

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

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HOW LONG CAN YOU WORK ON MAKING A ROUTINE TASK MORE EFFICIENT BEFORE YOU'RE SPENDING MORE TIME THAN YOU SAVE?  
(ACROSS FIVE YEARS)

	HOW OFTEN YOU DO THE TASK					
	50/DAY	5/DAY	DAILY	WEEKLY	MONTHLY	YEARLY
1 SECOND	1 DAY	2 HOURS	30 MINUTES	4 MINUTES	1 MINUTE	5 SECONDS
5 SECONDS	5 DAYS	12 HOURS	2 HOURS	21 MINUTES	5 MINUTES	25 SECONDS
30 SECONDS	4 WEEKS	3 DAYS	12 HOURS	2 HOURS	30 MINUTES	2 MINUTES
1 MINUTE	8 WEEKS	6 DAYS	1 DAY	4 HOURS	1 HOUR	5 MINUTES
5 MINUTES	9 MONTHS	4 WEEKS	6 DAYS	21 HOURS	5 HOURS	25 MINUTES
30 MINUTES		6 MONTHS	5 WEEKS	5 DAYS	1 DAY	2 HOURS
1 HOUR		10 MONTHS	2 MONTHS	10 DAYS	2 DAYS	5 HOURS
6 HOURS				2 MONTHS	2 WEEKS	1 DAY
1 DAY					8 WEEKS	5 DAYS

# Multiple Views

Eyes over Memory:

Trade-off of display space and working memory

## ➔ Juxtapose and Coordinate Multiple Side-by-Side Views

➔ Share Encoding: Same/Different

➔ *Linked Highlighting*



➔ Share Data: All/Subset/None



➔ Share Navigation



		Data		
		All	Subset	None
Encoding	Same	Redundant	Overview/ Detail	Small Multiples
	Different	Multiform	Multiform, Overview/ Detail	No Linkage

## ➔ Partition into Side-by-Side Views



## ➔ Superimpose Layers



# Linked Views

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

# Linked Views Options

highlighting: to link, or not

navigation: to share, or not

encoding: same or multiform

dataset: share all, subset, or none

→ Share Encoding: Same/Different

→ *Linked Highlighting*







→ Share Data: All/Subset/None

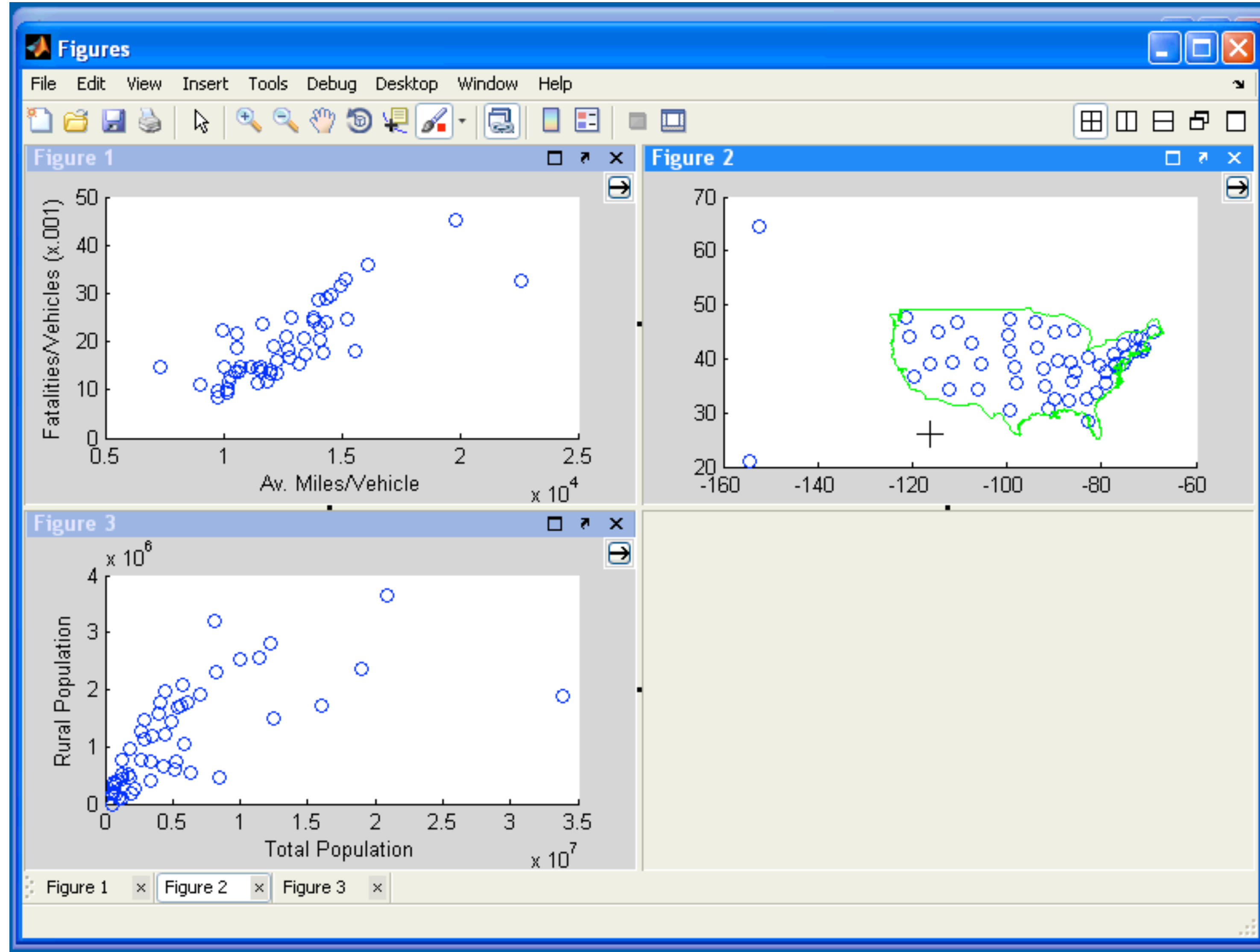


→ Share Navigation

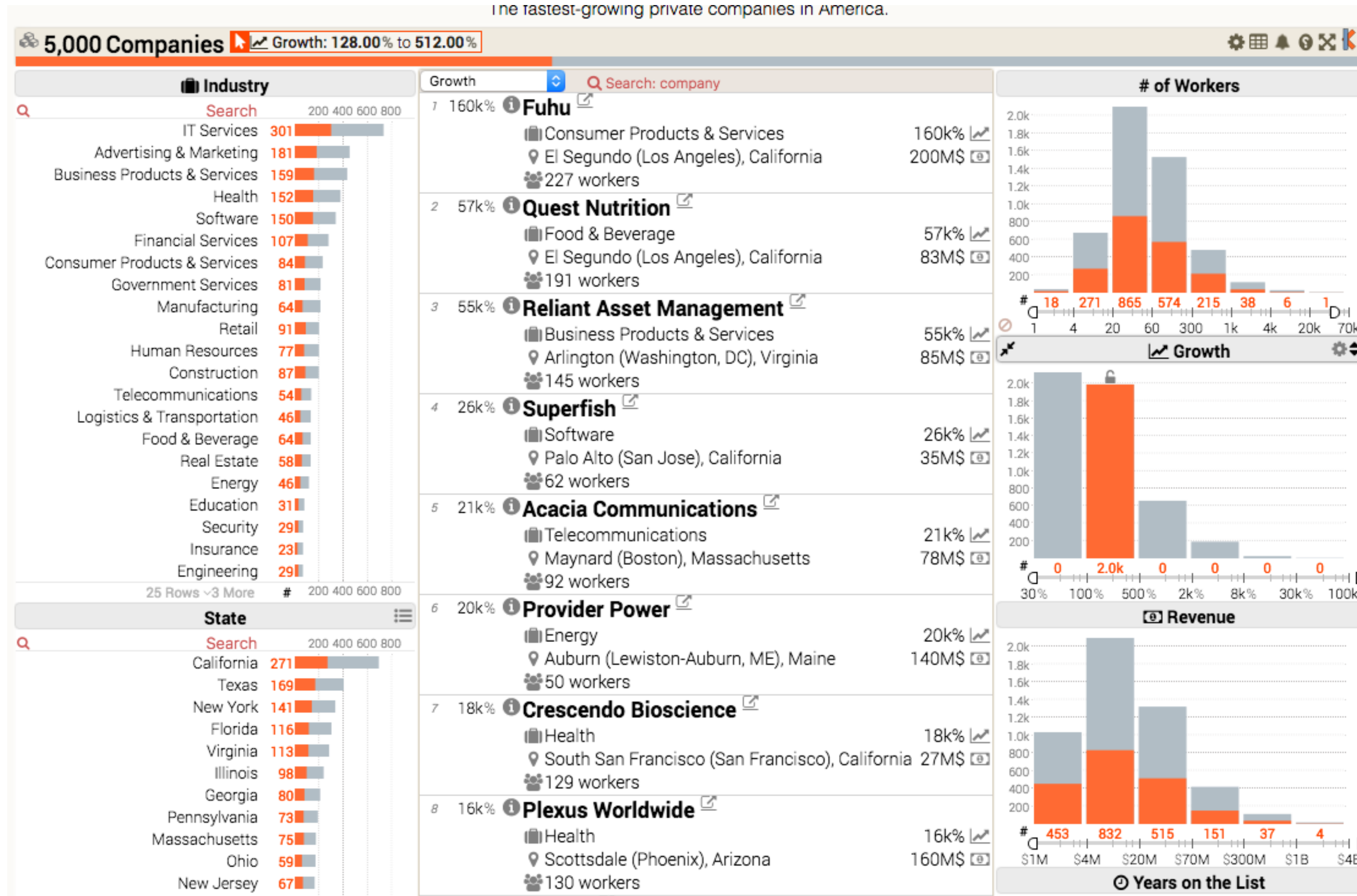


		Data		
		All	Subset	None
Encoding	Same	Redundant	 Overview/ Detail	 Small Multiples
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# Linked Highlighting



# Linked Highlighting



# Multiform

difference visual encodings are used between the views

- implies shared data

- either all data

- or subset of data (overview + detail)

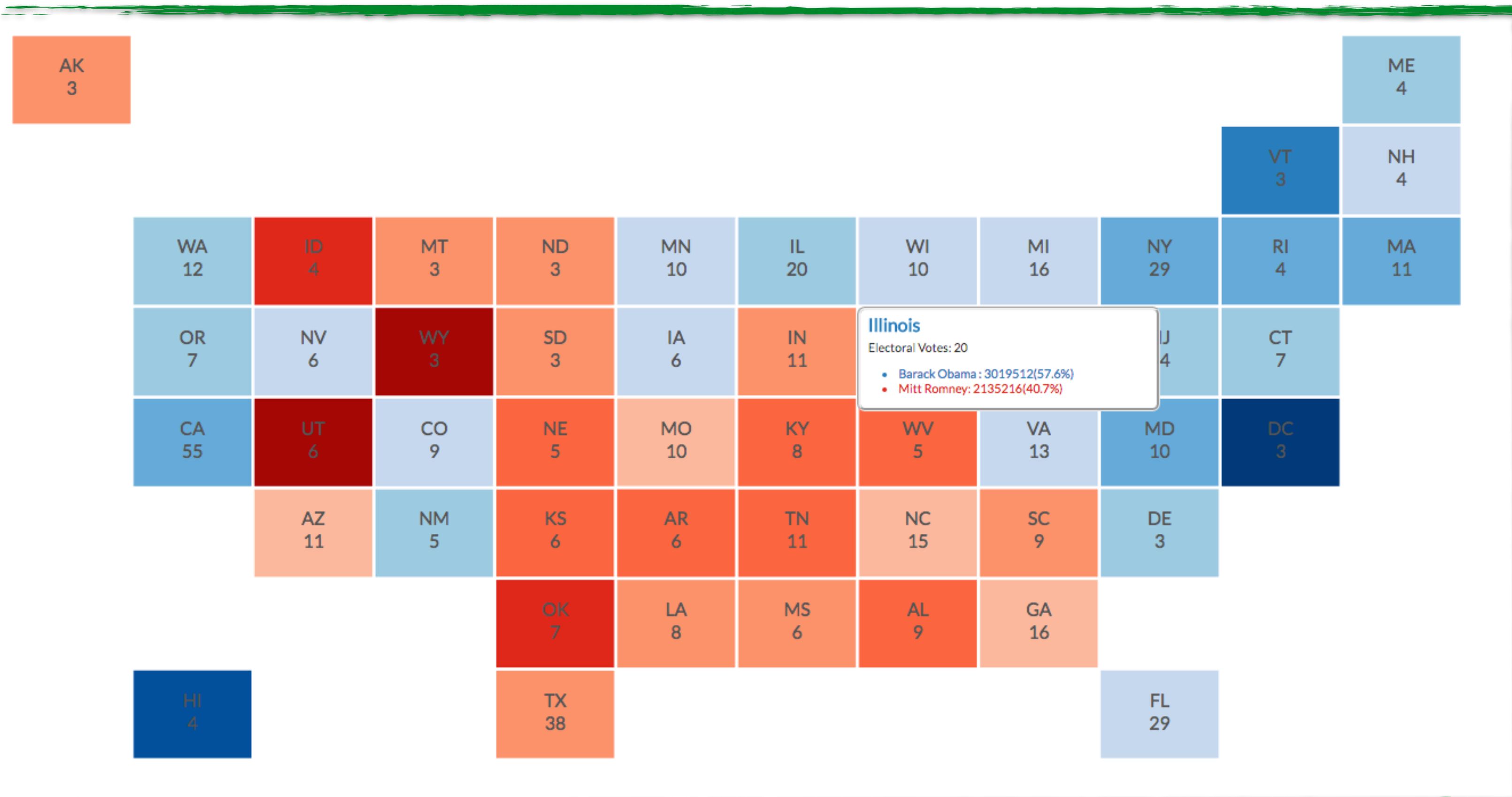
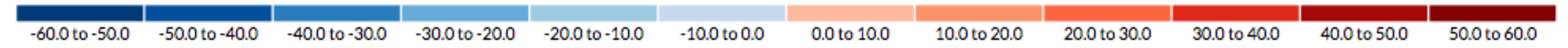
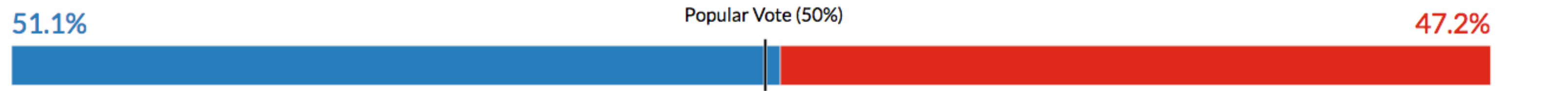
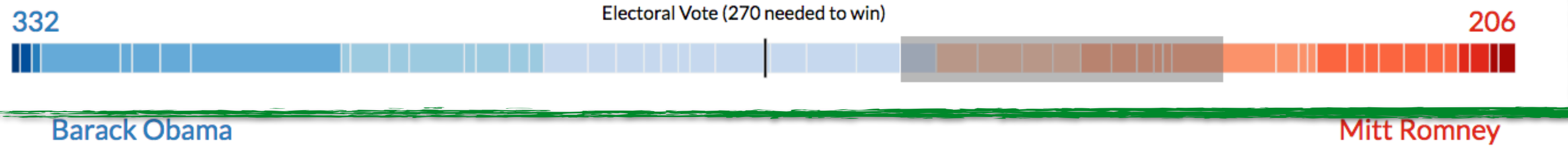
## **rational:**

