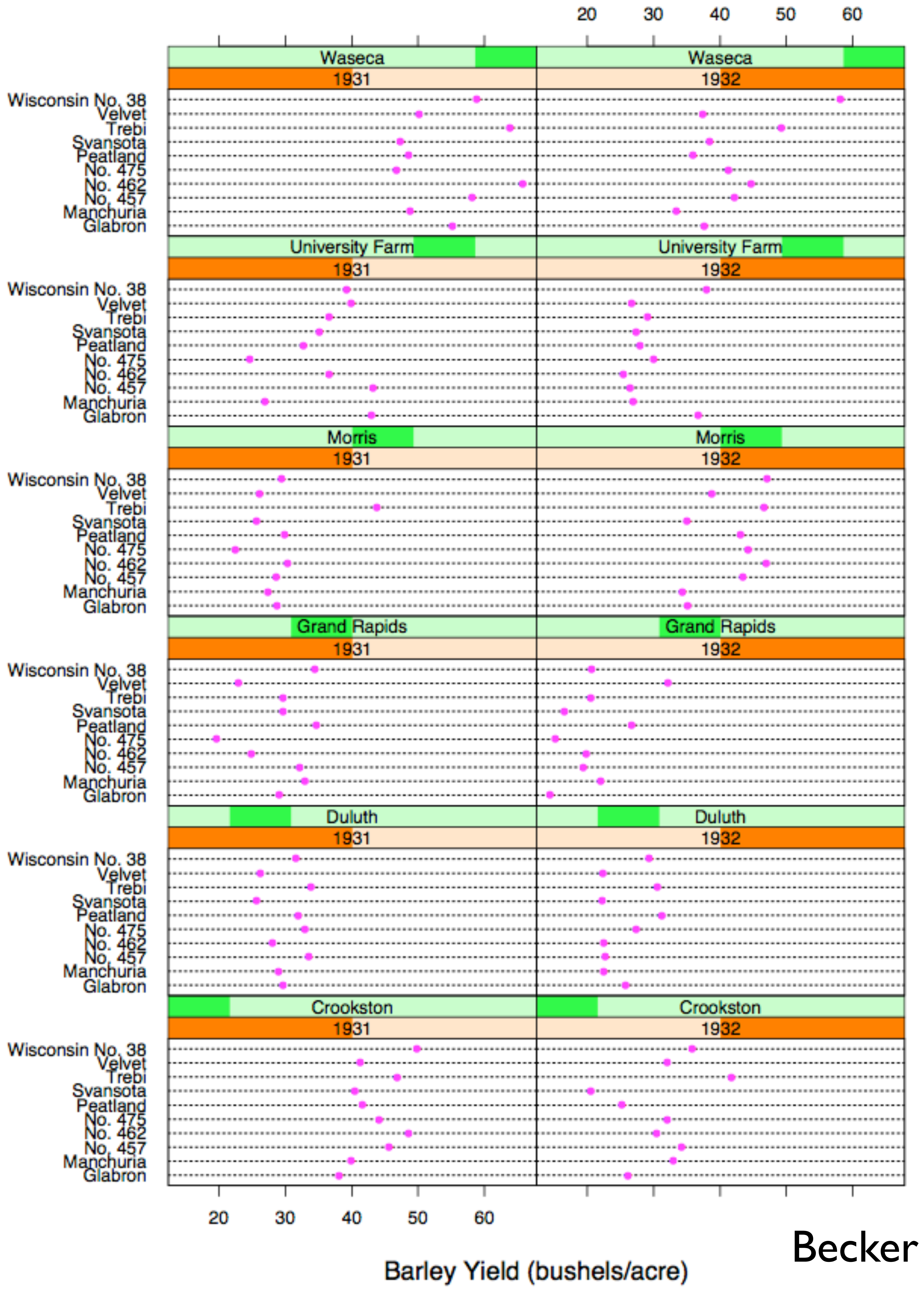
Columns partitioned by year

Rows partitioned by farm

Becker 1996

Superimposition vs Juxtaposition



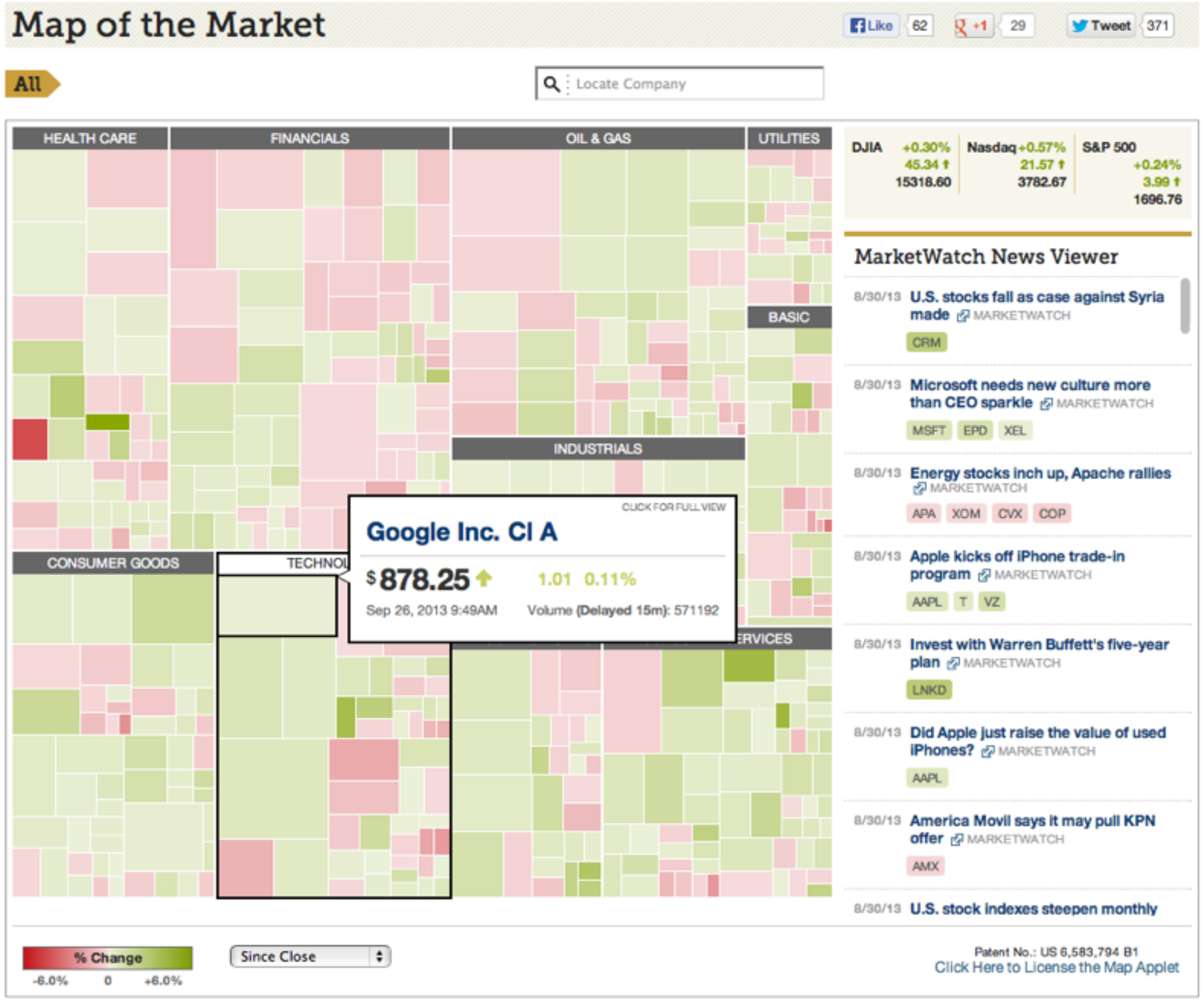


Becker 1996

Recursive Subdivision

partitioning: flexibly transform data attributes into a hierarchy