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

different views support different tasks

# US Presidential Elections from 1940 to 2012

Name: Your Name; E-Mail: Your E-Mail; UID: Your UID



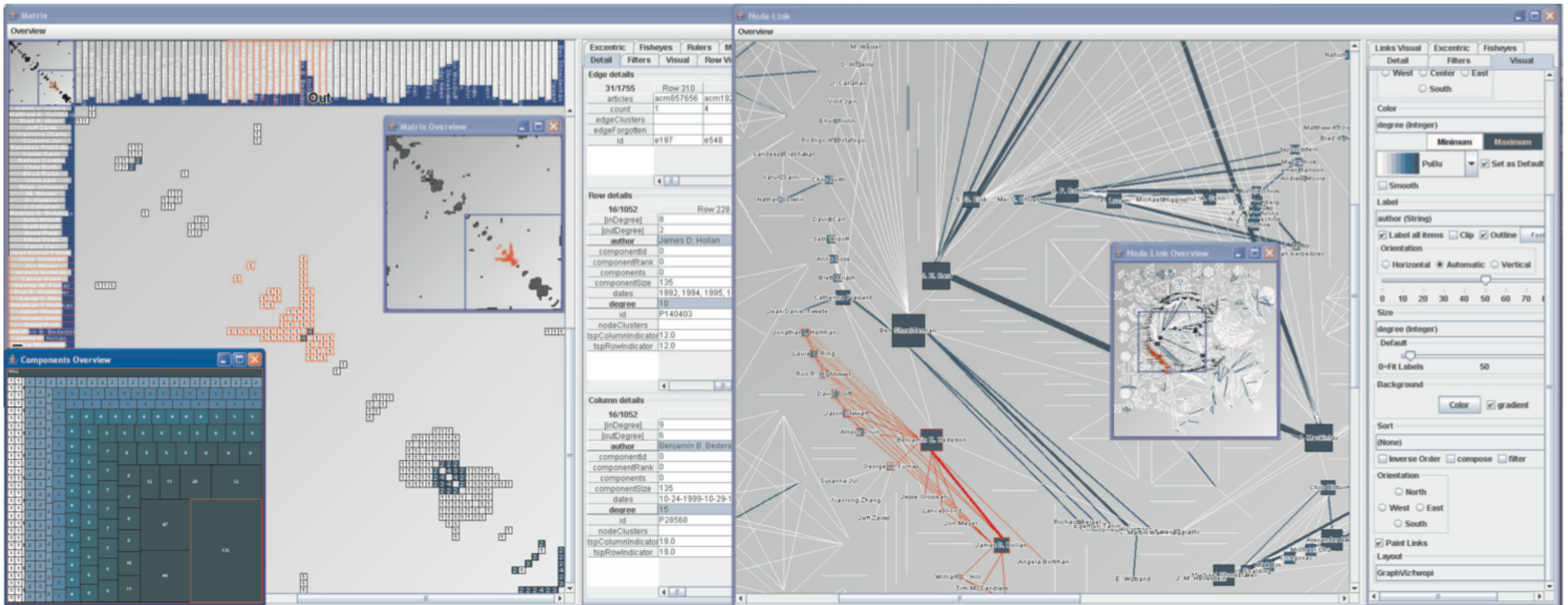
Brush selection is:

- North Carolina
- Georgia
- Arizona
- Missouri
- Indiana
- South Carolina
- Mississippi
- Montana
- Alaska

**Multiform**  
 Different Views  
 here also same data



# MatrixExplorer



Same Data - Different Idioms (Multiform)

Henry 2006

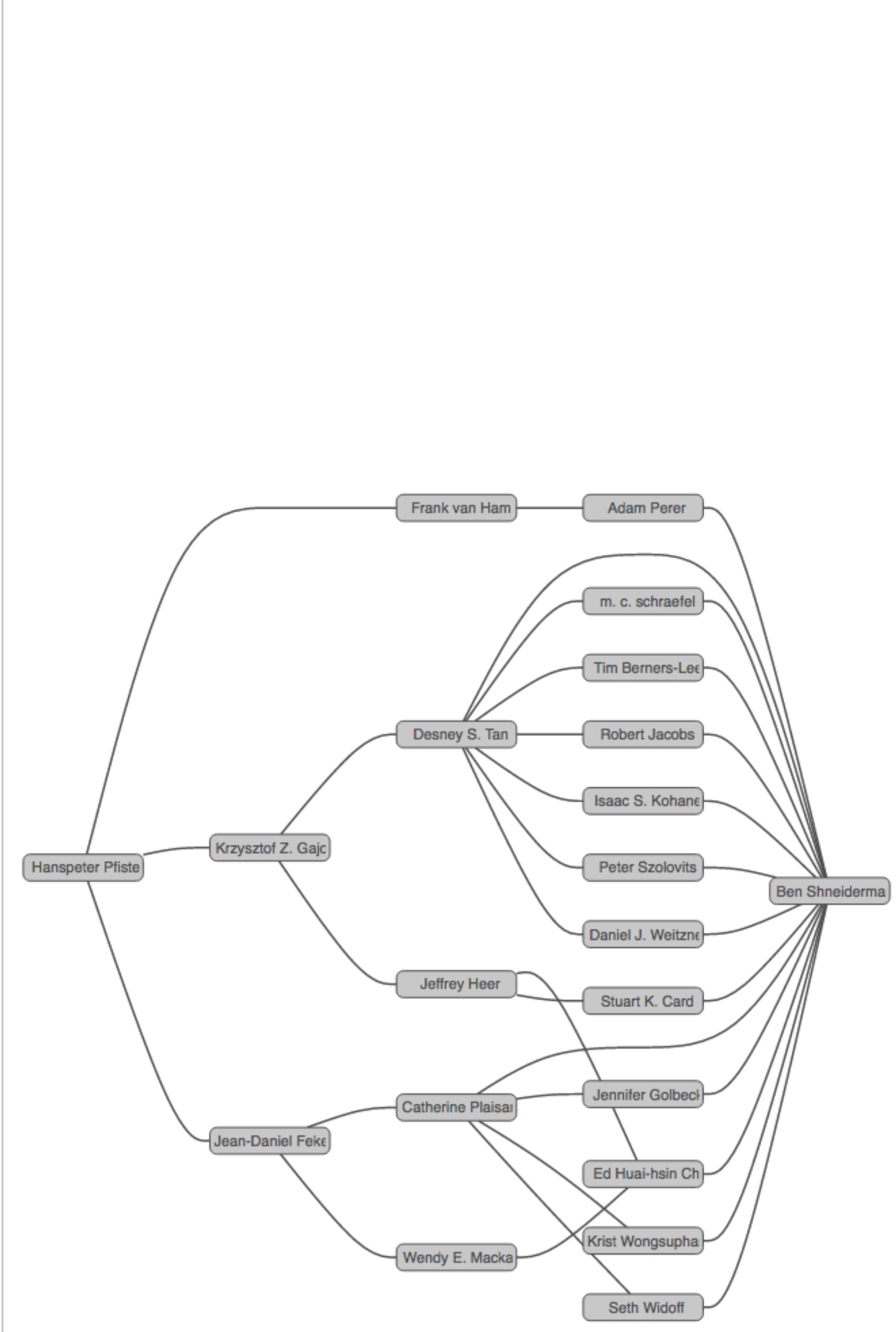
Start Hanspeter Pfister End Ben Shneiderman Length Paths 0 0 0 3 4 105

Path List

Path ID	Nodes	Length	CHI	TVCG	chi_publications	cited	degree	tvcg_publication
1.	Hanspeter Pfister - Frank van Ham - Adam Perer - Ben Shneiderman	3	0	0	1	0	8	38
1.	Hanspeter Pfister - Krzysztof Z. Gajc - Desney S. Tan - Ben Shneiderman	3	0	0	0	0	0	0
1.	Hanspeter Pfister - Jean-Daniel Fekete - Catherine Plaisant - Ben Shneiderman	3	0	0	0	0	0	0
4.	Hanspeter Pfister - Jean-Daniel Fekete - Catherine Plaisant - Jennifer Golbeck - Ben Shneiderman	4	0	0	0	0	0	0
4.	Hanspeter Pfister - Jean-Daniel Fekete - Wendy E. Macka - Ed Huai-hsin Ch - Ben Shneiderman	4	0	0	0	0	0	0
4.	Hanspeter Pfister - Krzysztof Z. Gajc - Jeffrey Heer - Ed Huai-hsin Ch - Ben Shneiderman	4	0	0	0	0	0	0
4.	Hanspeter Pfister - Krzysztof Z. Gajc - Jeffrey Heer - Stuart K. Card - Ben Shneiderman	4	0	0	0	0	0	0
4.	Hanspeter Pfister - Jean-Daniel Fekete - Catherine Plaisant - Krist Wongsupha - Ben Shneiderman	4	0	0	0	0	0	0

Path Topology

Active Page All



# 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**

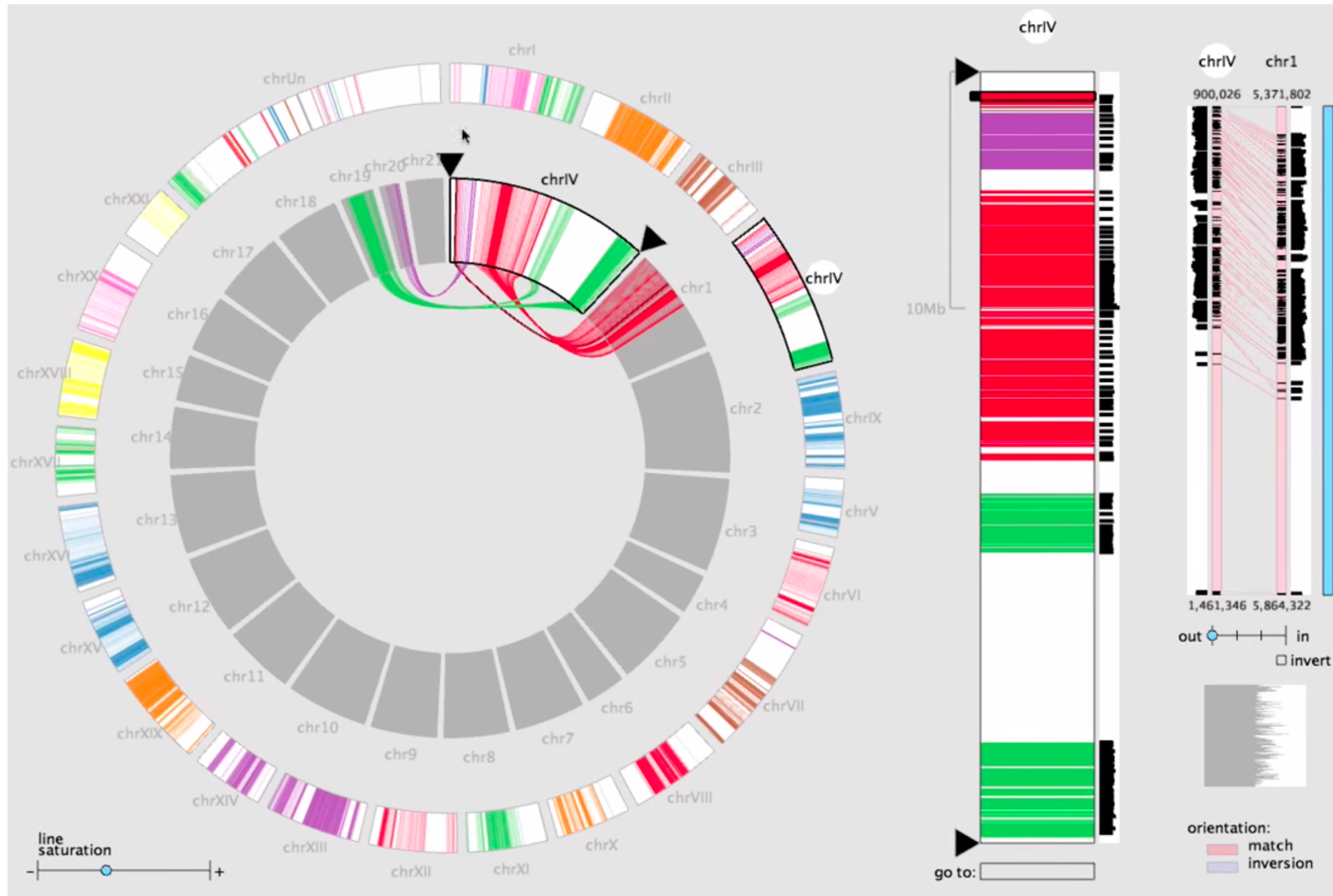
for large or complex data, a single view of the entire dataset cannot capture fine details

# Stack Zooming



Same Data - Same Encoding, Different Resolution

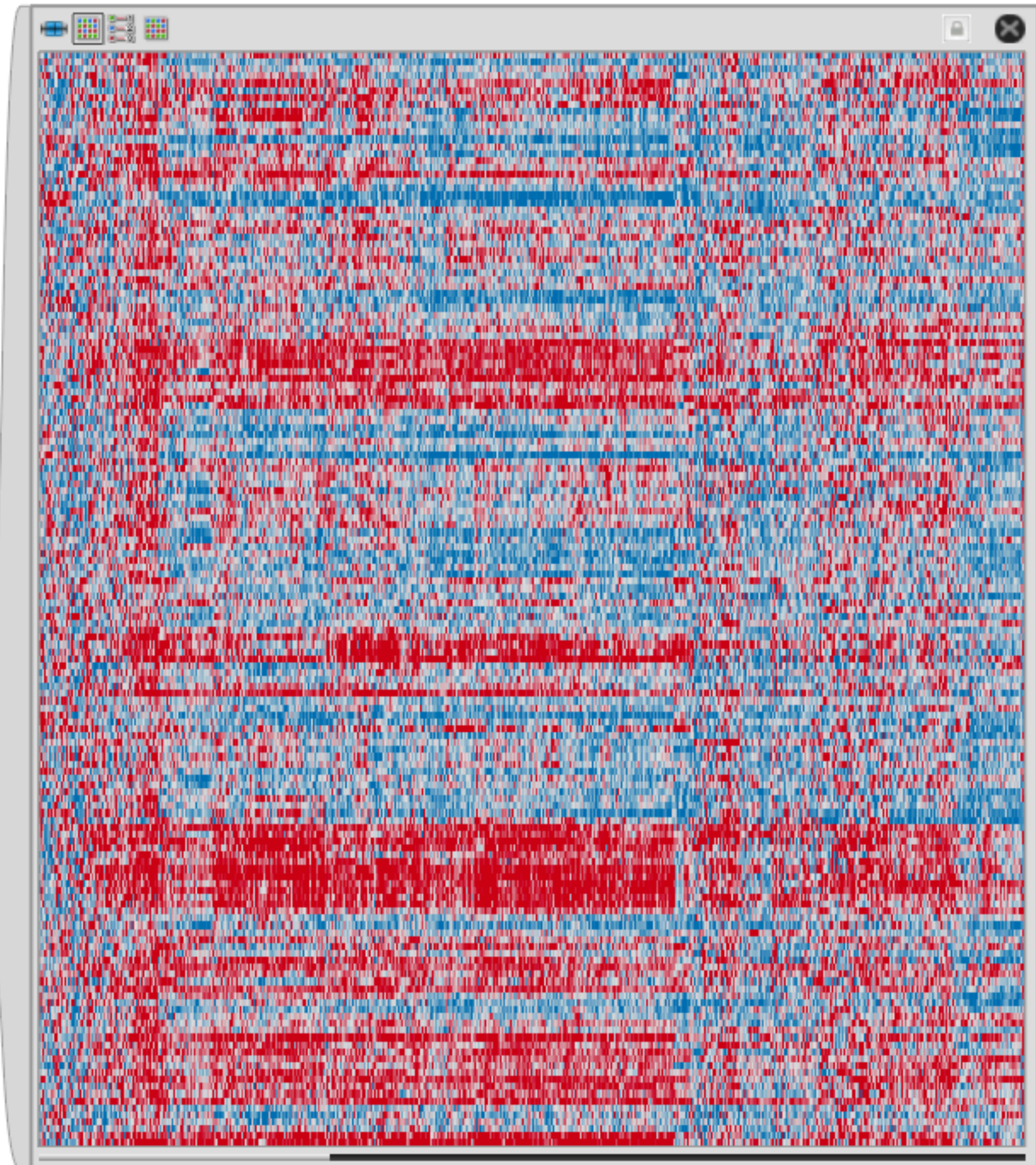
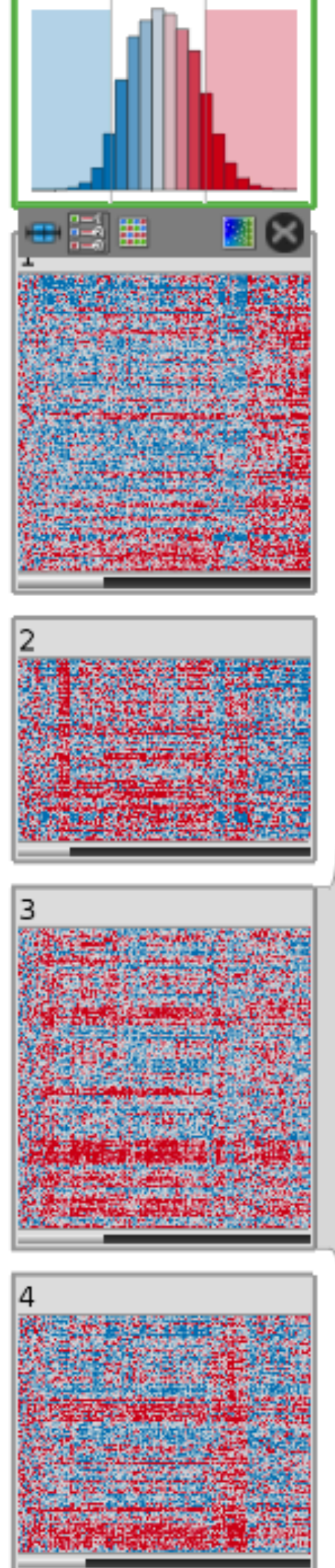
# MizBee