use treemaps as spacefilling rectangular layouts



Treemap

HiVE example: London property

partitioning attributes

house type

neighborhood

sale time

encoding attributes

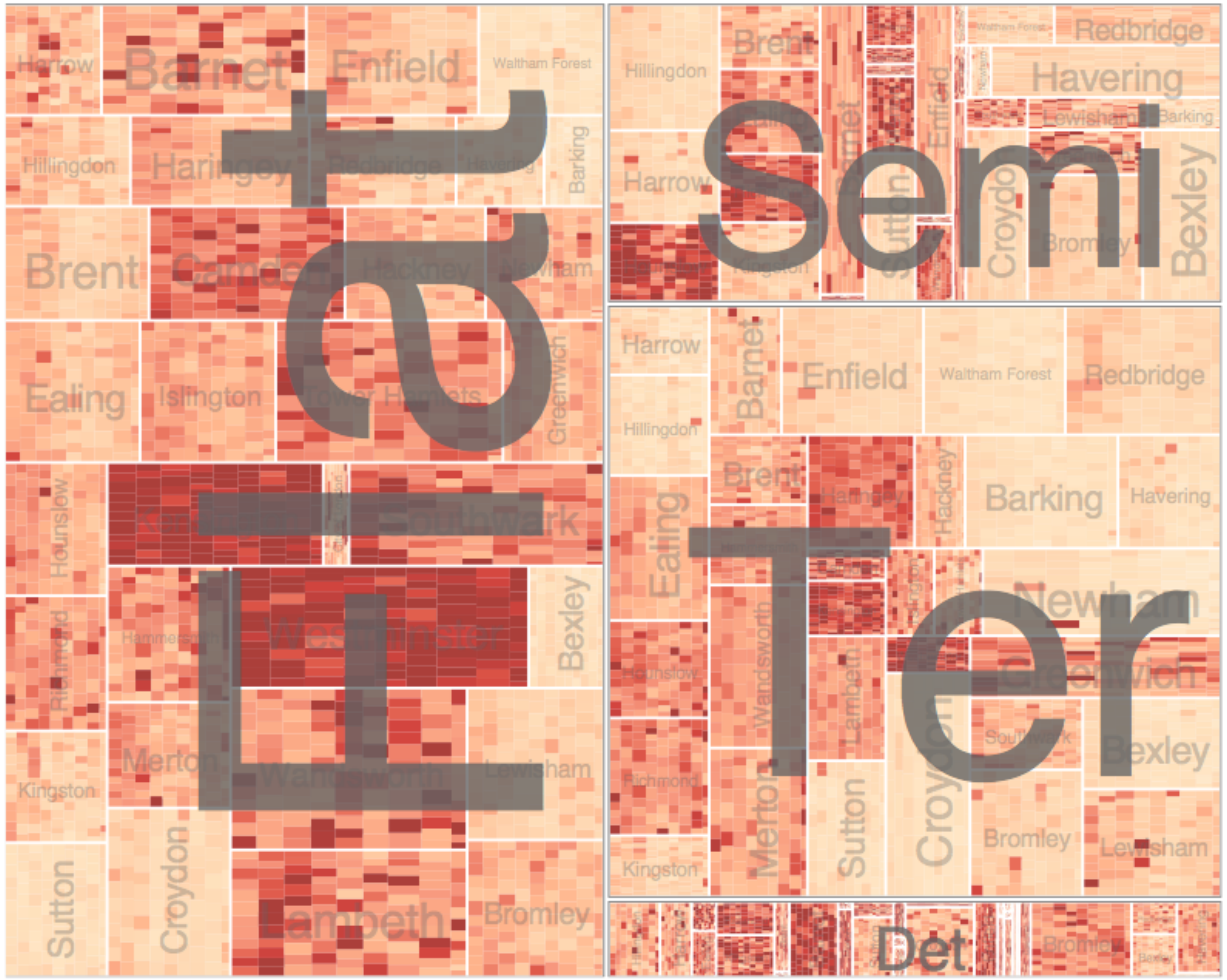
average price (color)