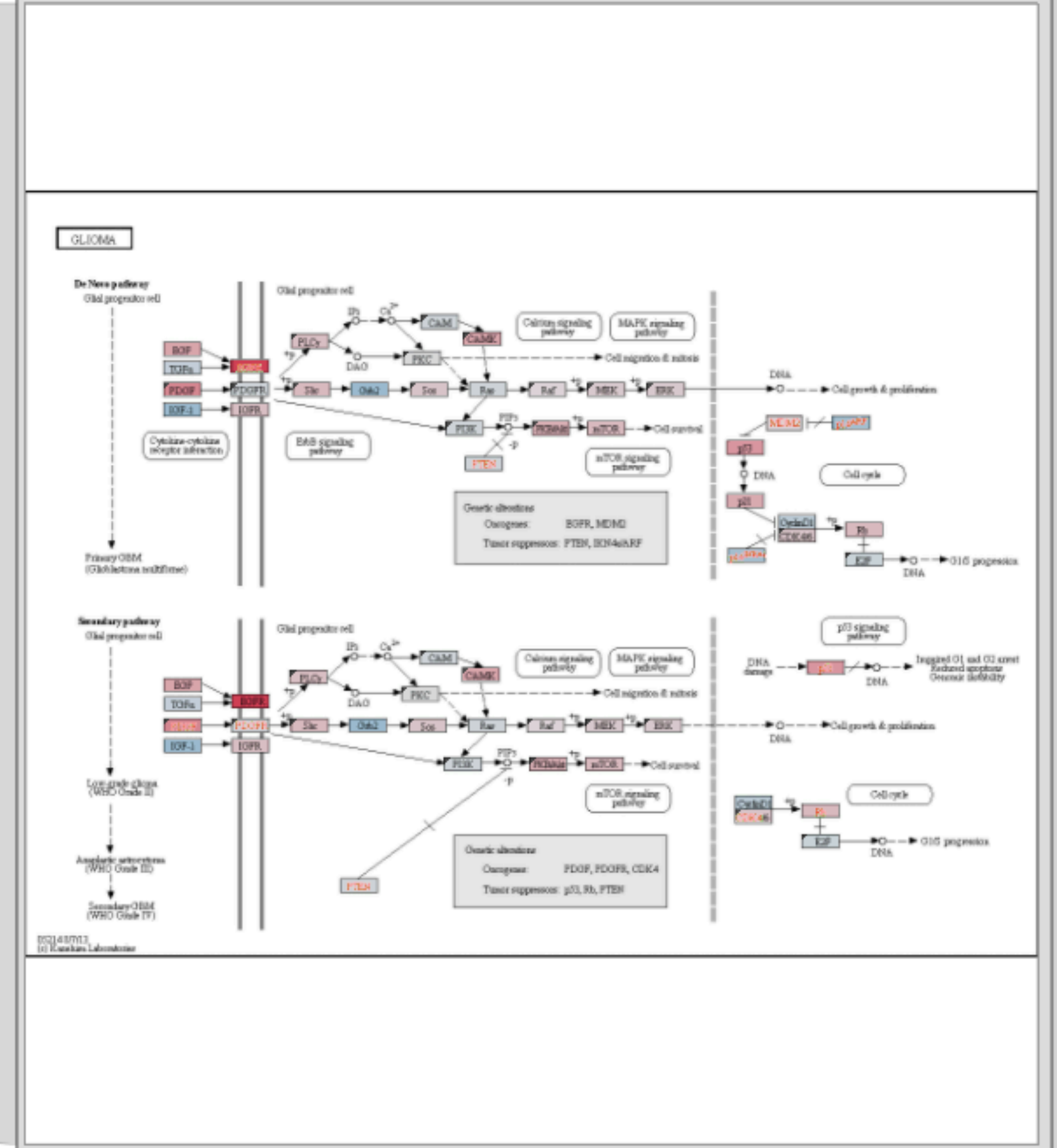
## Multiform Overview & Detail

# StratomeX

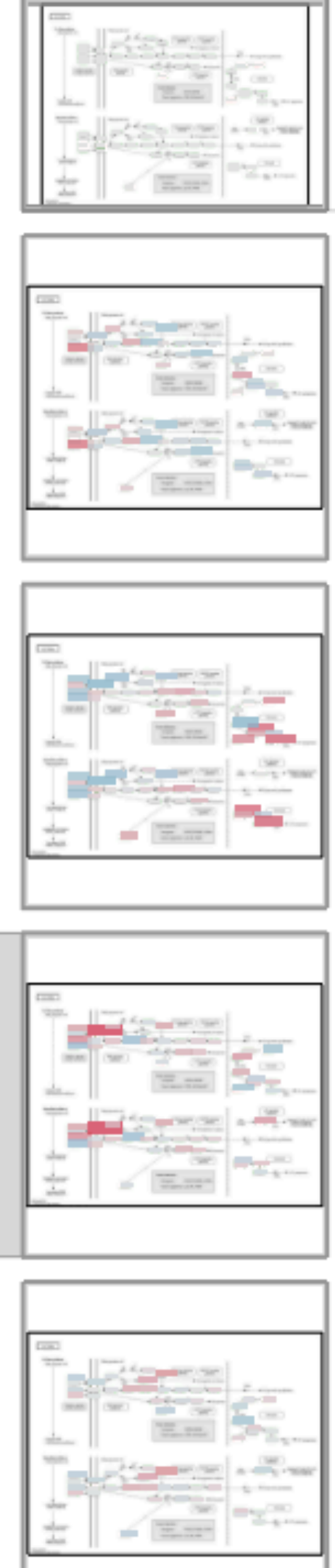
mRNA - 4 CNMF Clus



Glioma



Glioma



# SMALL MULTIPLES

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

## **rational**

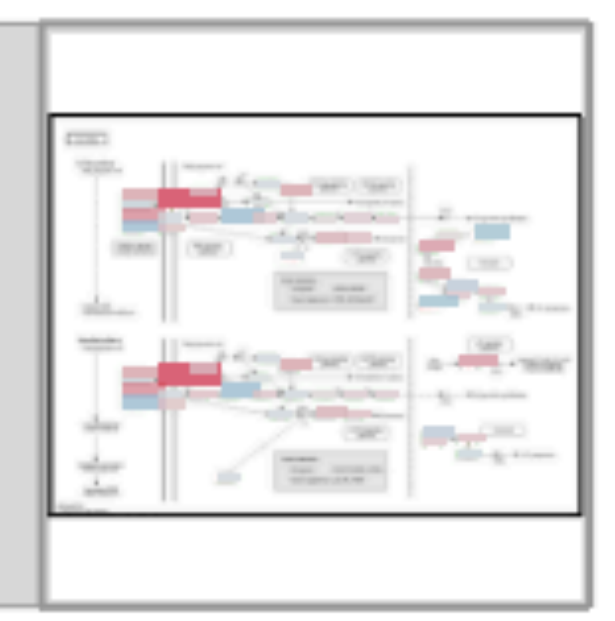
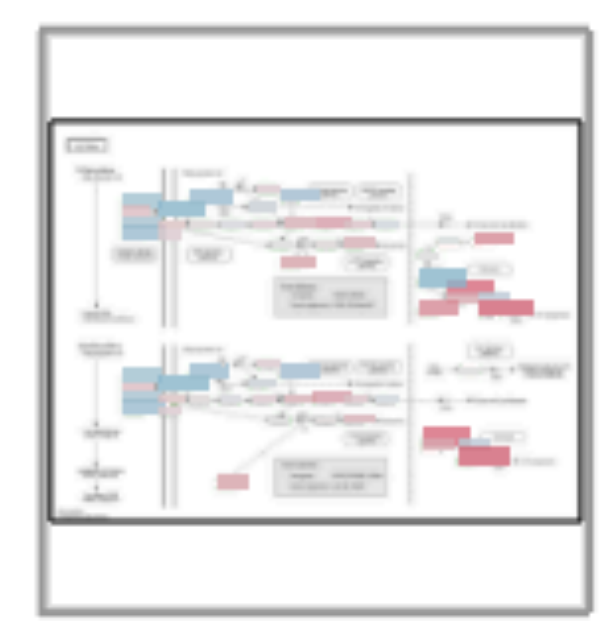
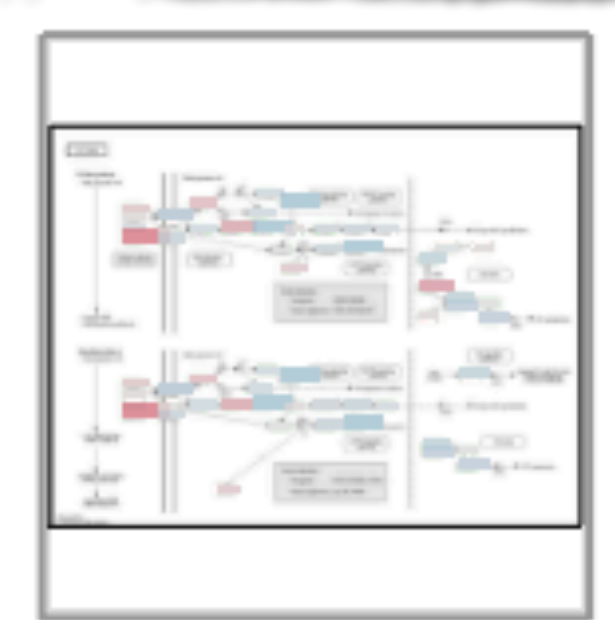
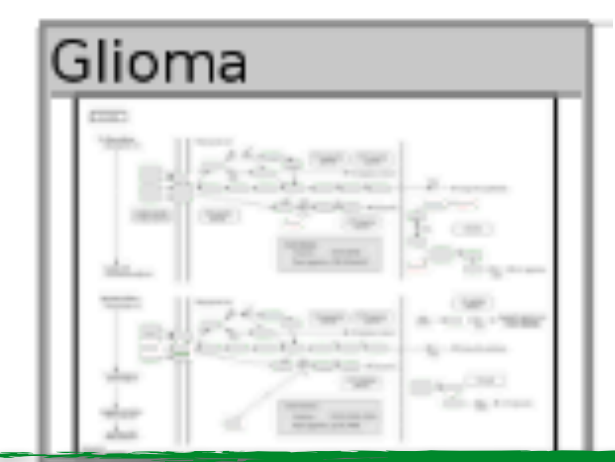
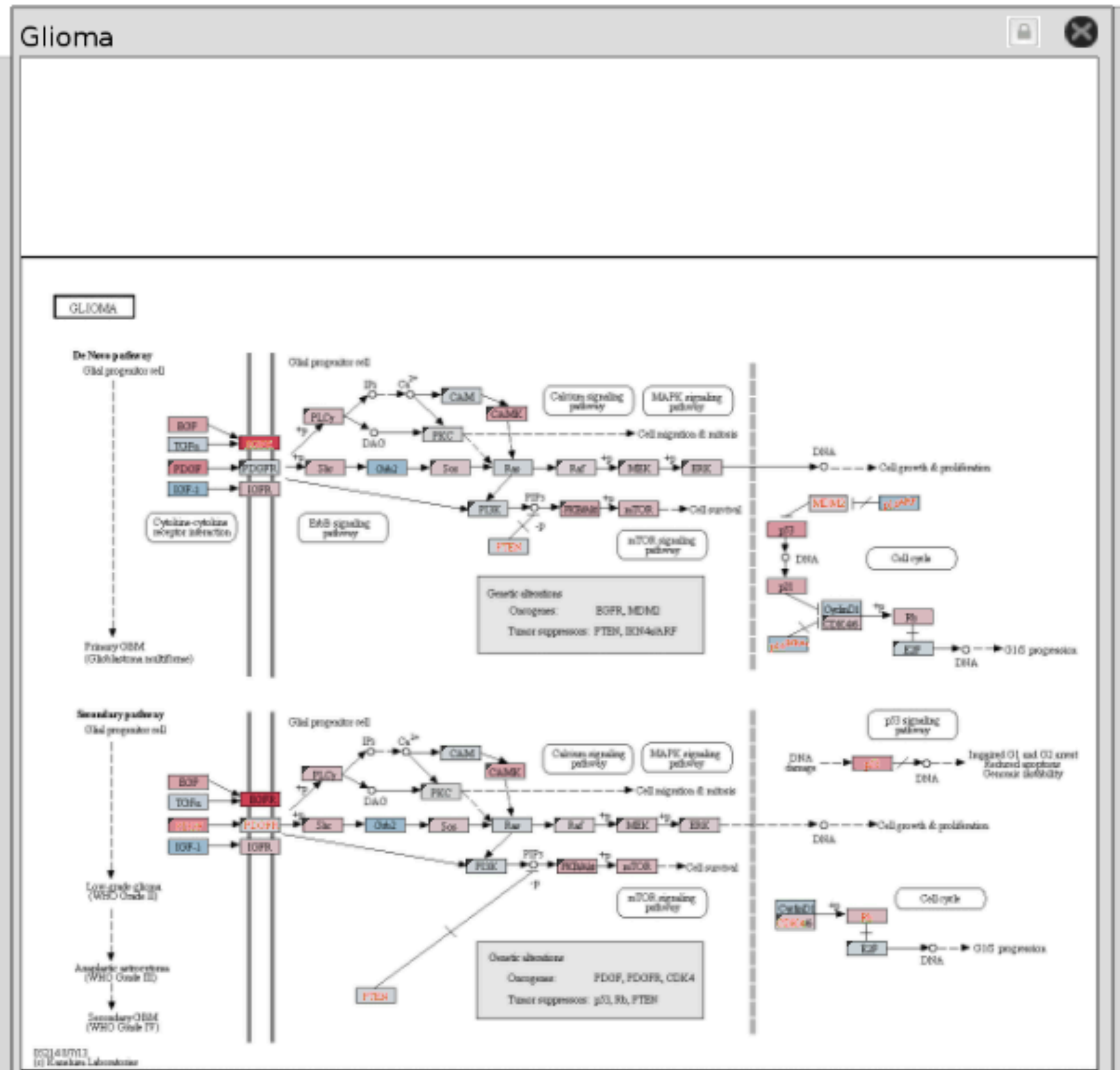
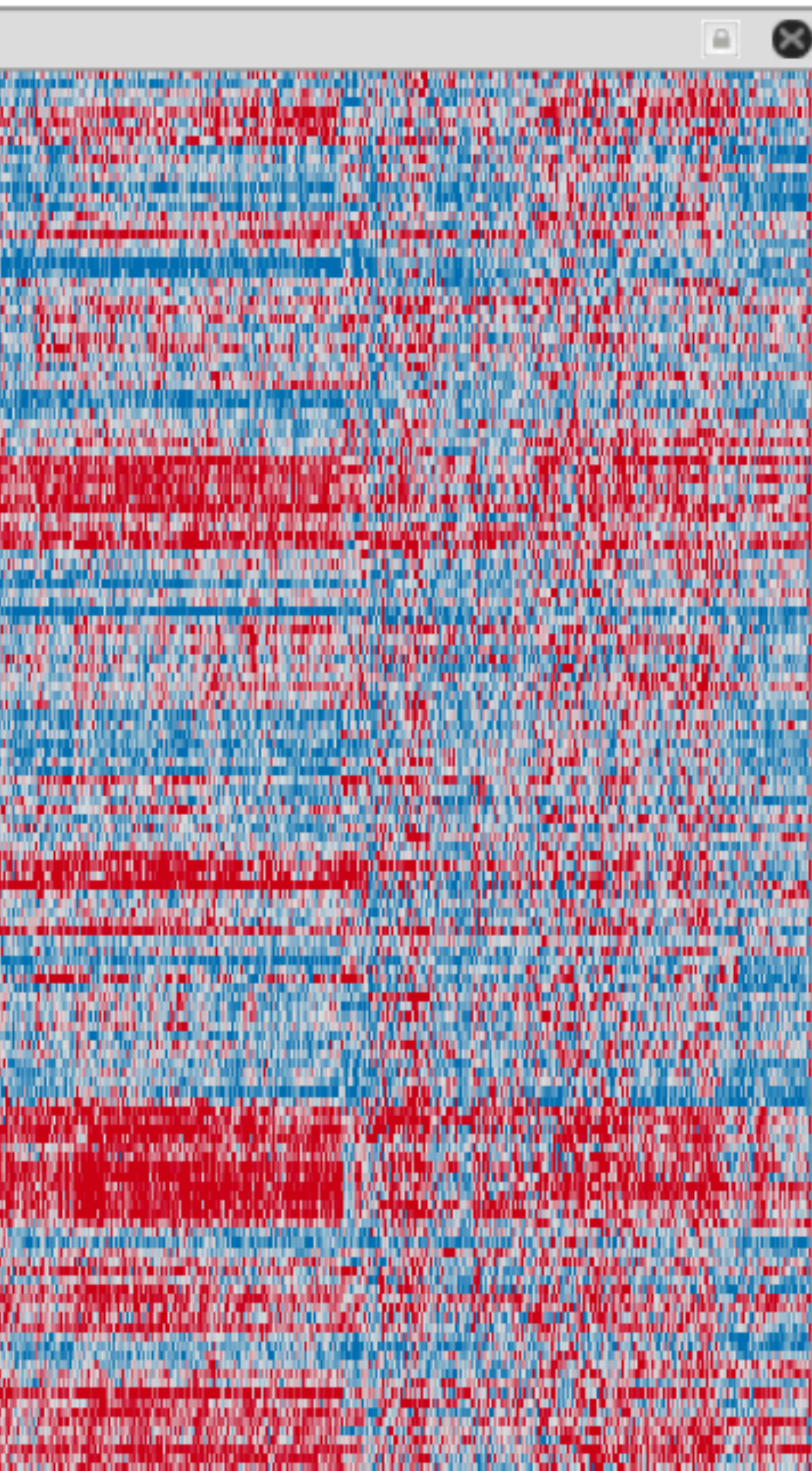
quickly compare different parts of a data set, relying on eyes instead of memory

# Small Multiples for Graph Attributes





# 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

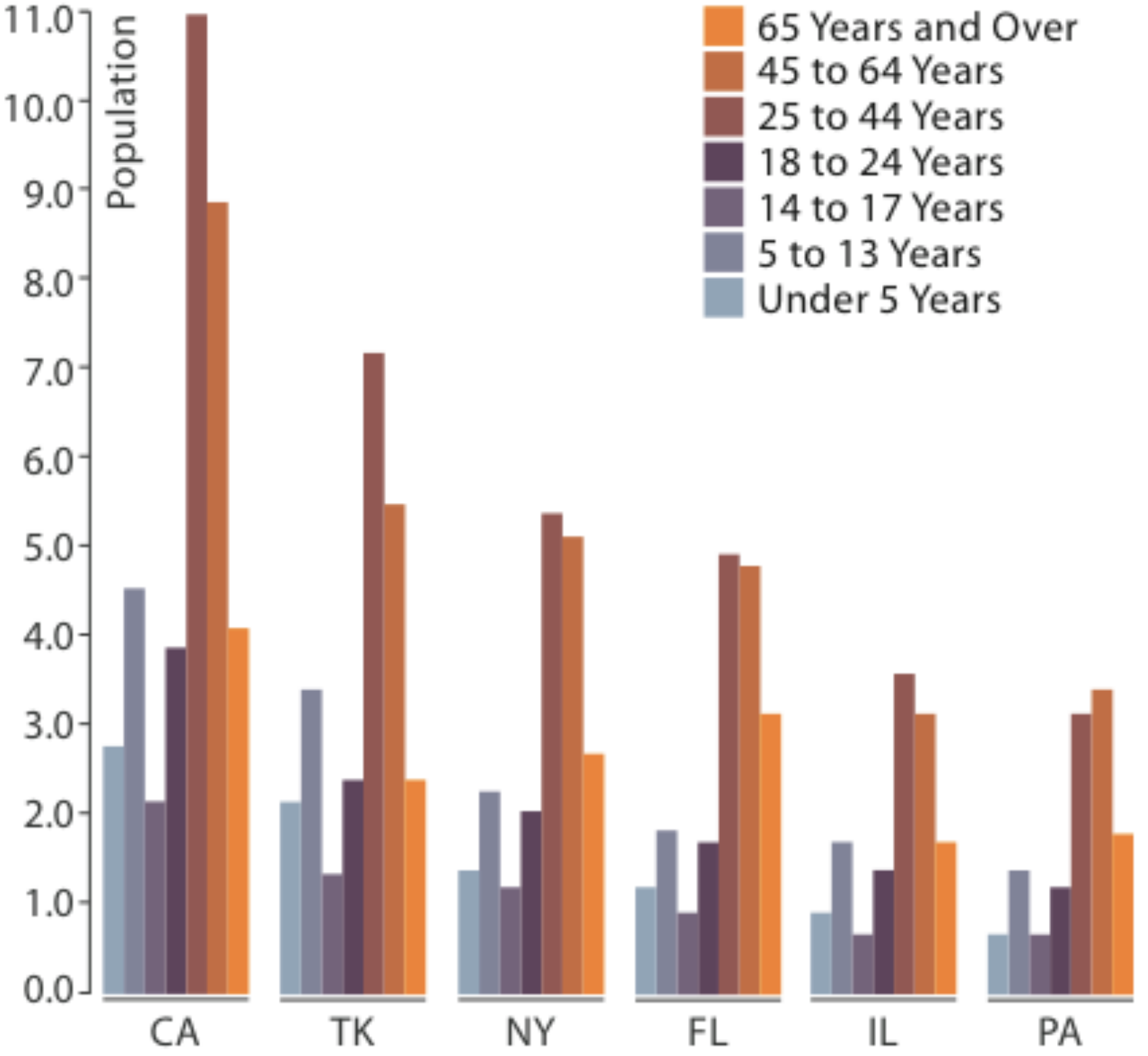
how many splits, and order of splits

how many views (usually data driven)