number of sales (size)

results

between neighborhoods, different housing distributions

within neighborhoods, similar prices



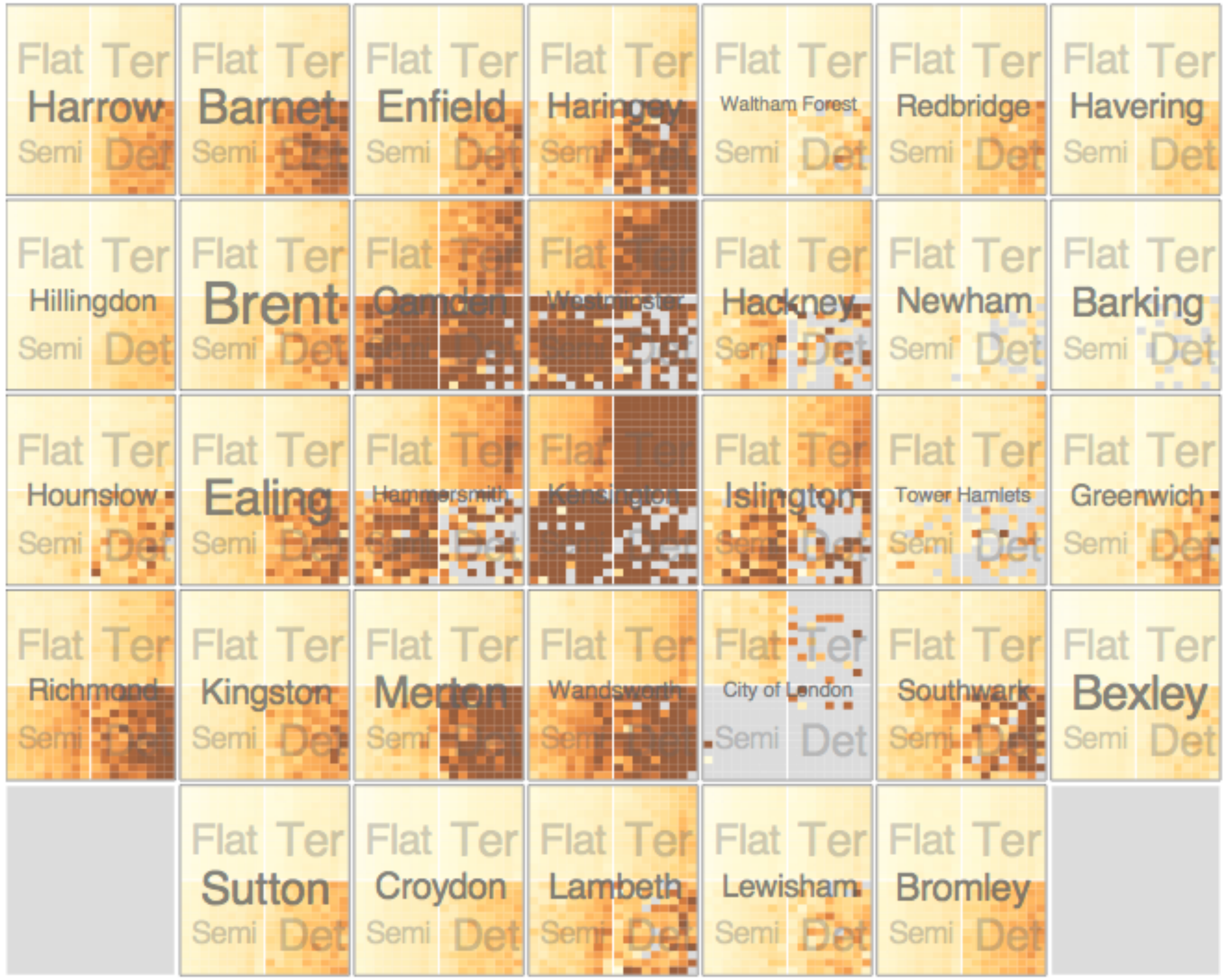
Slingsby 2009

HiVE example: London property

partitioning attributes
neighborhood
house type
sale time (year)
sale time (month)

encoding attributes
neighborhood location
(approximate)
average price (color)
n/a (size)

results
expensive neighborhoods near center of city



Slingsby 2009

Configuring Hierarchical Layouts to Address Research Questions

CITY UNIVERSITY LONDON

Aidan Slingsby, Jason Dykes and Jo Wood
giCentre, Department of Information Science, City University London
http://www.gicentre.org/hierarchical_layouts/