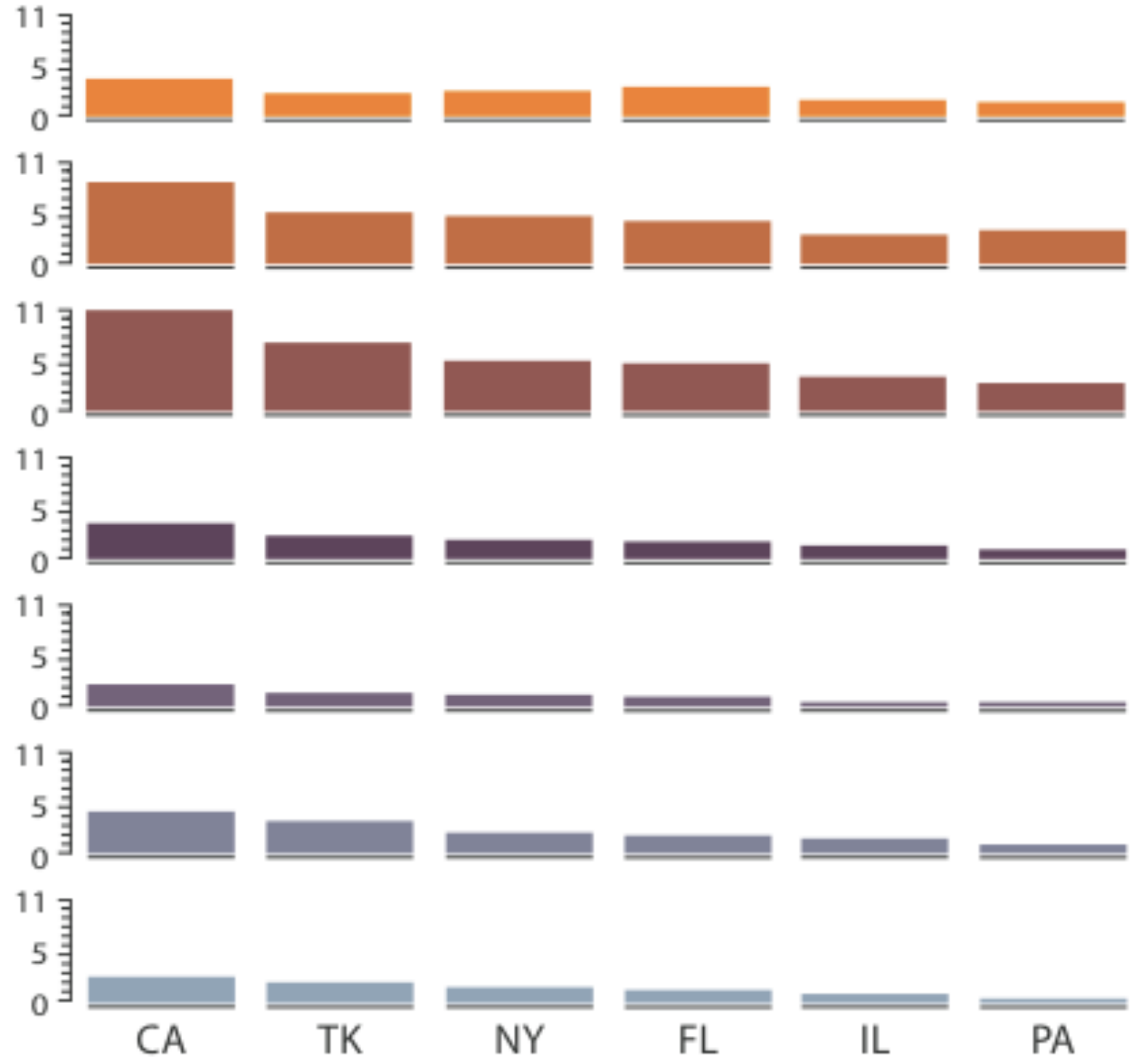
## **partition attribute(s)**

typically categorical

# Partitioning - Age Distribution by State

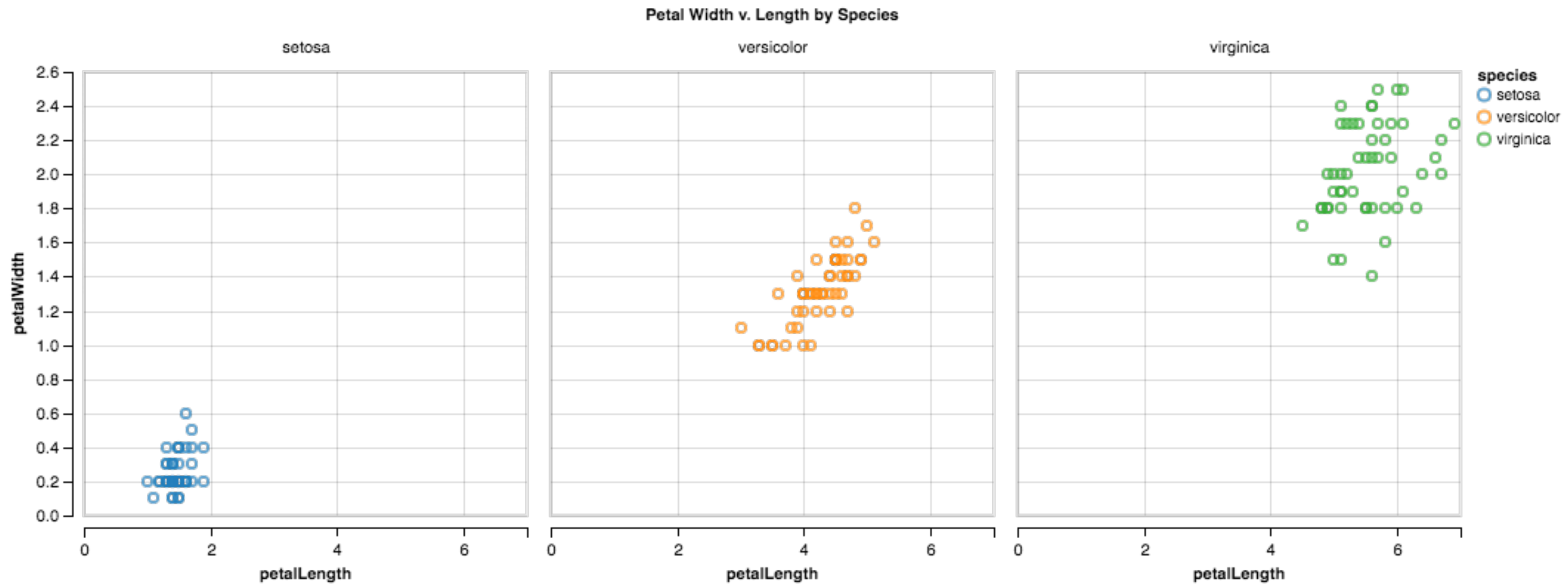


Partitioned by State



Partitioned by Age Group and State

# Partition by Category



# Trellis Plots

panel variables

attributes encoded in individual views

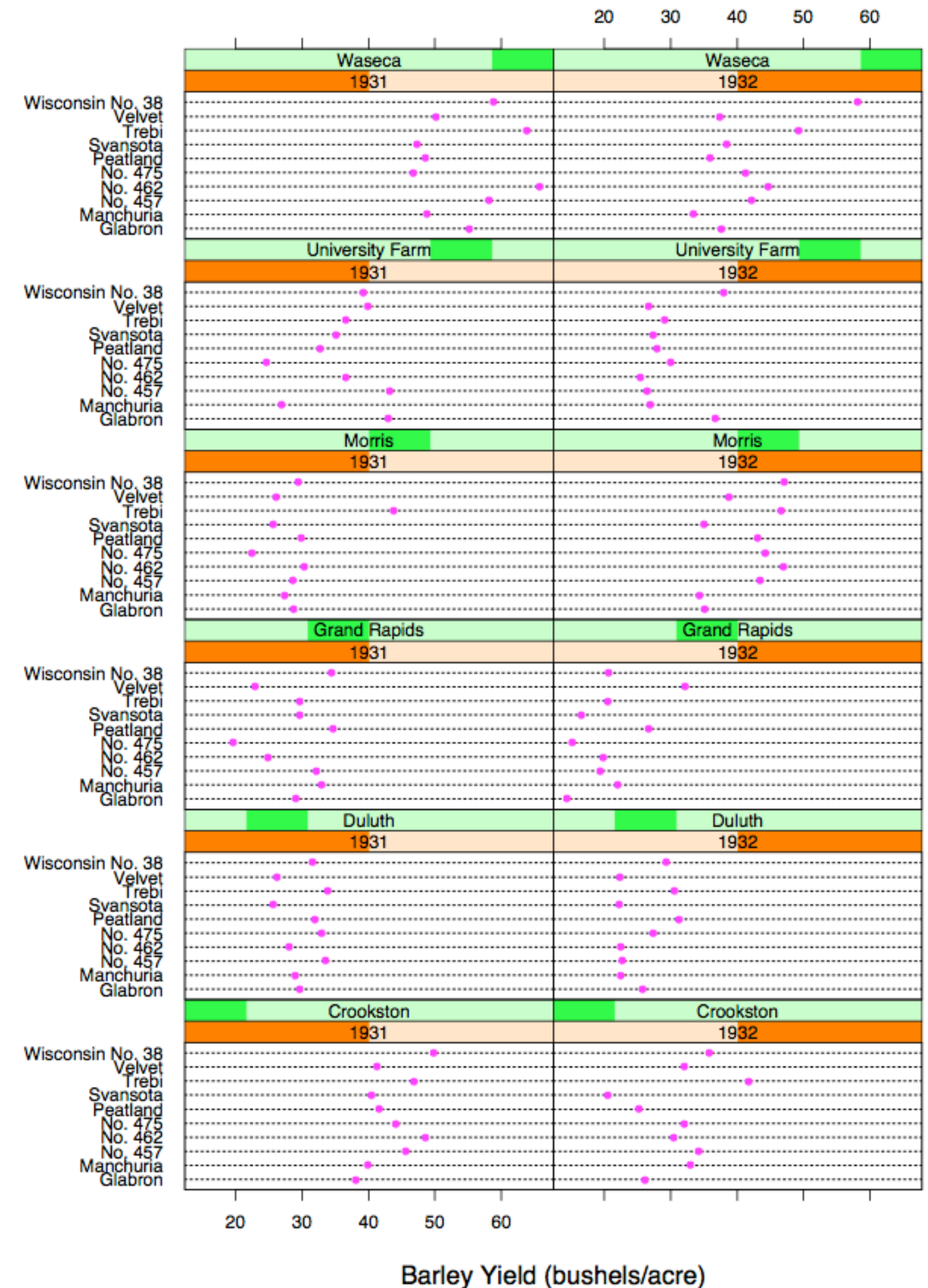
partitioning variables

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



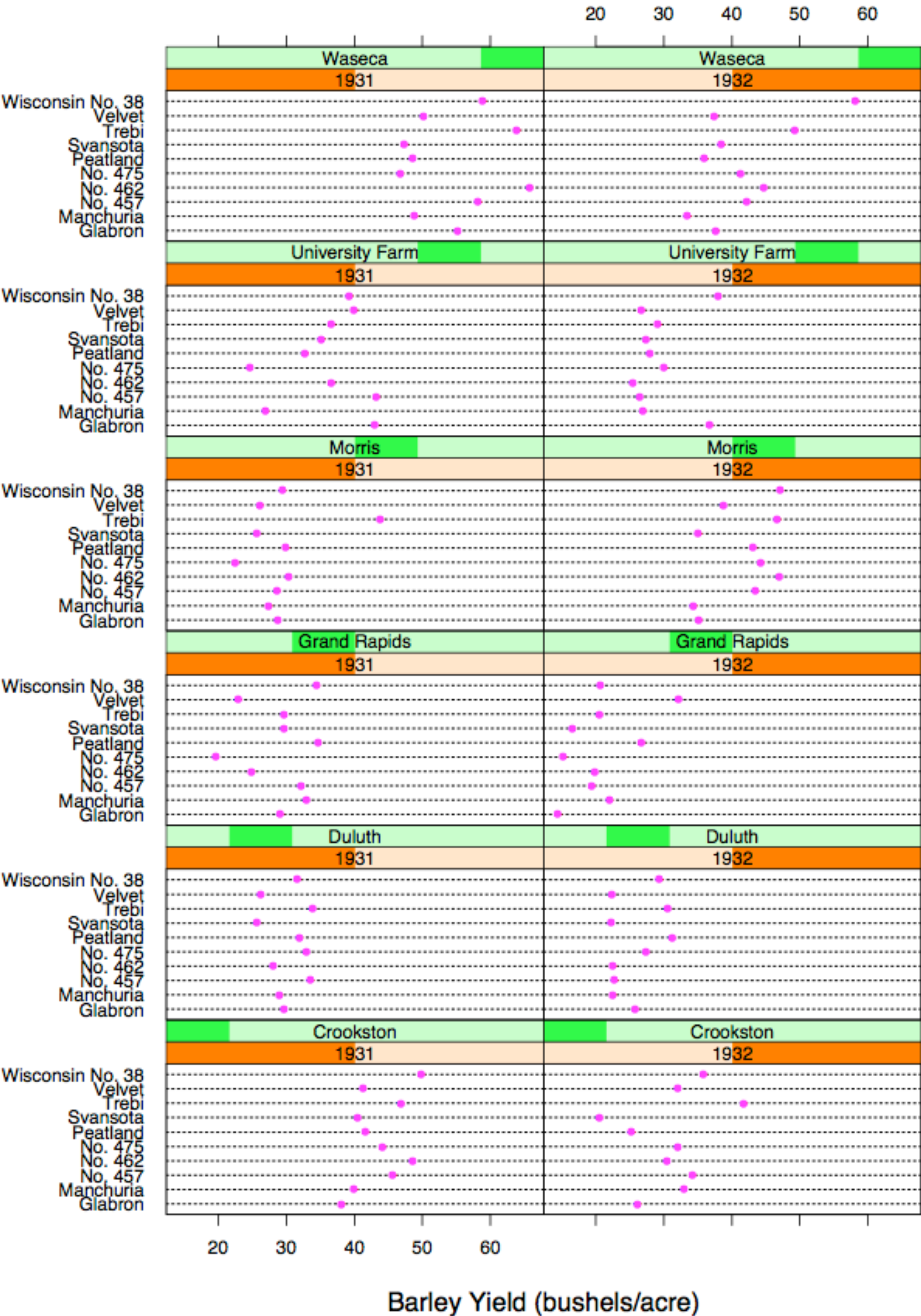
# Data

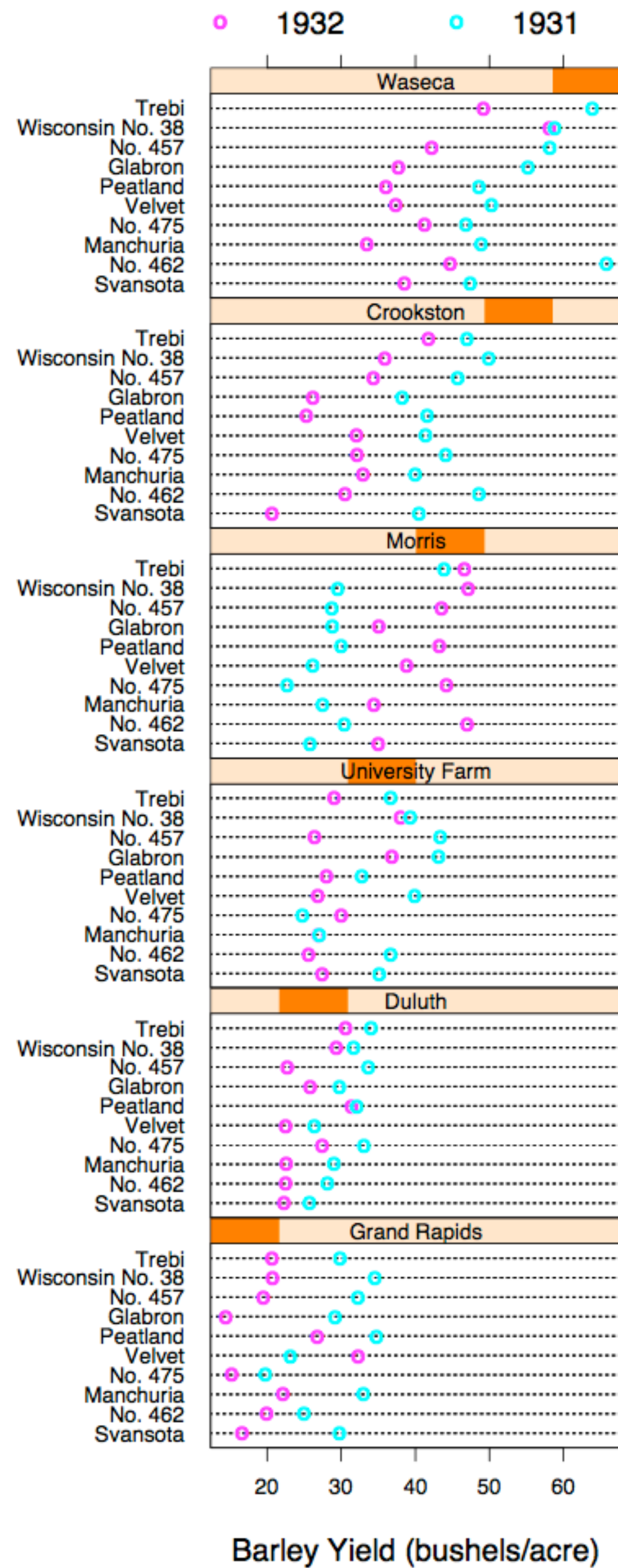
Barley Yields in two years across multiple farms for multiples barley strains

**partitioning variables**

Columns partitioned by year

Rows partitioned by farm





Barley Yield (bushels/acre)

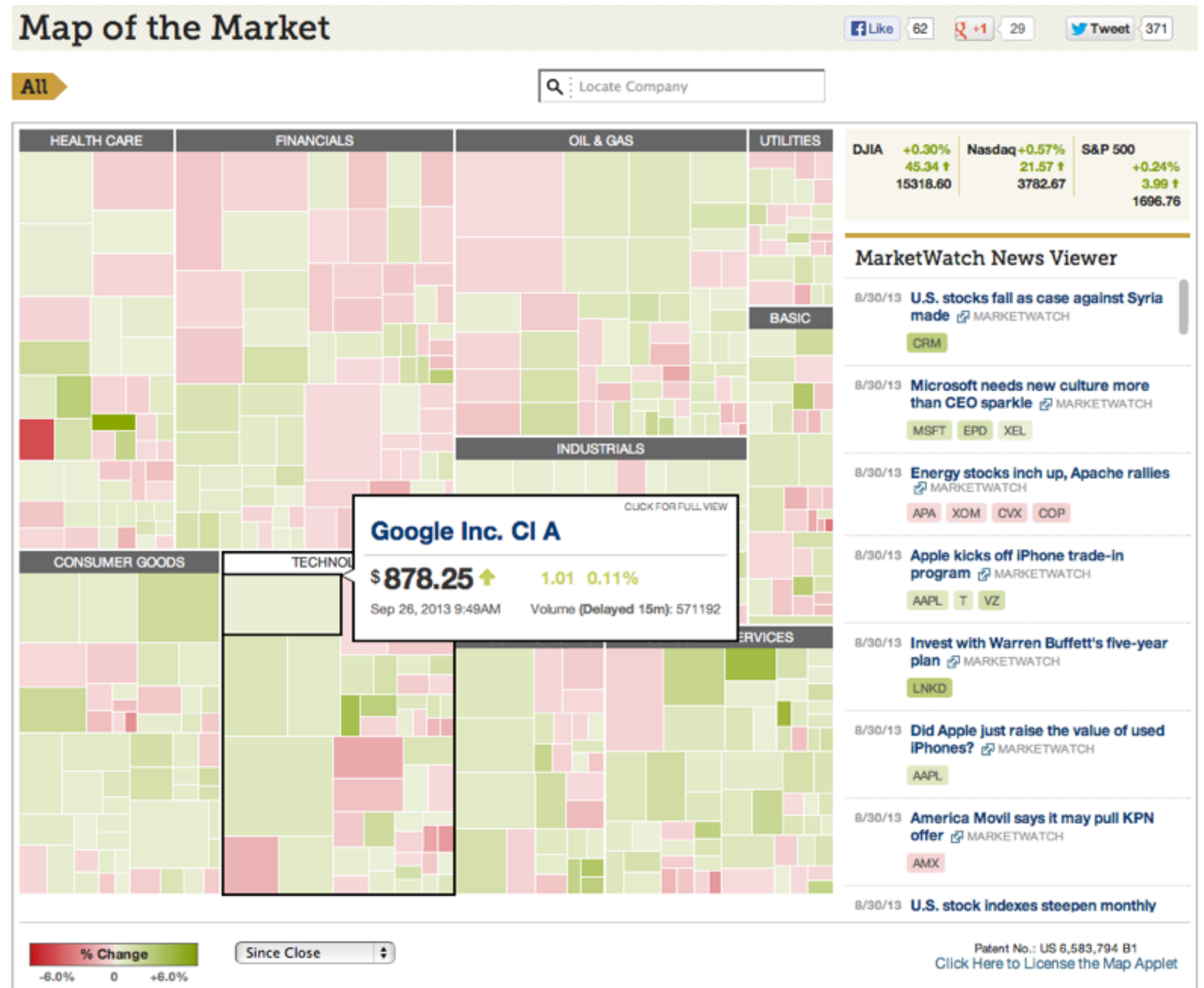
Barley Yield (bushels/acre)



# 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



# HiVE example: London property

## partitioning attributes

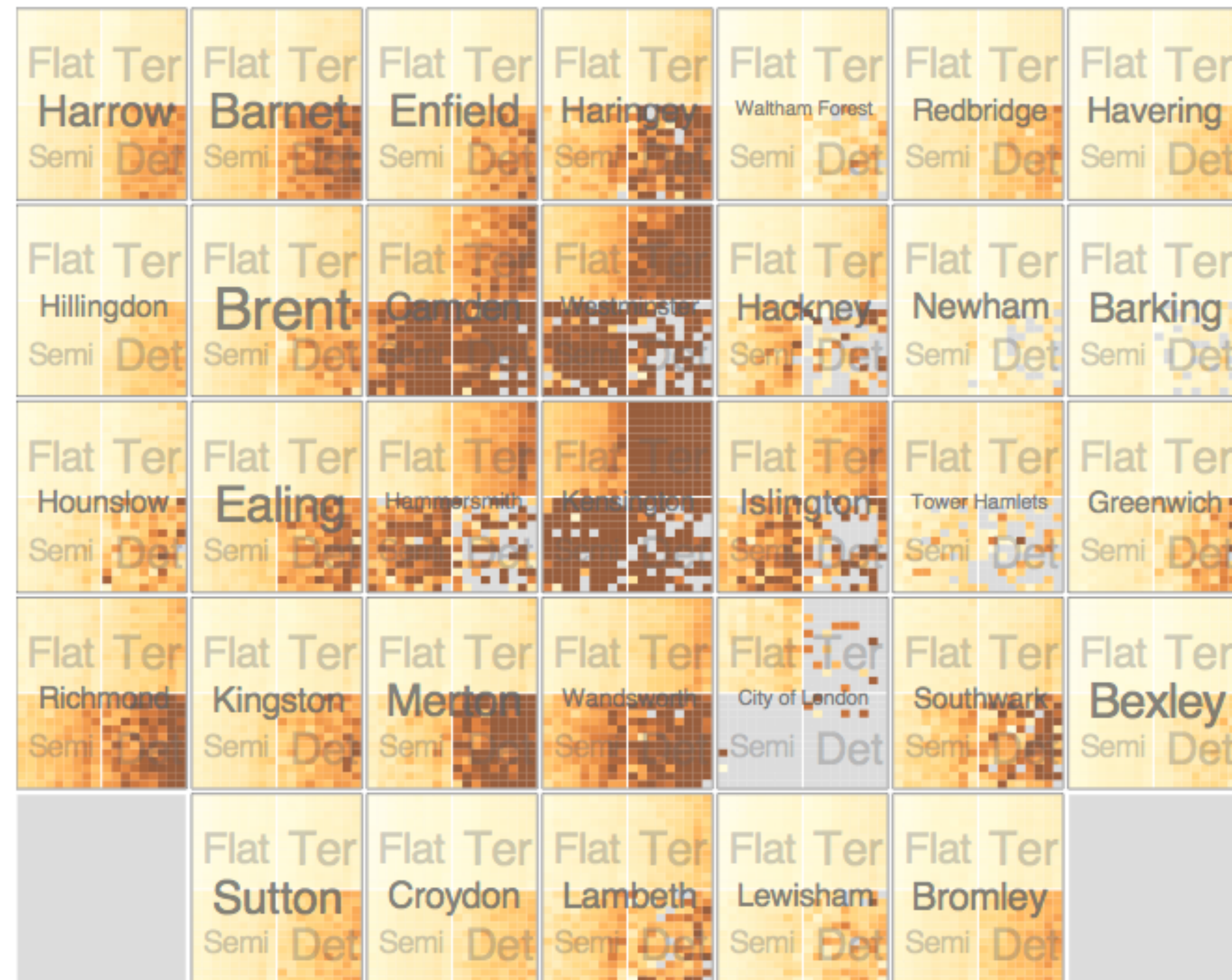
neighborhood  
house type  
sale time (year)  
sale time (month)

## encoding attributes

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

## results

expensive neighborhoods near  
center of city



# Configuring Hierarchical Layouts to Address Research Questions



Aidan Slingsby, Jason Dykes and Jo Wood

giCentre, Department of Information Science, City University London

[http://www.gicentre.org/hierarchical\\_layouts/](http://www.gicentre.org/hierarchical_layouts/)