CITY UNIVERSITY LONDON

https://vimeo.com/9870257

LAYERING

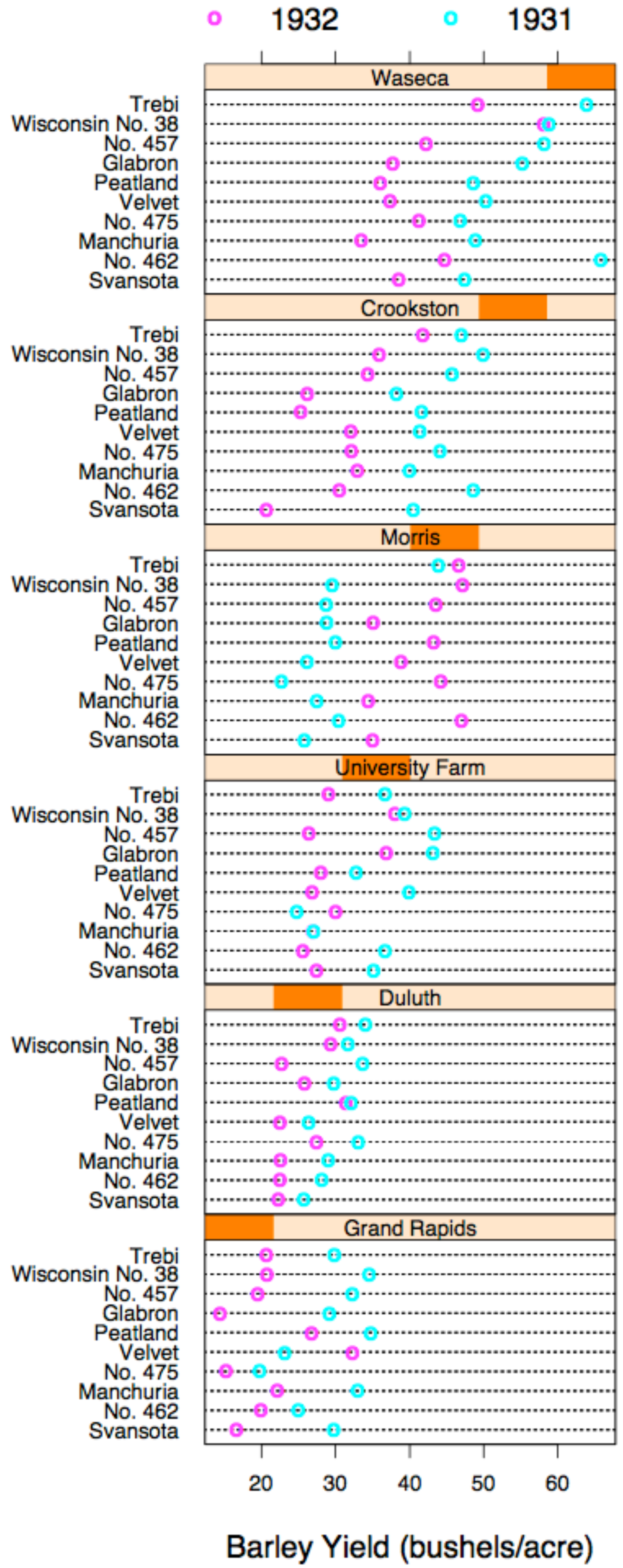
combining multiple views on top of one another to form a composite view