<https://vimeo.com/9870257>

# LAYERING

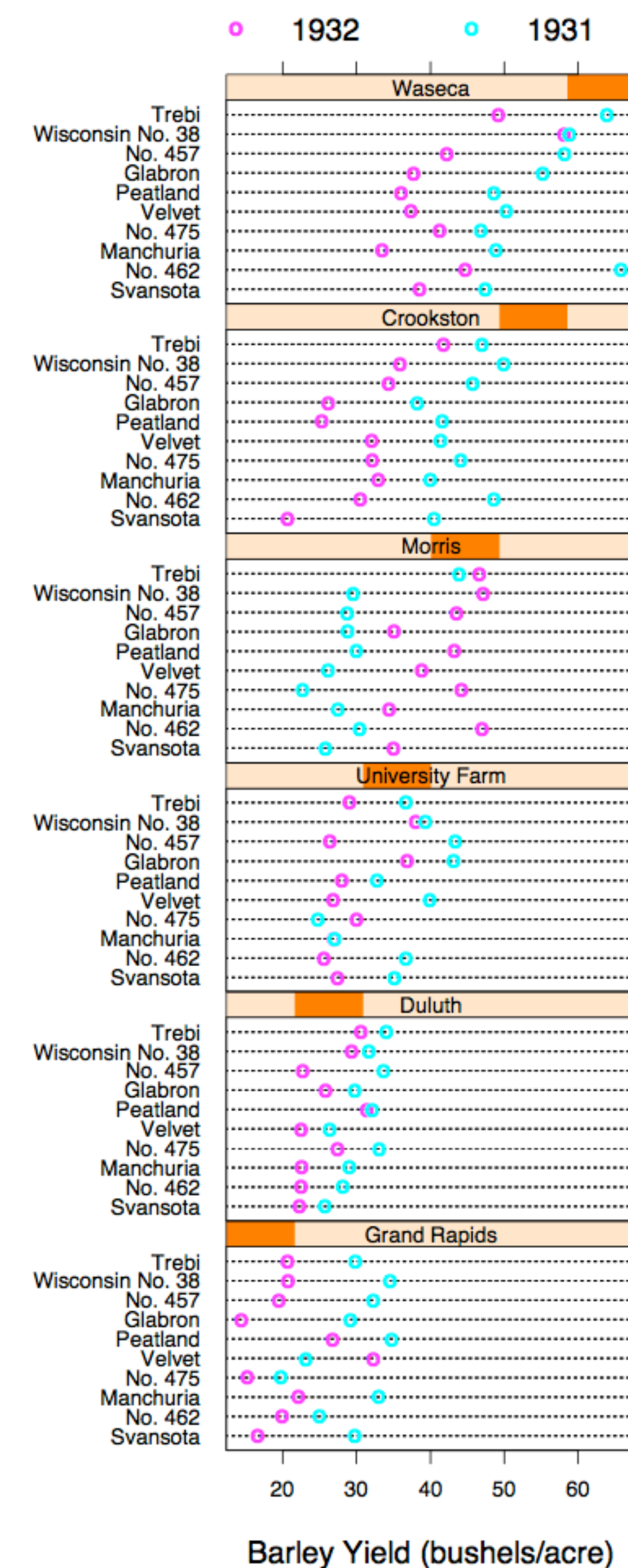
combining multiple views on top of one another to form a composite view