rational

supports a larger, more detailed view than using multiple views

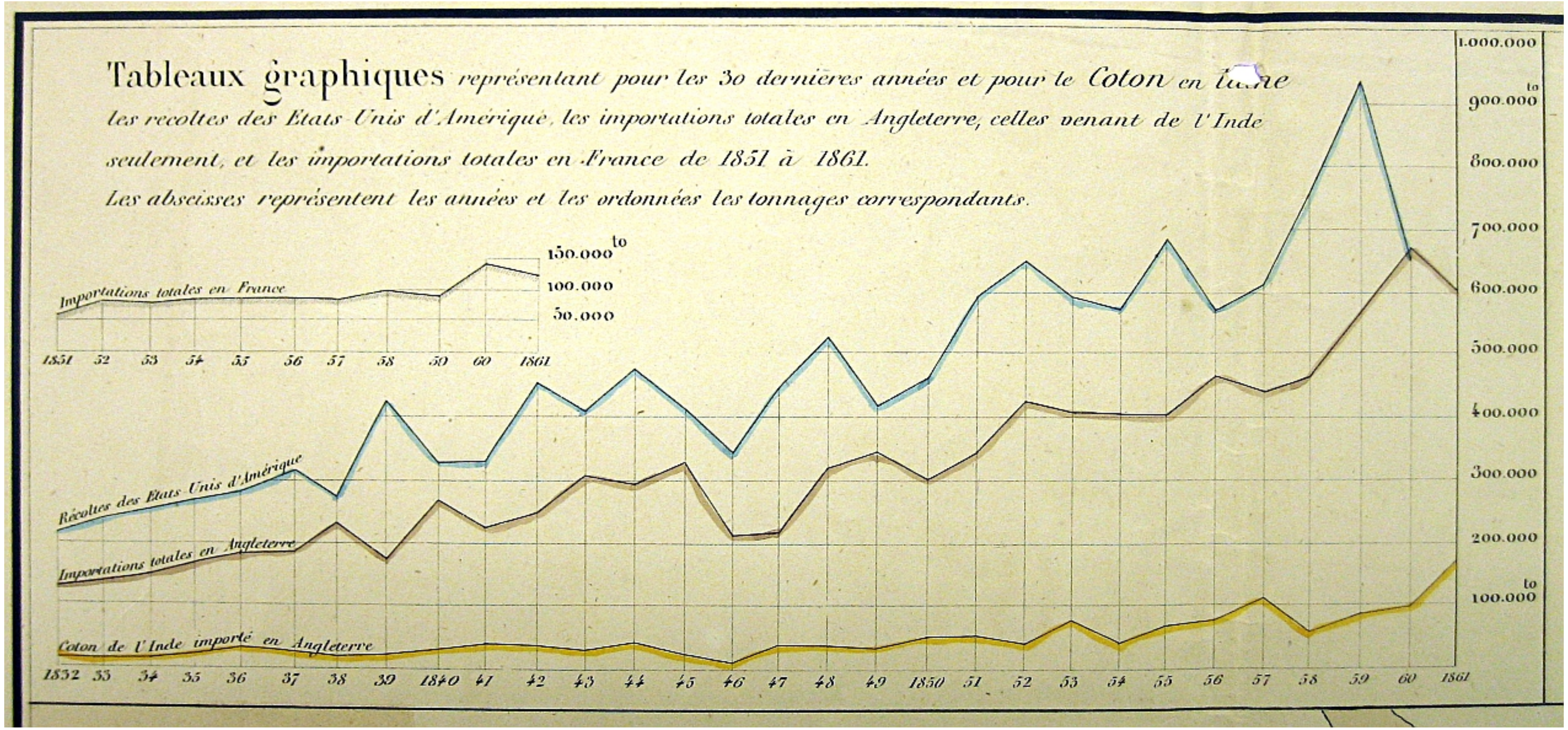
trade-off

layering imposes constraints on visual encoding choice as well as number of layers that can be shown

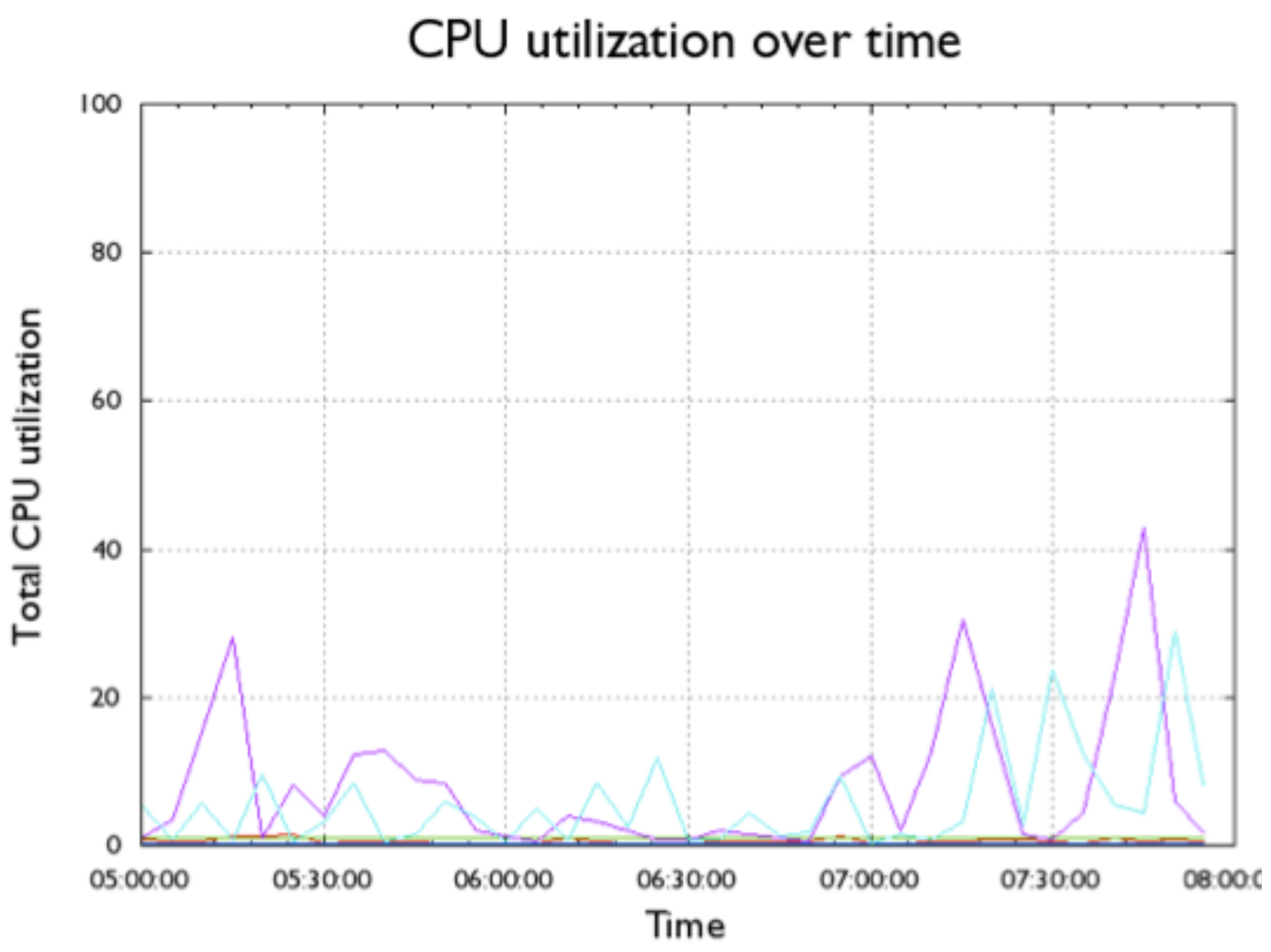


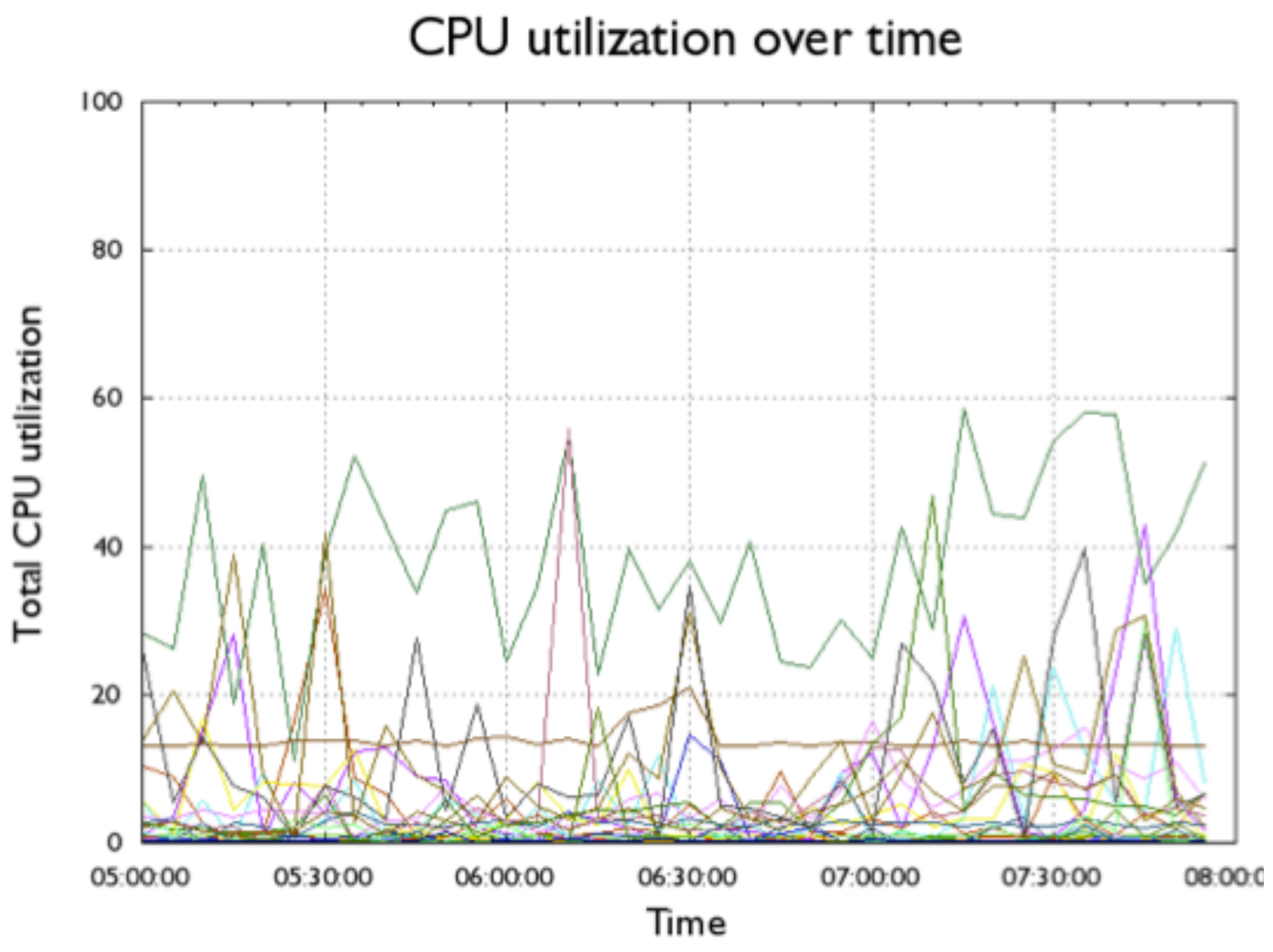
JOSEPH MINARD

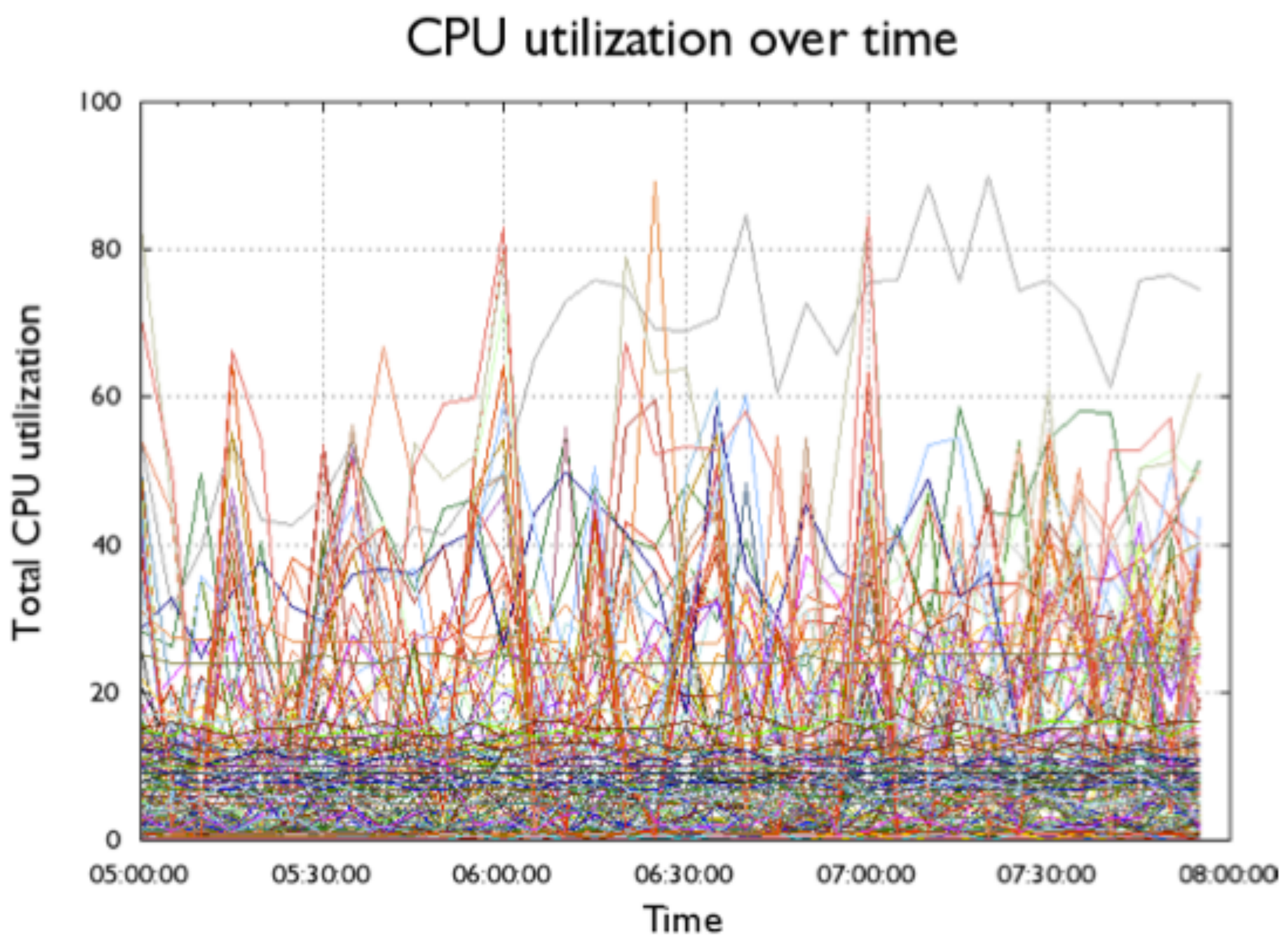
1781-1870



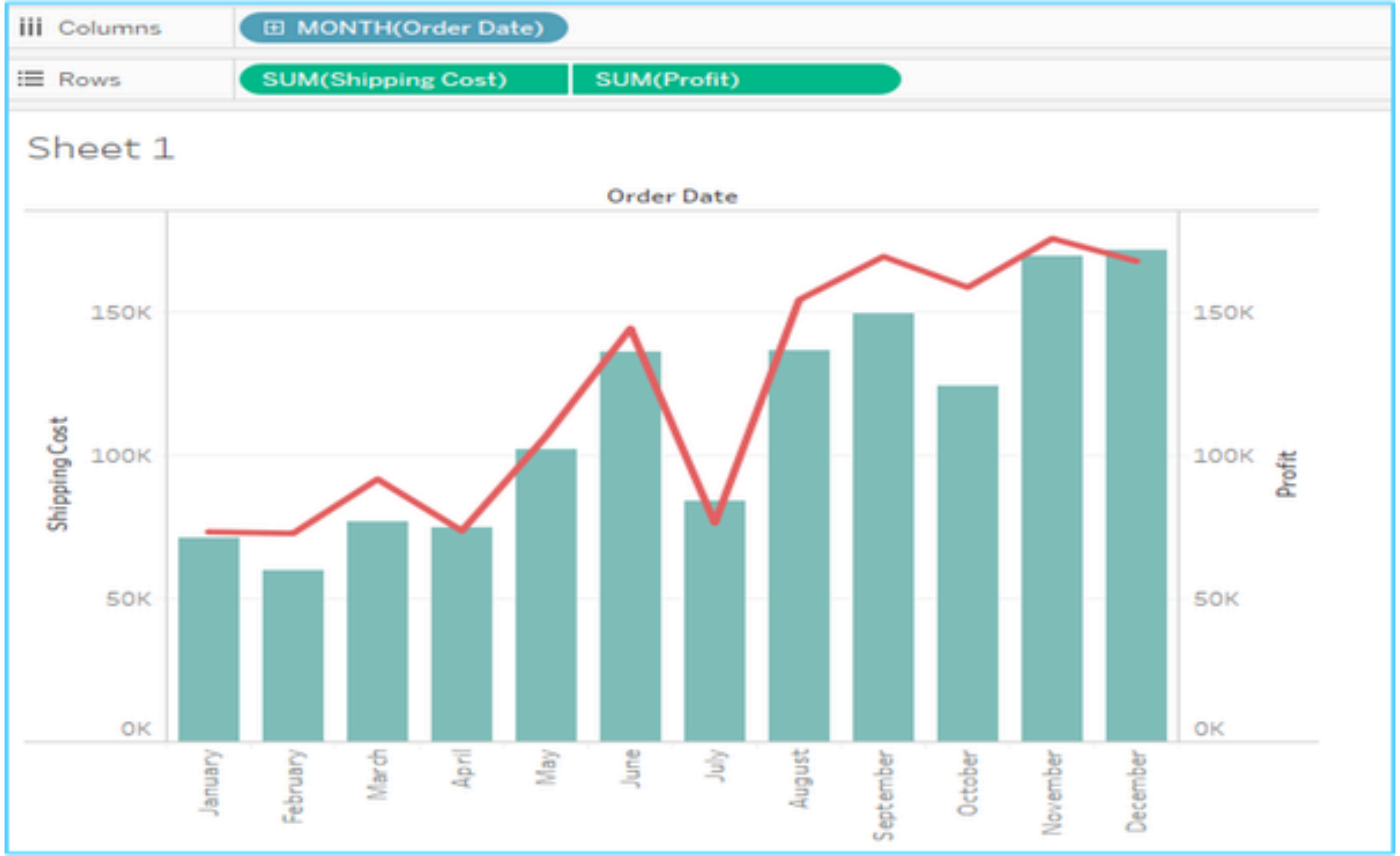
overlays


CPU utilization over time
Total CPU utilization