**rational**

supports a larger, more detailed view than using multiple views

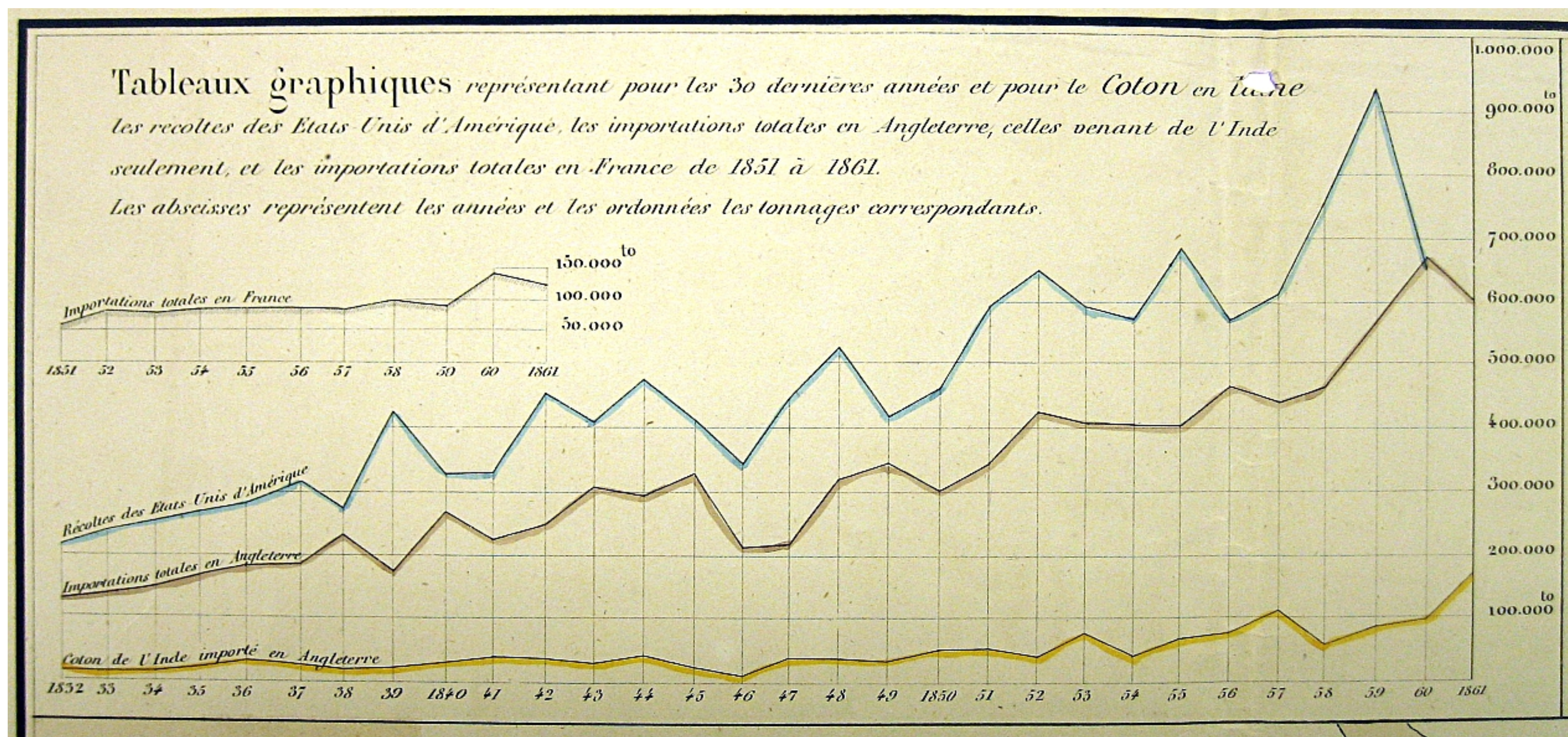
**trade-off**

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



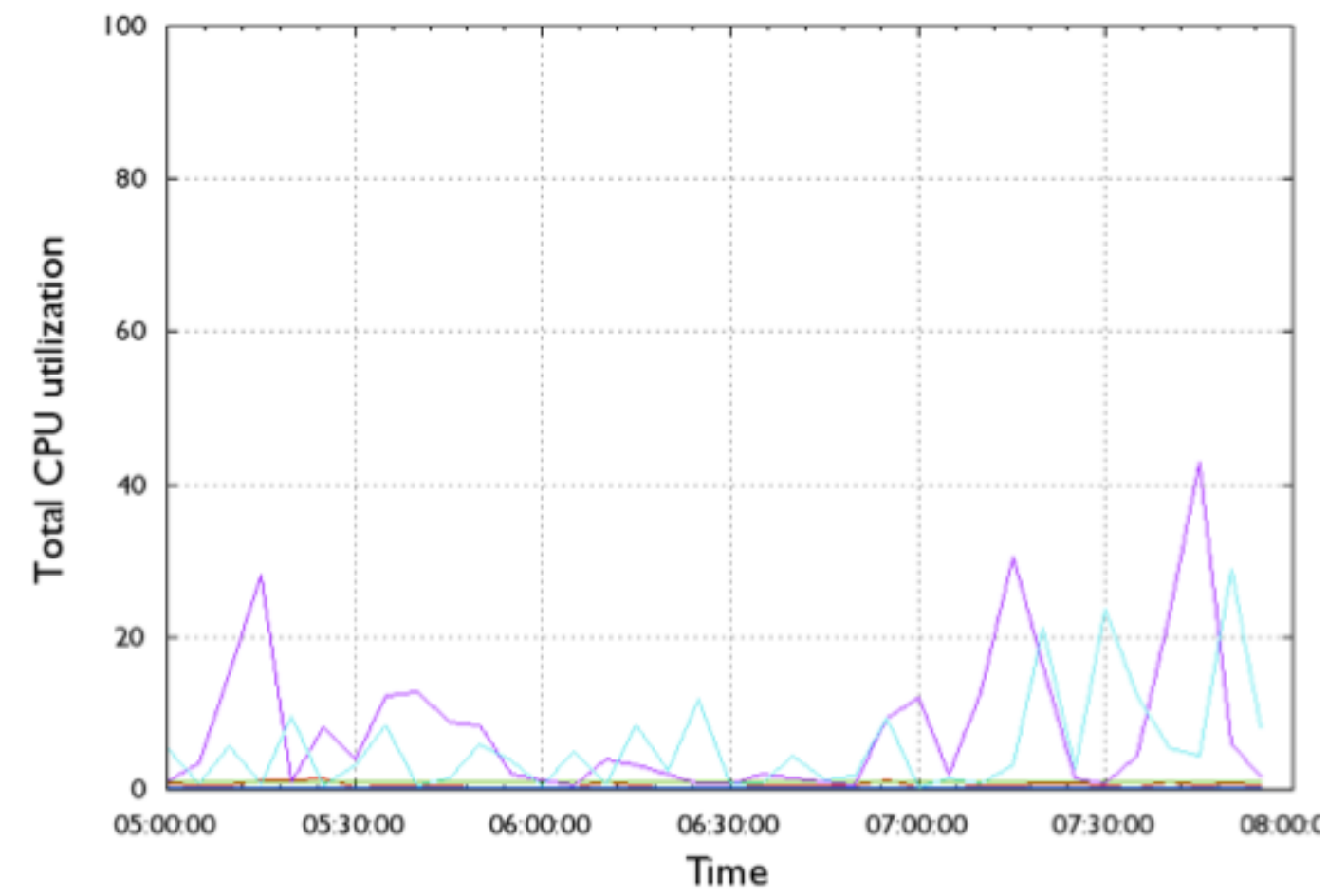
# JOSEPH MINARD

1781-1870

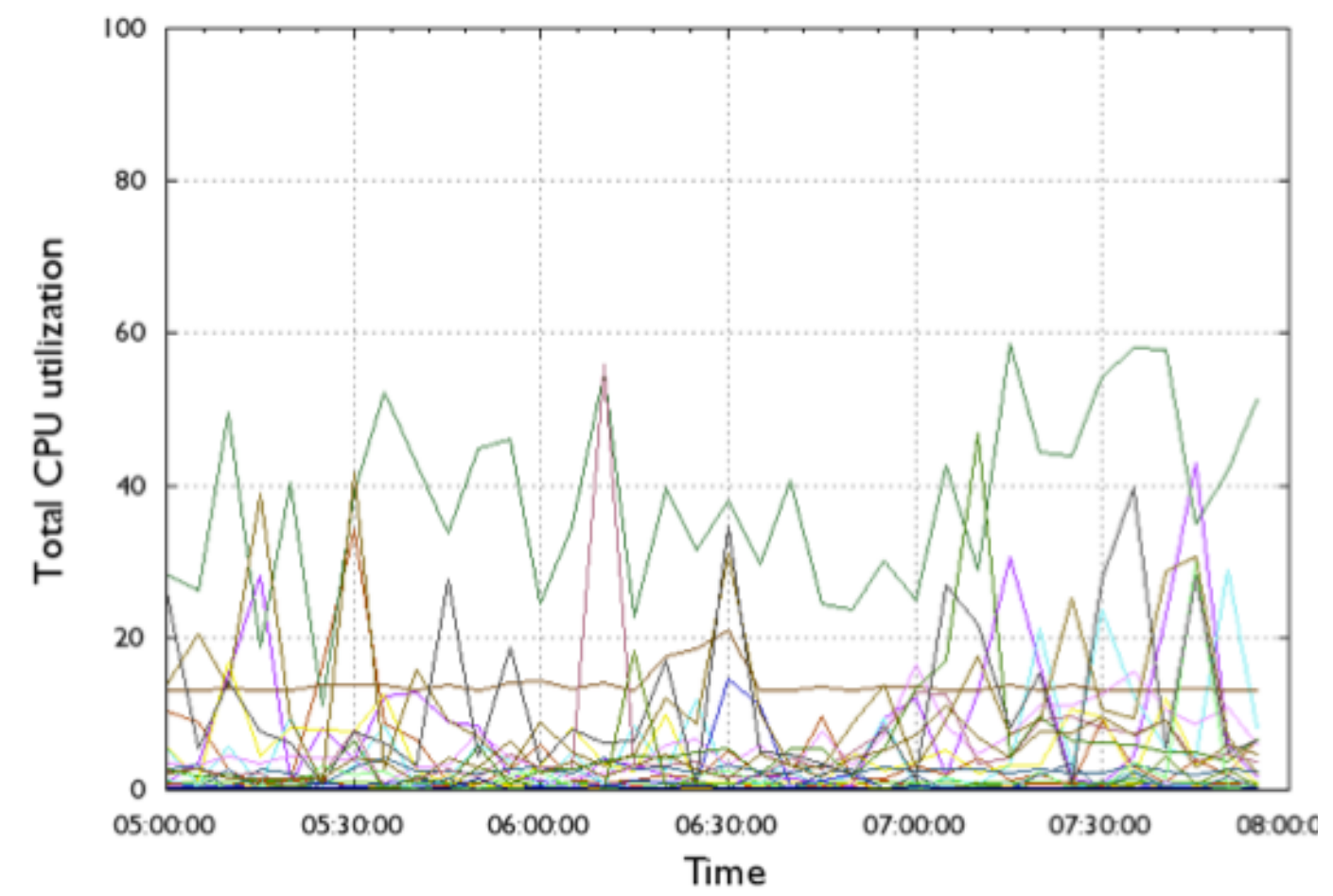


# overlays

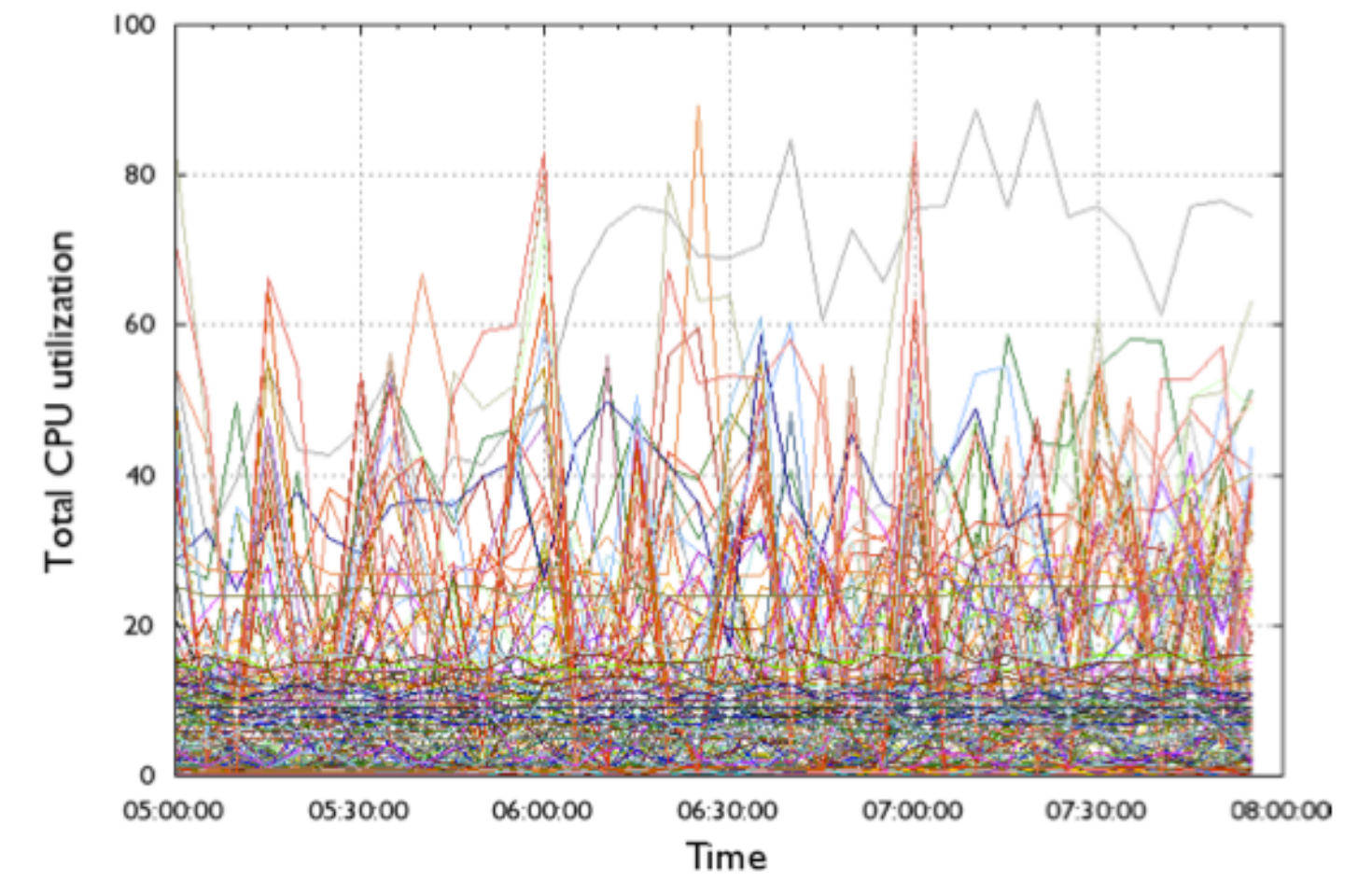
CPU utilization over time



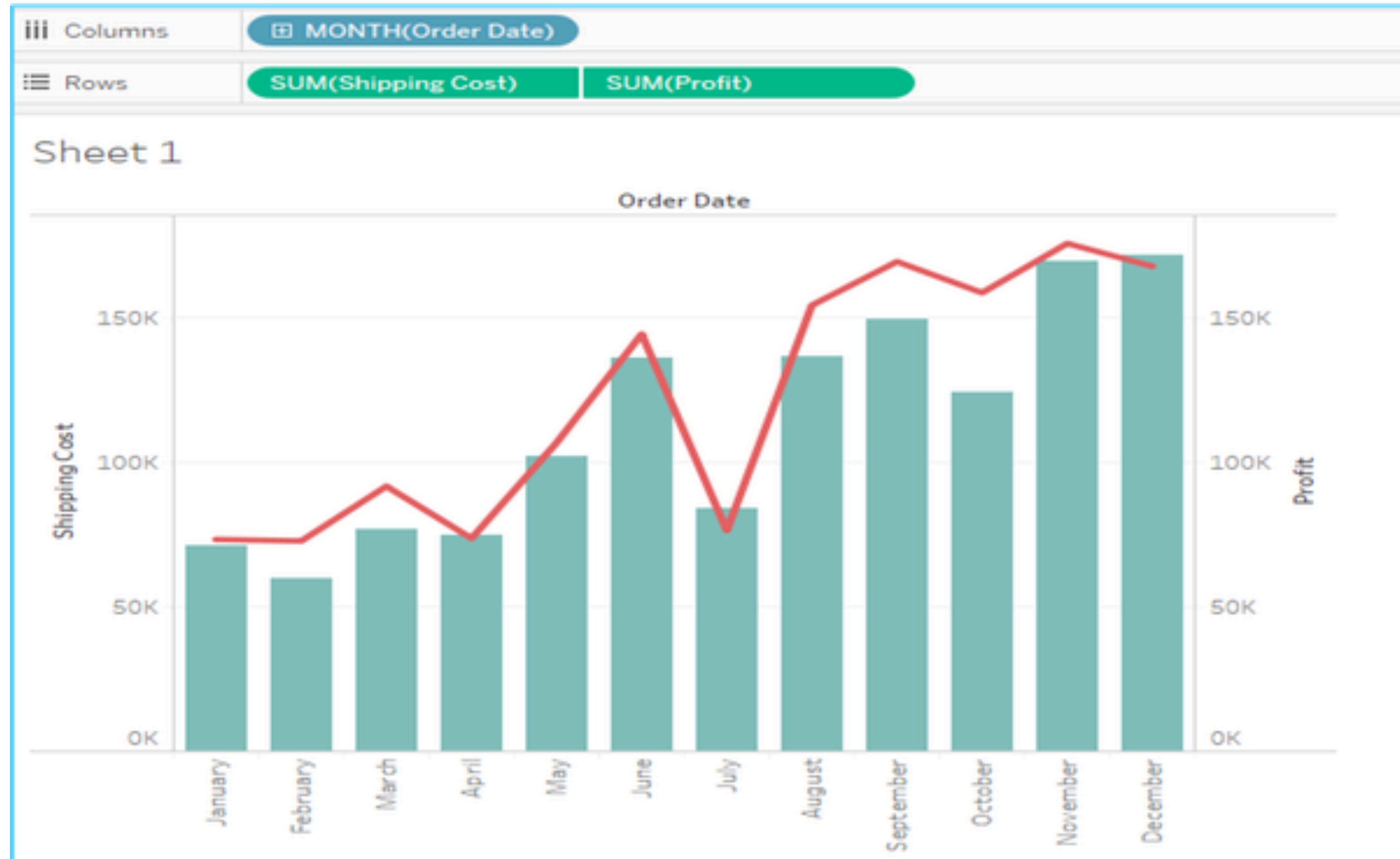
CPU utilization over time



CPU utilization over time



# Dual Axis



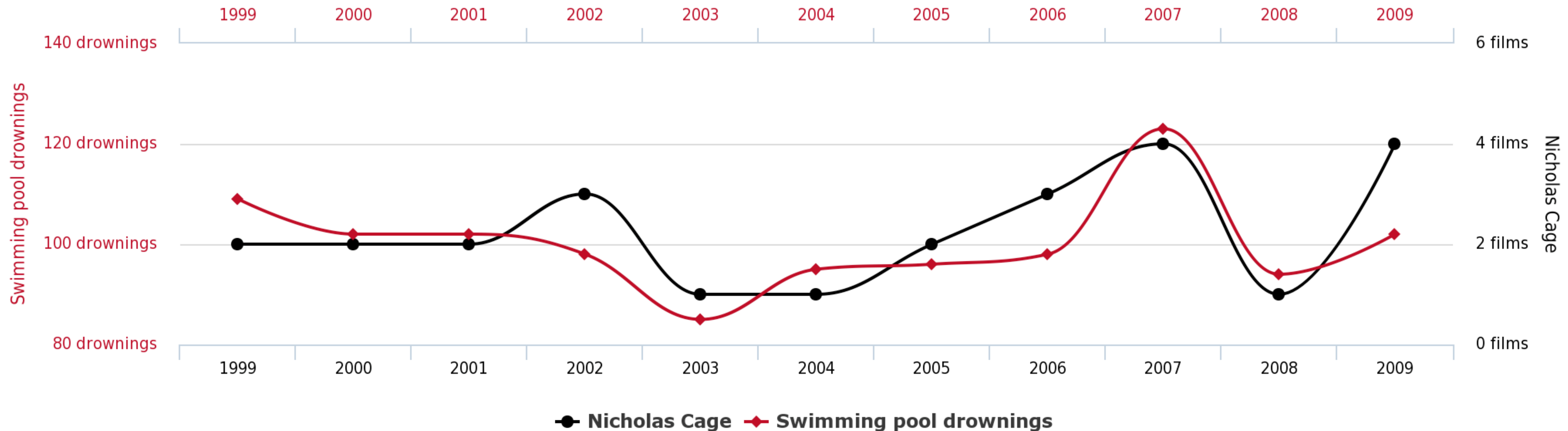


# Dual Axis (don't)

**Number of people who drowned by falling into a pool**

correlates with

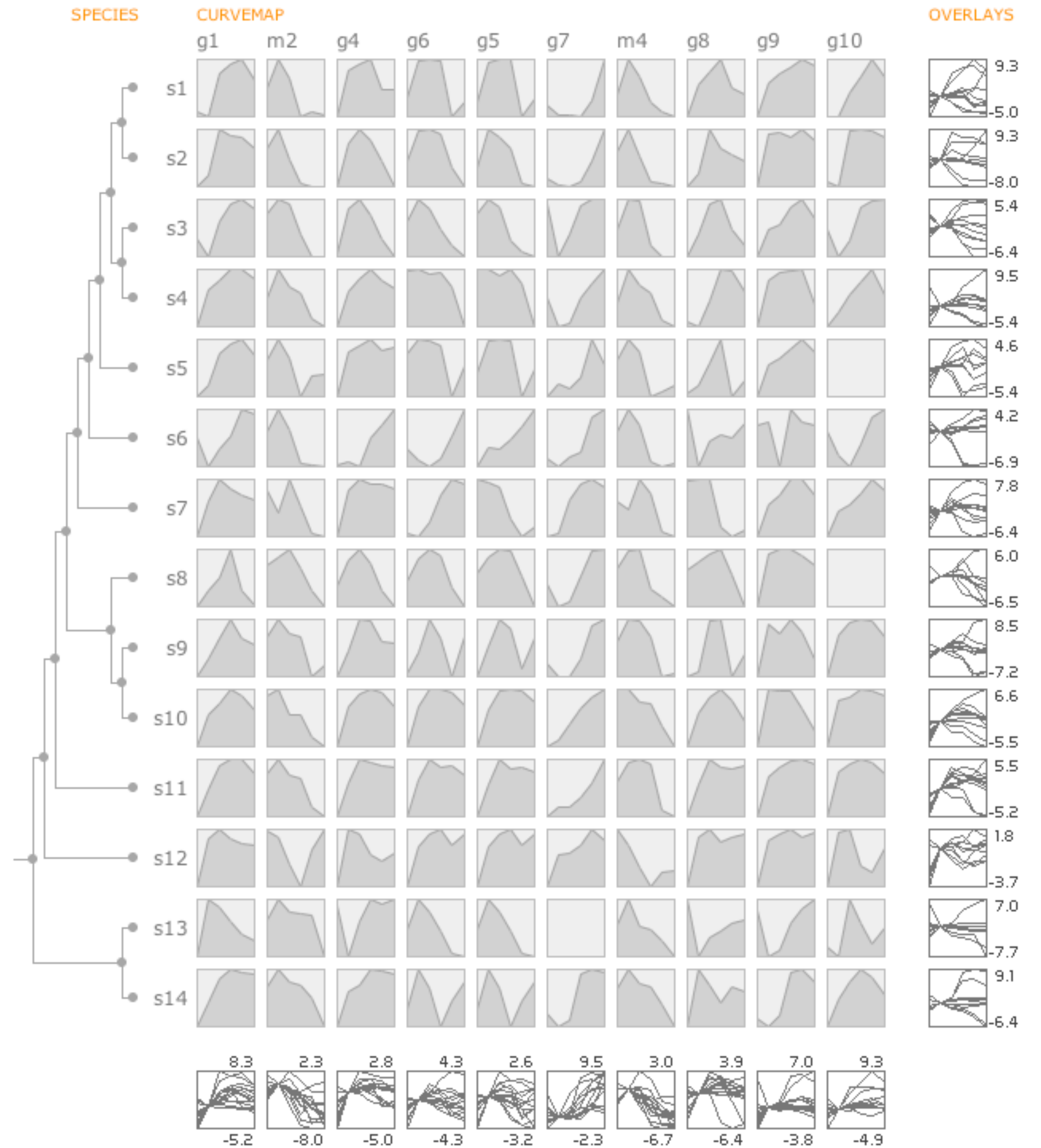
**Films Nicolas Cage appeared in**



# Combined

Partitioned + layered graph

Synchronized through highlighting



# MCV to the Max