Time


CPU utilization over time
Total CPU utilization
Time


CPU utilization over time
Total CPU utilization
Time

Dual Axis

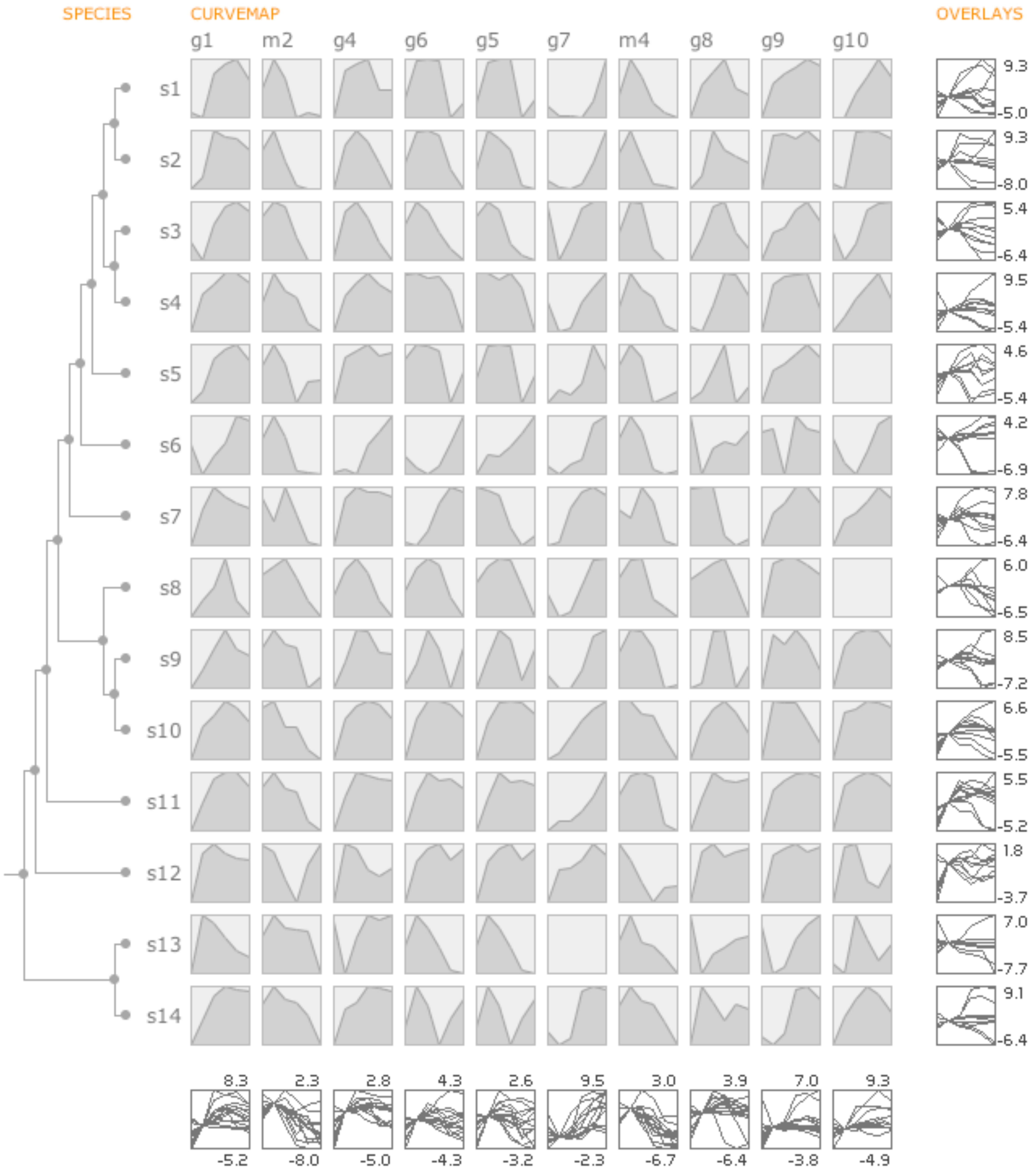

Columns
MONTH(Order Date)
Rows
SUM(Shipping Cost)
SUM(Profit)
Sheet 1
Order Date
Shipping Cost
Profit
150K
100K
50K
0K
January
February
March
April
May
June
July
August
September
October
November
December

Dual Axis (don't)

Combined

Partitioned + layered graph

Synchronized through highlighting



MCV to the Max